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Effects of computer-assisted instruction on performance of senior high school biology students in Ghana

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ABSTRACT

This study investigated the comparative efficiency of computer-assisted instruction (CAI) and conventional teaching method in biology on senior high school students. A science class was selected in each of two randomly selected schools. The pretest-posttest non equivalent quasi experimental design was used. The students in the experimental group learned science concepts (cell cycle) through the CAI, whereas the students in the control group were taught the same concepts by the conventional approach. The conventional approach consisted of lecture, discussions and question and answer teaching methods. Mann–Whitney *U* tests were used to analyze students' pretest and posttests scores. The results indicated that students that were instructed by the conventional approach performed better on the posttest than those instructed by the CAI. However, the performance of low achievers within the experimental group improved after they were instructed by the CAI. Even though the CAI group did not perform better than the conventional approach group, the students in the CAI group perceived CAI to be interesting when they were interviewed.

1. Introduction

The computer continues to be one of the most powerful agents influencing all aspects of human life and have advanced our lives in immeasurable ways for the past 50 years (Chalmers, 2000). Computers first found their way into the classroom in the early 1960s (Morrell, 1992); and for education in general, computer use in all its forms appears to offer almost endless avenues for adding to the teachers' instructional strategies and enrichment of the learner's experiences. For science education in particular, the computer appears to be a technology which when effectively integrated in instruction, would lead to improvement in student motivation and learning.

Computers in the classroom will certainly not offer a cure for all science education problems but it can definitely be seen as complementary to other approaches to teaching science if properly integrated. It is in this direction that there has been a massive drive to incorporate ICT into every aspect of school life in the developed countries. For example, the UK invested over £1.7 billion in training, hardware and software in recent years (Baggott La Velle, Wishart, McFarlane, & John, 2007). According to Wells and Lewis (2006), nearly 100% of public schools in the United States had access to the Internet by 2005. In recent studies in the UK and USA, the issue is no longer whether ICTs are used in courses but rather what student's preference for the balance of technology in their courses was (Salaway & Caruso, 2008).

However the situation is different in the developing countries of Africa where it is reported that although many countries put in place ICT policy reforms and services, a significant number have not fully capitalized on ICT as a tool owing to cost and administrative decisions (New Partnership for Africa's Development (NEPADs), 2001). It is admitted that even in the most technologically advanced country of Africa, i.e. South Africa (Lelliotte, Pendlebury, & Enslin, 2000) full access of the computer is usually restricted to the staff of non-governmental organizations, corporations and universities and the average users are often well-educated middle class males (Kinuthia & Dagada, 2008).

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In a recent educational reform in Ghana, computer literacy was officially introduced into the curriculum of the pre-tertiary educational institutions. Almost all the syllabuses revolve around issues about computers and not much insight is given into the plethora of uses the computer can be put once the service is supplied. It is our aim in this paper to give evidence of the possibility of teachers and learners benefiting from the computer in more ways than just computer literacy as enshrined in the curriculum as may be the case in many a developing country. This paper takes the position that attempts to put the computer to any particular use especially in a developing country like Ghana should be based on properly researched evidence. If the country invests its scarce resources in technology they must be fully utilized. They must not be limited to only computer education classes. The computers must be used as teaching tools.

We provide the status of computer use in Ghanaian secondary level of education and its potential for use in instruction in science with the hope that computer education will permeate all facets of the curriculum. The study therefore looked at the effectiveness of CAI as against the conventional approach of teaching in biology. There were two main objectives of this study:

1. To determine if there is a significant difference between the mean posttest achievement scores of students that were instructed through CAI and those instructed through the conventional approach of teaching.
2. To determine if there is a significant difference between the mean posttest achievement scores of high and low achievers when they are instructed through CAI.

2. Theoretical background

There are many terms that are currently in use so far as ICT in education is concerned. Many terms have come and gone and there are overlaps in some instances which are not necessarily identical. Bybee, Poewll, and Trowbridge (2008) categorize the uses of computer and associated technologies in science education into three as follows: learning about computers, learning with computers and learning through computers.

