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EFFECT OF COMPUTER ASSISTED INSTRUCTION (CAI) ON SENIOR HIGH SCHOOL STUDENTS' ACHIEVEMENT AT PIE CHART AND HISTOGRAM IN CORE MATHEMATICS

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ABSTRACT: *The study was designed to see the effect of CAI as a strategy on the academic achievement of senior high school (SHS) students in the subject area of mathematics. The sampled classes were assigned to two groups on the basis of their achievement scores in the pre-test. Two different treatments were applied during the study. The experimental group received instruction via CAI with the researcher as a facilitator while the control group was taught by the researcher using the conventional approach. Both groups took an achievement test just after the treatment was over to determine the treatment effect. Analysis of data revealed that both the CAI and the traditional approach have led to increase in students' performance in the teaching and learning of Pie Chart and Histogram in Core Mathematics but the CAI approach has led to much gain in terms of students' achievement than the traditional approach in the teaching and learning of Pie Chart and Histogram in Core Mathematics. It was concluded that the CAI was equally effective for the students in the experimental group because it helped students to develop Mathematical concepts adequately with limited teacher guidance.*

KEYWORDS: Computer Assisted Instruction (CAI), Experimental Group, Control Group, Traditional Method.

INTRODUCTION

Economic and social forces have always influenced educational practice. The most important jobs in a modern economy are based on technical education and information technology, jobs for which the vast majority of the current work force and new school graduates are unprepared. Thurow (1992) described the new global economy as being telecommunications-computer-transportation-logistics revolutions that permits global sourcing and a world capital market.

Schools are being prodded to embrace technology for school improvement. At the broadest level, Toffler (1991) explained that in a knowledge-based economy, the most important domestic political issue is no longer the distribution (or redistribution) of wealth, but of the information and media that produce wealth. This is a change so revolutionary that cannot be mapped by conventional political cartography. According to Toffler (1991):

> No nation can operate a 21st century economy without a 21st century electronic infrastructure, embracing computers, data communications, and the other new media. This requires a population as familiar with this informational infrastructure as it is with cars, roads, highways, trains and the transportation infrastructure of the smokestack period. Yet

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our pupils are unfamiliar with the "informational infrastructure" (p. 368-369).

However, most of our children ever touched a computer at school, and if they did, it was for some purpose other than mastering the device or using it as a resource. There is a serious gap between new job requirements and the ability to perform them. Meanwhile, jobs of the information age require increasing literacy and technical competence and also the abilities to learn, to work independently, and to work cooperatively. Wagner (1982) has indicated that interest in media systems (including computers and satellites) is likely to continue in education for the foreseeable future, because developments will provide a new scope for media use and because costs will decrease. But education is labour-intensive, clearly indicated by the school budget in which three-fourths of the funds are of teachers' salaries and benefits. Switching to a capital-intensive system, where technology replaces personnel, may be more appealing in education if there can be a reduction in overall real costs and if productivity (as measured in terms of achievement of graduates) remains the same or increases. Therefore, the school administrator must be aware of the variety of existing and emerging technologies, the types of applications, and the costs and efficacy of various uses.

Marsh (1993) observed that as long as teachers are trained in traditional college programmes and receive their professional internships in traditional school settings, the use of technology in the classroom will probably not make much difference in teaching and learning. However, if computers are to be effectively used in classroom instruction, each teacher will have to be trained on how to use technology and will have to accept a different role as "learning facilitator". Iqbal, (1999) identified that Computer Assisted Instruction (CAI), proved an efficient and effective media in education. Computer-Assisted Instruction (CAI) is based on the principles of programmed instruction. The major aim of the programmed instruction is to provide individualized instruction to meet special needs of individual learners.

According to Farooq (1997), during CAI, it is rather a device which provides students with interactive involvement with instructional materials. Therefore, the students might be given various degrees of control over their own learning, instruction could be tailored according to individual student's needs and Feedback on student performance could be stored for further reference. Pedagogic experience has shown that the didactic functions of the computer are by no means limited to simple presentation of information, enabling students to acquire and understand a body of knowledge.

Crowl et al. (1997), Robbyer et al. (1988) and Lepper and Gurtner (1989) revealed that when used in addition to regular instruction, CAI improves academic achievement besides influencing students' attitudes and motivation. Kankaanranta (2005) identified that active participation in the information society presumes novel knowledge, skills, and work approaches from children and teachers alike. CAI approach refers to the use of computer to give course content instruction in the form of drill and practice, tutorials and simulations. CAI learning also uses a combination of text, graphics, sound and video in the leaning process. It is an interactive instructional technique whereby a computer is used to present the instructional material and monitor the learning that takes place. CAI allows the students to direct their own progress

Pelgrum and Polmp (2004) considered western economies could be characterized as 'knowledge' because cognitive activities have been taken over by computers and other ICT applications making ICT part and parcel of the citizenry of the advanced countries. Ghana, like most of the developing countries, cannot afford to be left behind in this era of "educational

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technology". Therefore, the Government of Ghana placed a strong emphasis on the role of ICT in contributing to the country's economic development. Besides, the Government of Ghana in collaboration with other stakeholders of education has targeted a large share of their budgets to making computers more available in schools (Mangesi, 2007). As part of the collaboration, the Government of Ghana with the help of the Government of India has established the Kofi Annan Centre of excellence in Information Technology. This centre seeks to promote education and usage of ICT in line with the country's developmental agenda.