Learning about computers which deals with knowledge of computers may be thought of as a continuum which ranges from skills in and awareness of computers at lower level to programming at higher level (Tabassum, 2004). In this situation students develop technological literacy which essentially involves acquiring computer-related terminology. It may extend to how computer has developed in history and acquisition of simple programming skills for familiarity of the uses of the computer. The teacher in this scenario just teaches the students what they should know about the computer including the names of the various parts, how to use the keyboard and how to use computer packages among other things as may be prescribed by the prevailing computer curriculum. This is where the computer is taught as a separate and distinct subject just like mathematics or biology.

In learning with computers, students use computers as a tool in data acquisition, analysis, communication with other people, information retrieval and myriad other ways. The computer can be used in presentation in multiple forms and data analysis (Thomas, 2001). Application packages like SPSS and Excel are used to analyze data. Voogt and van den Akker (2001, pp. 2473–2477) assert that data presentation packages, word processor and other applications support students in their capability to structure information, and to easily present information in different formats. Students and teachers alike always use the internet to search for information for assignments and research. Teachers who use 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. It is in this direction that the use of the computer through the internet has become almost formalized in the everyday practice of teaching and learning. Also, there is the avenue for video conferencing which can be useful in collaborative learning environments and also used to facilitate distance learning.

Also, in learning with computers, the students use the computer to write reports, do homework, solve mathematical problems, and present reports like long essays and term essays while teachers may use the computer to search for information and present learning materials in power point format. Ornstein and Levine (1993, p. 551) argue that the use of the computer as a tool application is a personal decision on the part of students and not one requested by the teacher.

In learning through computers, computers either take over or assist the teacher with various functions of instruction. According to Soe, Koki, and Chang (2000) "learning from computers encompasses approaches to computer-assisted instruction in which the computer is used as a means for transmitting specific subject matter." In this approach, the flow of information is basically from the computer to the student. The computer presents the learning materials or activities for students to which the latter responds. During the course of the interaction, the computer retains records of the student's progress (Soe et al., 2000). Ornstein and Levine (1993, p. 551) believe that CAI emphasizes tutoring and/or drill and practice programmes and is appropriate when subject matter needs to be mastered or for practice of basic skills before advancing to higher levels of learning. Computer-assisted instruction as indicated by Cotton (1991) is rather and most often refers to drill and practice, tutorial, or simulation activities offered either by themselves or as supplements to traditional, teacher directed instruction. Voogt and van den Akker (2001, pp. 2473–2477) indicated that drill and practice and tutorial software programmes serve as an assistant for teachers by taking over some of their tasks. Thus in the CAI mode, the computer can more or less teach the students literally as in the tutorial application or it can be used to assist the teaching of the student as in drill and practice. This study employed the computer in the CAI mode. Specifically, this study employed the tutorial system of the CAI.

It must be pointed out then that, though technology has become part and parcel of the modern society and offer new learning and teaching opportunities, there must be recourse to educational theory to guide the design of such instructional strategies (Wild & Quinn, 1998). Modern examples of teaching machines, automated and computer assisted instructional devices owe their theoretical roots to the behaviourist tradition in psychology (Edwards, 1970). Although many researchers subscribe to the behaviourist tradition, the more recent developments in computer assisted instructional devices have been most significantly affected by the writings of B.F. Skinner (Edwards, 1970).

From the general principles of behaviourism, Skinner propounded his operant conditioning theory of learning. The operant conditioning is the learning process whereby a response is made more probable or more frequent (Bigge & Shermis, 2004). An operant according to Skinner (1938) is "an identifiable part of behaviour of which it may be said, not that no stimulus can be found that will elicit it but that no correlated stimulus can be detected upon occasions when it is observed to occur" p 21. Skinner indicates that the term refers to a posterior

event. Bigge and Shermis (2004) believe it is so called because behaviour operates upon the environment and generates consequences. Thus, in the process of operant conditioning, operant responses are modified or changed. Skinner's ideas came about as a result of his observations of the performance of animals in a device that he invented. In the device, an animal received a pellet of food (positive reinforcement) each time the animal correctly performed a required activity. Even though Skinner worked on low-level behaviours of animals, he applied the principles to complex behaviour of humans because he found operant conditioning highly effective in training animals and therefore was confident that it promised equal success when used with children and youth.

According to Bigge and Shermis (2004), in operant conditioning, teachers are considered architects and builders of students' behaviour. Learning objectives are divided into a large number of very small tasks and reinforced one after the other into minute stimulus-response bonds. In this approach, the teacher presents the problem to the student and when the correct answer is provided by the student, it is reinforced with a statement or a signal of approval by the teacher. The next question is then asked. Thus, the operants are reinforced or strengthened so as to increase the probability of their occurrence in the future. It is important and very necessary that teachers use properly timed and spaced schedules of reinforcement. Moreover, in operant conditioning the student assumes an active and participative role in the learning situation (Edwards, 1970). This indicates that the student takes care of his or her learning and therefore it is incumbent on him to produce the right response.

Skinner's reinforcement theory is central to computerized learning; especially drill and practice and tutorial learning (Tabassum, 2004). In these computer facilitated learning, students' behaviours are reinforced by being permitted to proceed to the next frame when they get the right answer (Bigge & Shermis, 2004). Tabassum (2004) indicates that Skinner illustrated how to develop programmed learning sequence which is being used directly to design tutorial modules. Some of the illustrations of Skinner indicated by Tabassum (2004) are as follows:

obtain a clear, detailed objective specification of what it means to know the given subject matter;
write a series of information, question and answer frame that expose students to the material in graded steps of increasing difficulty;
request the student to be active. Chabay and Sherwood (1992) note that a major advantage of CAI is that, by necessity, it requires the student to be an active participant in the learning process. They contend that it is not only possible, but necessary for the student to interact with the computer or else nothing will happen. This is because in order to progress from one screen of information to the next, the student must use the computer's input devices. Therefore, it is not possible for the student to be a passive observer;
provide immediate feedback. Thus, Skinner agrees with the continuity principle, but emphasizes the importance of the immediacy of the reinforcement to follow the response (Tabassum, 2004);
permit students to proceed at their own pace.

The tutorial mode of CAI follows these illustrations. There should be clear objectives, materials should be presented in graded steps and the student is active during the learning process. Moreover, there should be immediate feedback to students and the students should be able to proceed at their own pace as far as tutorials are concerned.

Basically, it can be said that the use of computer-assisted instruction especially in tutorials mode is supported mostly by the behaviourist view of learning. This is due to the principle of practice and reinforcement. Therefore, the developers of tutorials mostly incorporate this theory of learning in their programme.

3. Previous research

Various researches have been conducted in the field of CAI in a lot of countries. However, the outcome of these researches indicate that CAI is not uniformly effective in that some studies show no significant differences in achievement between CAI and non-CAI students (Ornstein & Levine, 1993, p. 551); especially those studies that compared CAI alone against conventional instruction (Cotton, 1991; Danley & Baker, 1988).

Kausar, Choudhry, and Gujjar (2008) indicated that CAI proved to be significantly superior to classroom lecture in terms of achievement in knowledge, analysis and synthesis of the Bloom's taxonomy when they conducted a comparative study to evaluate the effectiveness of CAI versus classroom lecture for computer science students. In terms of evaluation and application skills, they found out that CAI proved to be very much effective in increasing those skills as compared to classroom lecture. This study seems to suggest that CAI is able to improve student achievement and performance. Kulik and Bangert-Drowns (1983) found that CAI has the potential for improving student achievement scores in pre-college classes. Ivers and Barron (1998) reported significant learning increases when pre-service teachers worked in a paired condition using computer based instruction that was designed for learning. Moreover, Tirosh, Tirosh, Graeber, and Wilson (1990) reported that CAI was effective in improving performance and correcting misconceptions of pre-service teachers. Ryan (1991) did a meta-analysis of achievement effects on micro computer applications in elementary schools in reading and mathematics and found out that CAI was able to increase academic achievement. He indicated that a typical student score would be raised from the 50th percentile to the 62nd percentile when exposed to CAI. After analyzing 28 studies, Kulik, Kulik, and Bangert (1985) also concluded that a typical student score in the 50th percentile with conventional instruction would score in the 68th percentile with CAI. Snowman (1995) also reported that computer-based education has a positive effect on secondary students. He came to this conclusion when his meta-analysis showed that the typical student in a computer based class scored as the 60th percentile while the typical student in a traditional class scored at the 50th percentile in final examinations. These studies seem to suggest that the CAI is capable and has been able to improve student achievement.