The Curriculum Research and Development Division, CRDD (2007b) also acknowledged the importance of ICT in our modern world and believes that it is imperative for every young person to be competent in the use of ICT. , therefore, the teaching and learning of ICT has been enshrined in the education system. Thus, the teaching and learning of ICT will start from the basic level. In order to make this idea effective, ICT teaching syllabuses have been designed for pre- tertiary levels of our educational system.

The government of Ghana has invested huge sums of money in procurements of computers and establishment of computer labs in most Colleges of Educations. The new curriculum in Mathematics encourages teachers to make use of the calculator and the computer to help students acquire the habit of analytical thinking and the capacity to apply knowledge in solving practical problems (Ministry of Education, Youth and Sports (MOEYS, 2007) but it is still unclear whether these computers are being used effectively by teachers in their instruction.

This study was designed to see the relative effectiveness of computer-assisted instruction as a strategy on the academic achievement of senior high school (SHS) students in the subject of mathematics.

Available statistics from the West African Examination Council (WAEC) in Core Mathematics performance revealed that performance is not encouraging looking at the following percentages of candidates who failed the paper; 51.8%, 41.4%, 51.3%, 50.2%, 46.3%, 25.8%, and 39.3% for the years 1999, 2000, 2001, 2002, 2003, 2004, and 2005 respectively (Anamuah-Mensah, 2007). The persistent poor performance of students in Core Mathematics paper calls for concern since a pass in the discipline is a basic requirement for any student who would want to progress from the secondary level to post-secondary or tertiary levels. A major factor could be that, the approach to teaching has fallen short of achieving its desirable objectives as far as students' achievement is concerned. Studies have revealed that the method of teaching has a great influence on performance. Mucherah (2008) noted that poor teaching methods employed by teachers in teaching also influence students' achievement.

It is assumed (in many policy documents, amongst others European Commission, 1995; ERT, 1997; Panel on Educational Technology/PCACT/PET, 1997) that a shift from teacher-controlled towards more student-controlled arrangements of the learning process can be facilitated by ICT. Until now the potentials of ICT have hardly been utilised in education (Pelgrum & Plomp, 2004). In Ghana, the traditional method of teaching is used during Mathematics instruction. The CAI approach is not being practised. It is therefore necessary, to find out how the CAI approach could compare to the traditional teaching method with regard students' achievement in Mathematics hence, the need for this current research studies.

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Purpose of the Study

The purpose of the study was to find out the relative effects of computer-assisted instruction as a strategy on the academic achievement of (SHS) students in core mathematics. The study sought to find out whether computer- assisted instruction can be used to enhance the academic achievement of students in Core Mathematics at the Senior High School. In addition, the researcher investigated the effectiveness of CAI to the students.

Research Question

1. How effective is the CAI as a strategy to the student?
2. Does CAI as a strategy help improve students' achievement in Core Mathematics?

Null hypothesis

1. There is no significant difference between the mean scores of the students taught mathematics with CAI as a strategy and those taught without CAI.
2. There is no significant difference in the achievement of students in the pre-test and the post-test.

LITERATURE REVIEW

Nature of Computer-Assisted Instruction

According to Fourie (1999), CAI is an interactive instructional technique whereby a computer is used to present the instructional material and monitor the learning that takes place. It is also known as computer-assisted learning (CAL), computer-based education (CBE) and computer-based training (CBT). CBT allows the students to direct their own progress. CAI learning uses a combination of text, graphics, sound and video in the leaning process. It is especially useful in distance learning situations. The explosion of the internet as well as the demand for distance learning has generated great interest and expansion of computer-assisted instruction.

According to Sharp (1996), CAI programs use tutorials, drill and practice, simulation, and problem solving approaches to present topics, and they test the student's understanding. These programs let students progress at their own pace, assisting them in learning the material. Chambers & Sprecher (1983) identified two major types of CAI are identified as adjunct (first used by Kearsley, 1982) and primary. Adjunct CAI encompasses materials that supplement or enrich the learning situation. For example: short (half-to one-hour) CAI programs that support or illustrate concepts discussed in the regular classroom. Primary CAI materials, conversely, provide instruction of substitute or stand-alone variety and are usually of longer duration. Dewald, (1999) identified that Web-based instruction also provided opportunities for interactivity to make lesson meaningful for the student.

Characteristics of Computer-Assisted Instruction

The unique 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 brought about. The computer is able to record and store all the responses of all the students. It

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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 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, Panneerselvam & Santhanam, 1990). 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. When he has finished, the computer assigns him or her to the next program, records his progress and prints out a report for his teacher (Sampath et al, 1990). The students' information may be re-analyzed and much of the teaching strategies, which were not effective, may be rejected and strategies which have succeeded may be continued (Sampath et al, 1990).

Computer-assisted instruction is, therefore, not merely a sophisticated type of programmed instruction but it is also uses electronic data processing, data communication, concepts of audio-visual and media theory, communication theory, systems theory and learning theory. In contrast to CAI, computer-managed instruction (CMI) analyses the relationship between various factors pertaining to a pupil and suggests activities appropriate to individual students. This includes PLAN (Program for Learning in Accordance with Needs) and IPI (Individually Presented Instruction). In general, students learn well with CAI in considerably less time (Sampath et al, 1990). Web-based instruction is also unique in that student 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 (Moursund, 1998).

Drill and Practice

In CAI, the student sits at a specially designed electric typewriter, which is connected to a computer by telephonic lines. They identify themselves by a code number and their names. 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 program, the student's might be referred to a branching type of remedial exercise. The typical drill and practice program design includes the following four steps:

1) The computer screen presents the student with questions to respond to or problems to solve;
2) The student responds;
3) The computer informs the student whether the answer is correct; and
4) If the student is right, he or she is given another problem to solve, but if the student responds with a wrong answer, he or she is corrected by the computer (Sharp, 1996).