However, it should be noted that the discussion is never one sided in that Delafuente, Araujo, and Legg (1998) indicate that exam scores for pharmacy calculations taught in a traditional lecture format are similar to exam scores for those students learning the same material by CAI. Thus, there was no significant difference in final exam score between students taught by CAI and those by the traditional instruction. Fletcher-Flinn and Gravatt (1995) examined studies from 1987 to 1992 and realized that there were no significant differences between CAI and traditional instruction, when the modes of instruction were delivered by the same teacher. Again, Ybarrondo (1984) also found no significant difference between students taught by CAI and those of the conventional instruction. A study by Chang (2000) also produced mixed results. Whiles the CAI group performed better generally as compared to the traditional approach group, the traditional approach group performed better on test items involving application. Thus, while the CAI group did well on knowledge and comprehension level

items, the traditional approach group did better on application level items. Imhanlahimi and Imhanlahimi (2008) also found that the traditional method of instruction proved to be superior when compared to computer-assisted instruction. This review has shown that when CAI is used on its own i.e. used to replace the teacher, the result is not uniform. Thus whereas some research found CAI to be superior to the conventional approach, others found otherwise.

However, it has been found that student achievement increases when CAI is used in addition to or supplement the conventional instruction. Cotton (1991) after analyzing 59 research reports came to the conclusion that the single best-supported finding in the research literature is that the use of CAI as a supplement to traditional, teacher-directed instruction produces achievement effects superior to those obtained with traditional instruction alone. Many authors (Akour, 2008; Basturk, 2005; Bontempi & Warden-Hazlewood, 2003; Ornstein & Levine, 1993, p. 551, and Tabassum, 2004) support this conclusion.

On attitudes, Mitra (1998) has indicated that many studies that have been performed about the effects of CAI on students' attitudes do not agree whether or not it makes positive changes in attitudes towards science and science learning. Lepper and Gurtner (1989) reveal that when used in addition to regular instruction, CAI improves academic achievement besides influencing students' attitudes and motivation. Cotton (1991) notes that the use of CAI leads to more positive attitudes toward course content, quality of instruction and school in general. Selwyn (1999) also indicated that CAI improves a positive attitude towards science. Ybarrondo (1984) has indicated that even though CAI did not affect student achievement, students expressed their interest in the CAI material. The students felt that they had learned from it and would like to participate in CAI lessons in the future.

4. Significance of the study

Even though the use of the computer is believed by many educators to have positive impact on students, research on the computer use and effectiveness of CAI vary (Cotton, 1991, Ornstein & Levine, 1993, p. 551). Moreover the acquisition of computer hardware and educational software programmes involves a considerable monetary investment as indicated by Cotton (1991). It is therefore worthwhile that such investments are made based on empirical evidence. Therefore, even as Ghana seeks to incorporate the use of computers in its educational system, it is very necessary and important that the effects of the variety of computer usage are explored. This will help the nation to know and be assured that whatever technology they are bringing will have a positive effect on both teachers and students.

5. Research methodology

5.1. Sample

The subjects for the study comprised 75 senior high school (SHS) year two science students from two randomly selected schools in the Cape Coast town of the Cape Coast Metropolis in Ghana. There were 35 and 40 students in the experimental and control groups respectively. The year two students were chosen because they had done Information Communication and Technology (ICT) as a course of study and were therefore trusted to be familiar with the use of computer. These science students offer biology, chemistry, physics and elective mathematics.