Tutorials

In tutorials, the subject-matter is literally by the computer program. Explanations are given orally through audio-tape and needed visual presented in cathode ray tube as in television. The student responds on a typewriter keyboard or by pointing on the screen with a light pen. The computer reacts to student's response by 'talking' to him or her. The student makes further response. A kind of dialogue takes place between the student and the machine. 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

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feedback on each response. Each tutorial lesson has a series of frames that pose a question. 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 pupil's responses to the questions determine whether the computer will review the previous material or skip to more advanced work (Sharp, 1996).

CAI and Programmed Instruction

Computer-assisted instruction is not to exclude the teacher from the classroom. 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. The possibilities of the effective use of **CAI** in the educational scene are enormous (Sampath et al. 1990).

The popularity of programmed instruction (PI) reached its zenith in the mid 1960's but declined steadily through the 1970's. Programmed instruction represents a model of how instruction should occur. Nowhere is this model more consistently applied than in computer-assisted instruction. 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. An enormous amount of learner-centered software is available in almost every subject area (Helfer, 1999).

The use of computers in the teaching-learning process

The influence and impact of technology in our society has in no small way affected the educational system. The rapid development of technology (Kankaanranta, 2005) has challenged also learning environment to adopt ICT to support teaching and learning and in guiding children to become its diversified users.' Moreover Voogt and Van der Akker (2001) noted that it is generally accepted that the increasing impact of ICT on our society is also influencing teaching and learning. Thus, technology has found its way into the teaching and learning process. When the computer is used in the computer- assisted instruction mode, Ornstein and Levine (1993) believed that it emphasizes tutoring and /or practice and drill programs and is appropriate when subject matter needs to be mastered for practice of basic skills before advancing to higher levels of learning. The computer controls the instruction and tests the students. It goes further to diagnose student's problems among other things.

According to Ornstein and Levine (1993) the third role of the computer in education is termed computer- managed instruction. They define this usage as the system control and organization of instruction, characterized by testing, diagnostic data, learning prescriptions and thorough record keeping. Students and teachers alike are always using the internet for search for information for assignments and research. Voogt and Van der Akker (2001) believe that teacher using the internet can guide their students from remote locations creating new possibilities for distance education. Moreover, students and teachers can exchange messages among themselves through the internet. Thus the use of the computer through the internet has become formalized in the everyday practice of teaching and learning.

Cognitive Theories 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

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the computer as a model of the brain and employ much of the terminology and concepts of information processing.

Cognitive learning theories are most applicable to the CAI design and development of tutorials. This approach has been pioneered most actively by Robert M. Gagne, a former follower of Skinner and the behaviourist model. Gagne has emphasized the importance of identifying the goals of the learning task followed by the development of specific instructional objectives to meet these goals. In regard to the role of teacher or adviser in CAI, Gagne suggested that students be provided with a little help at a time, thus permitting the student to use as much as he needs. Another point raised by Gagne is in defence of drill and practice. He indicated his belief that drill and practice, if viewed as part of cognitive learning theory, simply speeds up the learning process, that it makes learning more efficient by making lower-level skills (such as the basic mathematics) automatic (Gagne, 1982).

Researches in CAI

Computer-assisted instruction (CAI) refers to applications specifically designed to teach a variety of subject areas to children and adults. In CAI, students receive feedback from the computer, which controls the sequencing of the subject matter (Freedman, 1991). Many studies concluded that using CAI to supplement traditional instruction is better than the instructional program itself. Goode (1988) found that students who used CAI scored significantly higher in mathematical concepts and computation than a control group of students who used the traditional approach. Also, Harrison (1993) found that students who received computer instruction showed greater increases in their achievement scores in multiplication and subtraction than students who received traditional mathematical instruction.

Tsai and Pohl (1977) studied the effectiveness of the lecture approach and CAI on college students learning how to use the program. They found a significant difference when achievement was measured by quizzes or final examination scores. Linn (1986) conducted an experiment in which he used computers as lab partners for a semester. The students learned to use the computer to collect and display data and saved and printed out their reports. It was found that the students instructed in the micro-based lab outperformed students who took the standardized test on scientific knowledge. In addition, these computer-taught students demonstrated a very positive attitude toward experimentation.

Moore, Smith and Auner (1980), Summerville (1984) and Fortner, Schar and Mayer (1986) found higher student achievement with computer simulations when students had to interpret the results of the experiments to make decisions. According to Thomas and Hooper (1991), the results of the science simulation studies showed no significant difference between students who use the traditional method and students who use the computer.

Tsai and Pohl (1977) used CAI for two groups of students studying introductory statistics received instruction for a two-week segment of the course in one of the following methods: (1) lecture/discussion (regular classroom); (2) programmed instruction (i.e. students were told to read materials in a programmed textbook); (3) CAI tutorials; (4) programmed instruction with periodic discussion sessions with faculty; and (5) CAI tutorials with periodic discussions with faculty. The results of the achievement tests at the close of the initial two-week period clearly favoured the CAI tutorials supplemented by the faculty sessions. Also, Aberson, Berger, Healy, and Romero (2002) used CAI for students (n = 84) enrolled in introductory and intermediate statistics courses. Students overwhelmingly rated the tutorial as clear, useful, and

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easy to use. The students who used the tutorial outperformed those who did not on a final examination.

Anderson-Cook, Dorai-Raj and Sundar (2003) found in their study on the use of applets in statistics courses that students in introductory statistics classes react very positively to the applets, both in terms of enjoying being able to experiment with them as well as being better able to discuss the concepts relating to statistical power. Cotton (2001) conducted a study and used drill-and-practice, tutorial, or simulation activities in CAI to supplement traditional teacher directed instruction. During the study, students often work independently or in pairs at computers around to do series of interrelated activities and instruction to address a variety of learning styles. Funkhouser (1993) and Rochowicz (1996) found that students of mathematics courses were more motivated, self-confident, joyful and the subject became more meaningful with CAI.

Szabo's (2001) study the effectiveness of CAI where the effectiveness was measured through heightened affective responses, or better attitudes, reduced learning time, higher course completion rates. It was found that CAI was more effective than traditional classroom instruction.

METHODOLOGY

Research Design

The main design that was used in this study is the experimental design. The type of experimental design used was the quasi- experimental design since the subjects were not be assigned randomly to the experimental and control groups (Creswell, 1994). It is a design used for comparing the achievements of two groups in the pre-test and post-test and also to determine how effective a treatment was. The specific type of quasi- experimental design used was the non-equivalent (pre-test and post-test) control group design. The pre-test- post-test designs were used to evaluate the effects of some changes in the environment on subsequent performance hence can be employed to find out the effect of changes in an educational environment (Bordens & Abbot, 2002).

The design can be depicted in the visual mode as:

Experimental group N O_1 X+ O_2

Control group N O_1 X- O_2

Where:

N = Non-equivalent

O_1 = Pre-test measure

O_2 = Post-test measure

X+ = CAI approach.

X- = Traditional teaching approach.

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It is a design used most often in educational research where random assignment of subjects in a school or classroom is impracticable (Cohen & Manion, 1994). In a typical school situation, schedules cannot be disrupted nor classes reorganized in order to accommodate the researcher's study and in such a case it is necessary to use groups that are already organized into classes or intact groups (Ary, Jacobs & Razavieh, 1990). The main weakness of this design is that it is inferior to randomized experiments in terms of internal validity (Trochim, 2000). This study was affected by this weakness since extraneous variables such as age, ability, maturation and previous learning experiences were difficult to control.

Another weakness of the design which is also a threat to internal validity is the interaction between the control and experimental groups especially when both groups are in the same school. However, this weakness was minimized in the study since both groups were in different schools which are at least 5km apart. Quantitative data were used in the study. Scores of students from the achievement test for both pre-test and post-test constituted the quantitative data.

Population

The population of the study comprised all SHS students and their teachers in the Cape Coast Metropolis. The target population was 'form 2' students in these schools. Form 2 students were used because they had been in the school for a year and by then had covered some topics in Core Mathematics. Also, Statistics was taught in 'form 2'. The accessible population was six hundred (600) form 2 students, five Mathematics and three ICT teachers in two schools in the Metropolis with state-of-the-art facilities and well furbished ICT laboratories.

Sample and Sampling Procedure

The sample was all students in the selected classes of School A and School B including their Mathematics and ICT teachers. Non-equivalent (pre-test- post-test) control groups design was used to collect quantitative data on the effect of computer-assisted-instruction on the academic achievement of second year Mathematics students in School A and School B in the Cape Coast Metropolis. The second year students of these schools formed the targeted population of the study. These schools were selected purposively because they have well equipped computer laboratories and at least two 'form 2' classes. A class was selected at random from each of the school by the use of random number table. The researcher administered pre-test to both classes and the results compared. The class with the lower mean became the experimental group in order to establish the effect of the intervention. However in the selection of the subjects, cluster sampling was used because an entire group of individuals (classroom) was used (Creswell, 1994).

The academic achievement of students was the dependent variable whilst the teaching strategies (Conventional approach, and CAI were the independent variables). The main treatment used was the computer- assisted instruction (CAI). The experimental group was taught using the CAI with the teacher (researcher) as a facilitator while the control group was taught by the researcher using only the conventional way of teaching. The students were assessed before the study (pre-test) to determine their entering characteristics and after the study they were assessed again (post-test) to find out if there was any change in behaviour. Mathematical software was developed by an expert in computer programming that was used in the CAI. Two topics in Statistics (Pie Chart and Histogram) which was treated were transformed into multi-media formats by an expert to be used by the experimental group.

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Instrument

The principal instruments for this study was be pre-test and post-test (test items) constructed by the researcher with the help of the doctoral committee to ensure content validity. The lesson notes taught was also transformed into a multi-media format by an expert in computer programming for the experimental group to ensure content validity and item relevance. The post-test was based on the topics(s) that was taught during the experiment. For the reliability of the tests, the Kuder-Richardson 20 (K-R 20) was used.

Pilot Testing

After the Mathematics Achievement Test items on Pie Chart and Histogram were modified based on expert advice, it was field tested. The test was administered to students in one of the senior secondary schools in the Cape Coast Metropolis to determine its reliability. This school was part of the target population but did not take part in the main study. Forty (40) form three students took part in the test and it took them approximately one hour to complete. Both the question papers and the answer sheets were collected from the students just after the test. Students' total scores for the items ranged from 0 to 30. The reliability of the test was calculated using the KR-20 formula and found to be 0.68. Item analysis was conducted to fine tune the instrument.

Data Collection Procedure

A pre-test was conducted after permission was granted. Two different treatment patterns were applied during the experiment. The control group was taught using only the conventional approach by the researcher. The experimental group was taught using CAI with the teacher (researcher) as a facilitator.