5.2. Instrument

The instruments for this study were pretest and posttest (test items) and semi-structured interview constructed by the researchers. The pretest was developed based on a range of biology topics in the SHS year one integrated science subject. The pretest was done to find out whether the two groups were performing at the same level. Moreover, it was also used to categorize students into the achievement levels i.e. high and low achievers. The posttest on the other hand, was based on the topic cell cycle, which was taught during the experiment. Each test (pre and post) consisted of 30-item multiple choice questions. These tests were aimed at finding out the performance of students before and after the experiment. To ensure content validity of the tests, table of specifications for the lesson plan was used to develop the test items. The tests were also given to two experienced biology teachers for review. For the reliability of the tests, the Kuder-Richardson 21 reliability coefficient was used. This was used because the items were scored dichotomously. The reliability of the tests was found to be 0.6.

A semi-structured interview also formed part of the instruments for this study. Nine students from the experimental group were randomly selected and interviewed individually by the researchers to find the effect of computer-assisted instruction on them. The interview covered a range of issues as far as the CAI was concerned from the students' points of view.

6. Research design and procedure

The design used for the research was the quasi-experimental design since the subjects were not assigned randomly to the experimental and control groups (Creswell, 1994, pp. 127–139). The aim was to evaluate the effects of CAI (Bordens & Abbot, 2002, pp. 300–302) on senior high school (SHS) science students' academic performance in biology after they were taught a topic in the West Africa Secondary School Certificate Examinations (WASSCE) biology syllabus with the computer.

The pretest-posttest non-equivalent group design was used to collect quantitative data to find out whether there was any significant difference between the academic achievements of students taught by CAI and those taught by the conventional approach. Two schools were selected randomly from nine schools that had computers through the use of computer generated random numbers. The first school selected was designated as the experimental school and the second school as the control. From each of the selected schools one class was selected at random to participate in the study. The subjects were in the control or experimental group if their class was selected as such. The academic achievement of students was the dependent variable while the teaching strategies (Conventional approach and CAI) were the independent variables. This study employed two different treatments. The treatment for the experimental group was the tutorials of the computer-assisted instruction mode whiles the control group was taught by conventional approach of teaching. However, the content to be taught and learnt was the same for the two groups; it was the modes of delivery that were different. The development of the treatments went through phases.

A lesson plan was developed for the conventional approach of teaching. This lesson plan used three instructional strategies comprising lecture, discussion and intermittent questions and answers to present the content material to the students. The CAI was developed with the assistance of a computer programmer based on the content that used was for the development of the lesson plan of the conventional approach. It was ensured that the content conformed to what has been prescribed by the senior high school biology syllabus. The CAI was developed in the Microsoft Power Point 2003 and its associated packages. The CAI was developed based on the suggestions of Alessi and Trollip (2001) for the development of effective learning software. The software included graphics, text and hyperlinks. There was an animation of the concepts presented at the end of the lesson. Since students were expected to learn at their own pace, timed pauses was not used. The format of this CAI tutorial was such that concepts were presented, questions asked and students were encouraged to progress. There were two quizzes of five questions each in this material. This was done based on the definition of tutorials by Kausar et al. (2008) that "tutorials are designed to introduce unfamiliar subject matter. The format of a computer tutorial often emulates a dialogue between the computer and the student, i.e. information presented, questions are asked of the student and on the basis of the response given, a decision is made to move on to new material or review what has already been presented".

Each treatment was taken to the appropriate school. Before the commencement of the teaching, the pretest was conducted in both groups. The control group was instructed through the conventional approach. The students were taught the concepts by a biology teacher based on the developed lesson plan. The experimental group on the other hand was instructed through the CAI. In this group, the software was installed on the computers in the schools computer laboratory. This group did not enjoy the presence of a visible biology teacher. The two groups were taught simultaneously. After the teaching in both groups, the posttest was conducted. Some students in the experimental group were selected randomly through Excel generated random numbers and interviewed. The interviewees were given assurances of confidentiality and anonymity at the beginning of the interview session. All the interviews were recorded with an audio tape-recorder with the permission of the interviewees. The study took about two weeks to complete.