Data Analysis

The experimental and the control groups' mean scores from the pre-test was analyzed using the t-test for independent samples. The t-test was more effective since it evaluated the difference between the mean scores of the groups. One-way univariate analysis of co-variance was used to find out whether the treatments had an effect on students' academic achievement. Box-and-whisker plot was also used to compare the performance of the two groups of students on the pre-test and the post-test. The t-test for dependent samples was used to analyze the pre-test and the post-test scores of the experimental and the control groups to determine whether the groups achieved better on the post-test with respect to their pre-test scores. Frequencies and percentages were also employed to analyze the pre-test and the post-test scores of the two groups of students.

RESULTS AND DISCUSSIONS

Research question 1: Research question one sought to find out whether the CAI is an effective teaching strategy for students at the senior high school form two (SHS 2) students in the learning of pie chart and histogram. The null hypothesis formulated and tested based on the research question is stated below:

H_o: There is no significant difference between the mean scores of the students taught mathematics with CAI as a strategy and those taught without CAI.

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H1: There is significant difference between the mean scores of the students taught mathematics with CAI as a strategy and those taught without CAI.

As shown in Table 1, 8(15.1%) students had a score of 18, 6(11.3%) students had a score of 22, and 5(9.4%) students had a score of 17 and 20 respectively. One (1.9%) student had a score of 26, 2(3.8%) students each had a score of 23, 24, and 25 respectively. However, 1(1.9%) student had a score of 9, 2(3.8%) students had a score of 11 and 12 respectively and 4(7.5%) students had a score of 14. This gave a mean of 18.36.

Table 1: Frequency Distribution Table of Pre-test Scores for Control Group

Score (30)	Frequency	Percentages (%)
9	1	1.9
11	2	3.8
12	2	3.8
14	4	7.5
15	3	5.7
16	4	7.5
17	5	9.4
18	8	15.1
19	2	3.8
20	5	9.4
21	4	7.5
22	6	11.3
23	2	3.8
24	2	3.8
25	2	3.8
26	1	1.9
Total	53	100

Mean = 18.3

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As shown in Table 2, 9(15.5%) students had a score of 19, 7(12.1%) students had a score of 15, and 5(8.6%) students had a score of 14, 17 and 23 respectively. One (1.7%) student each had a score of 21 and 25. However, 1(1.7%) student had a score of 7, 2(3.4%) students had a score of 9, 10, 11, and 12 respectively and 4(6.9%) students had a score of 13. This gave a mean of 16.64.

Table 2: Frequency Distribution Table of Pre-test Scores for Experimental Group

Score (30)	Frequency	Percentages (%)
7	1	1.7
9	2	3.4
10	2	3.4
11	2	3.4
12	2	3.4
13	4	6.9
14	5	8.6
15	7	12.1
16	2	3.4
17	5	8.6
18	3	5.2
19	9	15.5
20	5	8.6
21	1	1.7
22	2	3.4
23	5	8.6
25	1	1.7
Total	58	100

Mean = 16.64

As shown in Table 3, 11(19.6%) students had a score of 27, 7(12.1%) students had a score of 23 and 24 respectively. Six (10.3%) students had a score of 25 and 29 respectively. However, 1(1.7%) student each had a score of 15, 18, and20 and 3(5.2%) students had a score of 30. This gave a mean of 25.34.

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Table 3: Frequency Distribution Table of Post-test Scores for Experimental Group

Score (30)	Frequency	Percentages (%)
15	1	1.7
18	1	1.7
20	1	1.7
21	3	5.2
22	2	3.4
23	7	12.1
24	7	12.1
25	6	10.3
26	5	8.6
27	11	19.6
28	5	8.6
29	6	10.3
30	3	5.2
Total	58	100

Mean = 25.34

As shown in Table 4, 11(20.8%) students had a score of 26, 10(18.9%) students had a score of 27, and 5(9.4%) students had a score of 24 and 29 respectively. However, 1(1.9%) student each had a score of 15, 20, 21, and 22 respectively, 4(3.8%) students had a score of 14 and 7(13.2%) students had a score of 30. This gave a mean of 26.47.

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Table 4: Frequency Distribution Table of Post-test Scores for Control Group

Score (30)	Frequency	Percentages (%)
14	4	7.5
15	1	1.9
20	1	1.9
21	1	1.9
22	1	1.9
23	2	3.8
24	5	9.4
25	2	3.8
26	11	20.8
27	10	18.9
28	3	5.7
29	5	9.4
30	7	13.2
Total	53	100

Mean = 25.34

Preliminary analysis was done by comparing the two groups' scores from the pre-test using t-test for independent samples. As shown in Table 5 there was a statistically significant difference between the mean scores of students in the experimental and control groups before instruction ($t_{(109)} = 2.26$, $p = .026$) with the control group (M =18.36, SD = 3.908) performing better on the pre-test than the experimental group (M = 16.64, SD = 4.132). The results indicate that on the average, students in both groups had different preconceptions and they had started the treatments with different levels of learning.

Table 5: Results of Independent Samples t-test for the Pre-test Scores of Experimental and Control Groups

Groups	N	Mean	Std. Deviation	t- value	p- value
Experimental	58	16.64	4.132	2.25	0.026*
Control	53	18.36	3.908		

*Significant, since $p < 0.05$

ther used to compare the performance of the two groups of students on the pre-test. The graph as in Figure 5 shows that the group labelled as the control group had lower and upper quartile marks which were higher than that of the group labelled the experimental group. Also the median mark for the control group was better than that of the experimental group. This shows that the group that was taken as the control groups did better on the pre-test than the group that received the CAI instruction.

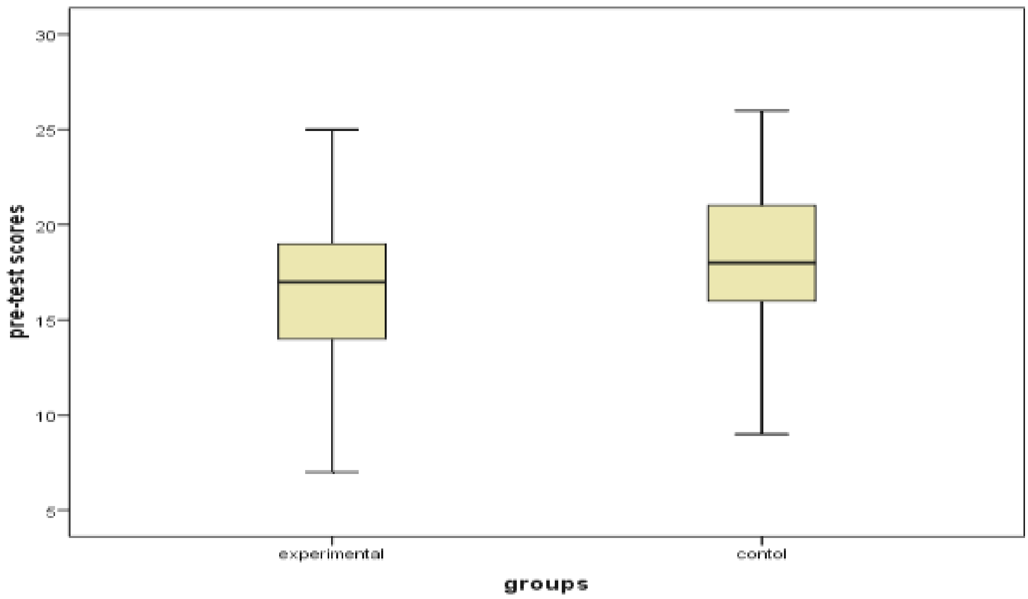

Figure 5: Box-and-Whisker Plot for the pre-test scores

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Box and Whisker plot was again used to compare the performance of the two groups of students on the post-test. The plot as in Figure 6 shows that the group labelled the control group had lower and upper quartile marks which were again higher than that of the group labelled the experimental group. Also the median mark for the control group was better than that of the experimental group. This shows that, as mentioned above, the group that was taken as the control groups still performed better on the post-test than the group that received the CAI instruction.

Most research findings indicate that students taught with CAI perform better than those taught with the traditional method. Example, Linn (1986) found that the students instructed in the micro-based lab outperformed seventeen year olds who took a standardized test on scientific knowledge, in addition, these computer-taught students demonstrated a very positive attitude toward experimentation

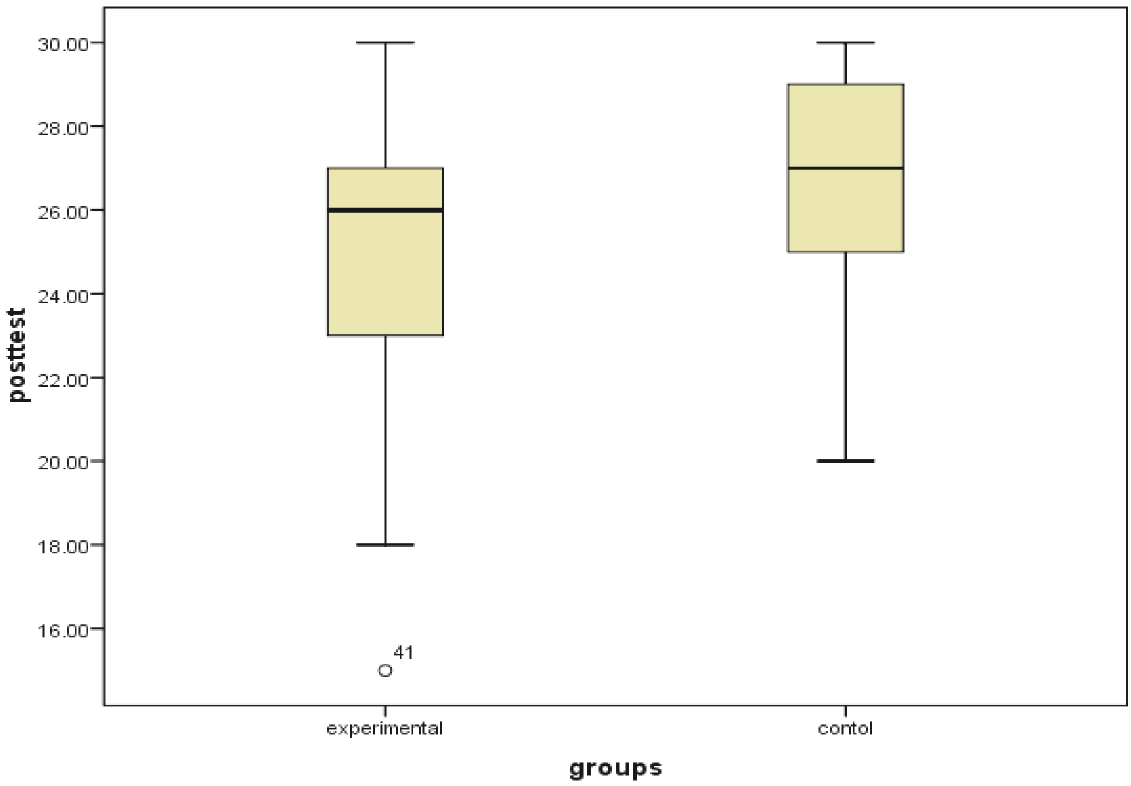

Figure 6: Box-and-Whisker Plot for the post-test scores

Since there was a significant difference between the control group and experimental group in the mean scores of the two groups in the pre-test, if the independent samples t-test was used to

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ascertain the effect of the intervention, the researcher would risk committing a type II error, whereby the existence of a relationship between teaching methods and performance may be unnoticed because the experimental group had to 'catch up' before the effect of the intervention can be established. The researcher was aware of the limitation of the choice of control and experimental groups using the procedure described above and used analysis of covariance (ANCOVA) to investigate the impact of the intervention (Pallant, 2005).

To find out whether the treatment had an effect on the students' achievement, a one-way between-groups Analysis of Covariance (ANCOVA) was conducted to compare the effectiveness of the treatments on the students' achievement because there was significant difference in the mean performance of the two groups on the pre-test.

The Mean scores on the pre-test were used as the covariate in this analysis. Table 7 shows the means, standard deviations and adjusted means of the experimental and the control groups.

Table 6: Descriptive Statistics for the Post-Test Scores

Means	Means	Adjusted Means	Std. Deviation	N
Experimental	25.34	25.51	3.06	58
Control	26.47	26.47	2.48	53

*Significant, since p < 0.05

After adjusting for pre-test mean scores, there was significant difference between the experimental group (CAI approach) and the control group (traditional approach) on post-test mean scores. [$F_{(2, 109)} = 7.121$, $p = 0.001$, partial eta squared= 0.117] as shown in Table 7. There was a relationship between the pre-test and post-test mean scores, as indicated by a partial eta squared value of 0.080. It can be concluded that the interventions had statistically different effect regarding the teaching of pie chart and histogram. Thus the traditional method of teaching the topics on the face of it seemed superior to the CAI method.

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Table 7: Results of One-Way Univariate Analysis of Co-variance

Source	Type III Sum of Squares	Df	Mean squares	F	Sig	Partial Eta Squared
Corrected model	103.397[a]	2	51.698	7.121	.001	.117
Intercept	2770.454	1	2770.454	381.605	.000	.779
Pre-test	68.230	1	68.230	9.398	.003	.080
School	16.469	1	16.469	2.268	.135	.021
Error	784.081	108	7.260			
Total	75249.000	111				
Corrected Total	887.477	110				

Box and Whisker plot was again used to compare the performance of the two groups of students on the post-test. The plot as in Figure 6 shows that the group labelled the control group had lower and upper quartile marks which were again higher than that of the group labelled the experimental group. Also the median mark for the control group was better than that of the experimental group. This shows that, as mentioned above, the group that was taken as the control groups still performed better on the post-test than the group that received the CAI instruction.

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Most research findings indicate that students taught with CAI perform better than those taught with the traditional method. Example, Linn (1986) found that the students instructed in the micro-based lab outperformed seventeen year olds who took a standardized test on scientific knowledge, in addition, these computer-taught students demonstrated a very positive attitude toward experimentation.

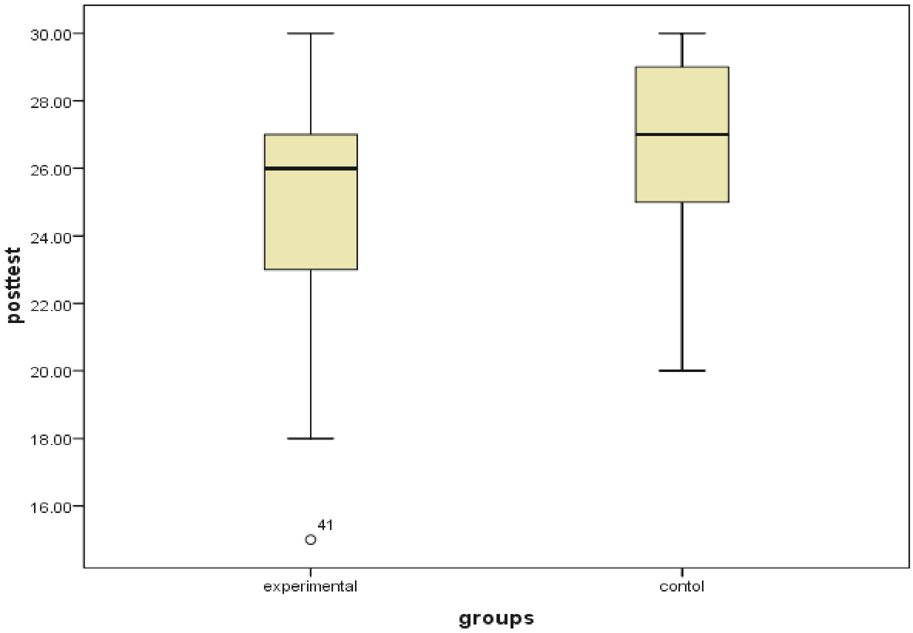

Figure 6: Box-and-Whisker Plot for the post-test scores

Linn's finding is at variance with the finding from this study which shows that the control group which was taught with the traditional method performed better on the post-test than the group taught by the CAI.   Goode (1988) also found that fifth and sixth grade pupils who used CAI scored significantly higher in mathematical concepts and computation than a control group of students who used the traditional approach. Again, there is a sharp contrast between Goode's finding and the finding of this research which indicates that the control group which was taught using the traditional approach performed better on the post-test than the experimental group which received instruction via CAI.

Research Question Two

The second research question was used to find out whether CAI as a strategy helped improve students' achievement in Core Mathematics. The null hypothesis tested is stated below:

H_0: There is no significant difference in the achievement of students in the pre-test and the post-test.

H_1: There is a significant difference in the achievement of students in the pre-test and the post-test.

To find out whether the groups achieved better on the post-test than the pre-test, the dependent samples t-test was used. The results as in Table 9 shows that in both groups there were

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significant differences between their pre-test scores and their post-test scores. That is, in both groups students improved on their performance. However, the score of 8.71 by the experimental, which represents the difference between their post-test and pre-test mean scores as compared to that of 7.02 by the control group, indicated that the experimental group had much gain on the intervention than the control group.

Harrison (1993) found that students who received computer instruction showed greater increases in their achievement scores in multiplication and subtraction than students who received traditional mathematical instruction, and Burns and Bozeman's (1981) study showed that a curriculum supplemented with CAI led to gains in achievement in some areas of curriculum. Their findings are consistent with this finding that the experimental group gained much in the intervention than the control group.

Table 9: Results of Dependent Samples t-test for the Pre-test and Post-test Scores of Experimental and Control Groups

	Groups	Mean	Standard deviation	t-value	p-value
Experimental	Pre-test – post-test	-8.71	4.69	14.15	.001*
Control	pre-test – post test	-7.02	3.94	12.96	.001*

*Significant, since p < .05

FINDINGS

Analysis of the pre-test scores using the independent sample t-test indicated that the control group with a mean score of M=18.36 and standard deviation of 3.91 performed significantly better on the pre-test than the experimental group which had a mean of 16.64 and standard deviation of 4.132, [$t_{(109)} > 1.96$, $p < 0.05$].

Analysis of the post-test scores using the independent sample t-test showed that there was a statistically significant difference between the mean scores of the control and the experimental group. Indeed it was evident that both groups improved on their performance on the post-test as compared to the pre-test. Thus the control group with a mean of 26.47 and standard deviation 2.48 performed significantly better on the pot-test than the experimental group with a mean of 25.34 and standard deviation of 3.06. [$t_{(0.05,109)} > 1.96$, $p < 0.05$].

This finding is incoherent with the earlier studies by Linn (1986) that the students instructed in the micro-based lab outperformed seventeen year olds who took a standardized test on scientific knowledge. It also gave discordance to the findings of Goode (1988) who found that fifth and sixth grade pupils who used CAI scored significantly higher in mathematical concepts and computation than a control group of students who used the traditional approach.

Analysis of the post-test scores using a one-way between-groups Analysis of Covariance (ANCOVA) with the Mean scores on the pre-test as the covariate revealed that the treatment had a positive effect on the students' achievement. There was significant difference between

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the experimental group (CAI approach) and the control group (traditional approach) on post-test mean scores [F (2, 108) = 7.121, p = 0.001, partial eta squared= 0.117]. This showed that the treatment explained about 12% of the variation in the scores in performance on the post-test. There was also a relationship between the pre-test and post-test mean scores, as indicated by a partial eta squared value of 0.080. It can be concluded that the interventions were statistically effective for the teaching of pie chart and histogram.

Analysis of the post-test and the pre-test scores using the dependent samples t-test indicated that in both groups there were significant difference between their pre-test scores and their post-test scores. That is in both groups students improved on their performances on the post-test as compared to the pre-test. However, the score of 8.71 by the experimental group, which represents the difference between their post-test and pre-test mean scores as compared to that of 7.02 by the control group, indicated that, the experimental group had much gain on the intervention than the control group. This finding is coherent with the earlier studies by Harrison (1993) who found that students who received computer instruction showed greater increases in their achievement scores in multiplication and subtraction than students who received traditional mathematical instruction. It also supported those of Burns and Bozeman's study (1981) who showed evidence that a curriculum supplemented with CAI led to gains in achievement in some areas of curriculum.

CONCLUSIONS

Based on the findings from this study, the following conclusions can be drawn.

1. Both the CAI and the traditional approach have led to increase in students' performance in the teaching and learning of Pie Chart and Histogram in Core Mathematics.
2. The traditional method of teaching the topics, Pie Chart and Histogram in Core Mathematics on the face of it seemed superior to the CAI method.
3. The CAI approach has led to much gain in terms of students' achievement than the traditional approach in the teaching and learning of Pie Chart and Histogram in Core Mathematics.
4. The CAI approach helps students to develop Mathematical concepts adequately with limited teacher guidance.

RECOMMENDATIONS

1. The government of Ghana in close collaboration with the Ministry of Education and other stake holders in Education should try and transform the Mathematics curriculum into a multi-media format to facilitate teaching learning in schools.
2. Through in-service training, Teachers should as much as possible try to learn and use the CAI approach in their instructions since it exposes both students and teachers to new ways of teaching and learning Mathematical concepts.

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3. In teaching concepts in Pie Chart and Histogram, the practice of feeding students with information should be minimized since by its effect on students' achievement, the experimental group had much gain on the intervention than the control group.

4. The CAI approach which uses tutorials, drill and practice, simulation, and problem solving approaches should be encouraged in many Mathematics instructions, since it offers students more opportunities to explore, discuss, challenge and test their pre-existing ideas about concepts.

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