7. Analysis

The results of the pre and post tests were analyzed using Mann–Whitney *U* test. Statistically, violations of the assumptions underlying the *t*-test are most likely to go undetected with small samples. On the other hand the Mann–Whitney *U* test does not require normality of distribution nor homogeneity of variance for the two groups in the study. The Mann–Whitney *U* test was therefore used instead of the *t*-test because of its usefulness with small samples. The Mann–Whitney test was used to find out if there were any statistically significant differences in the academic performance of the control group and the experimental group. The test was also used to find out if there have been any statistically significant differences in the academic performance of high achieving and low achieving students in the experimental group. The responses that were derived during the interview were transcribed and analyzed to help bring out the attitudes of students toward the CAI.

8. Results

The first null hypothesis tested for the posttest was that no significant difference at the 0.05 level would be found between the means of the posttests of students in the control and experimental groups. The Mann–Whitney *U* test was used. From Table 1, it could be seen that there was no significant difference between the pretest scores of the students in the two groups. This therefore indicates that the students were performing at the similar levels before the treatment. However, there was a statistically significant difference in the posttest scores. The null hypothesis is therefore rejected.

The performance of the computer-assisted instruction group (experimental) was lower with a mean rank of 31.60 and actual mean of 19.57 as compared to the conventional approach (control) with a mean rank of 43.60 and actual mean of 21.85. But there was a decrease in performance in the mean scores of both groups on the posttest.

The second hypothesis was that no significant difference would be found between high achievers and low achievers when taught with CAI. This hypothesis was tested with the Mann–Whitney U. The high achievers performed significantly better on the pretest than the low achievers as indicated in Table 2. However, there was no significant difference between the high achievers and the low achievers on the posttest as can be seen from Table 2. The null hypothesis is therefore not rejected.

In the control group however, the high achievers performed better both on the pretest and posttest than the low achievers as can be seen from Table 3. This seems to suggest that the teaching approach used in the control group seems to favour high achievers than low achievers.

9. Discussion

The result of this study has shown that those students who received traditional instruction performed better than those in the CAI class; an outcome similar to Imhanlahimi and Imhanlahimi (2008) that students in CAI group did not perform better than those taught by traditional instruction approach. The students in the experimental group however indicated that they understood the lesson that was

Table 1
Results of the Mann–Whitney analysis on students' pre and post tests scores of control and experimental groups.

The study groups		*N*	Mean rank	Mean	Z	*P*-value
Pretest scores of the groups	Experimental	35	35.51	25.80	−0.939	0.347
	Control	40	40.17	26.28		
Posttest scores of the groups	Experimental	35	31.60	19.57	−2.388	0.017*
	Control	40	43.60	21.85		

Significance $^*P < 0.05$.

Table 2
Results of Mann–Whitney analysis on pre and post tests scores of high and low achievers in the CAI group.

Achievement levels		*N*	Mean rank	Mean	*Z*	*P*-value
Pretest scores of the groups	High achievers	25	23.00	26.76	−4.636	0.000*
	Low achievers	10	5.50	23.40		
Posttest scores of the groups	High achievers	25	19.78	20.28	−1.639	0.101
	Low achievers	10	13.55	17.50		

Significance $^{*}P < 0.05$.

Table 3
Results of Mann–Whitney analysis on pre and post tests scores of high and low achievers in the control group.

Achievement levels		*N*	Mean rank	Mean	*Z*	*P*-value
Pretest scores of the groups	High achievers	29	26.00	27.10	−4.926	0.000*
	Low achievers	11	6.00	24.09		
Posttest scores of the groups	High achievers	29	23.90	25.28	−3.008	0.003*
	Low achievers	11	11.55	22.18		

Significance $^{*}P < 0.05$.

delivered through the CAI when some were interviewed. Comments like "it was easy to understand" and "explanations were clear" came from the students. This confirms the observation by Ybarrondo (1984) that students indicated that they have learned from the CAI. However, their performance as compared to the conventional approach group was low. The CAI group students were particularly satisfied with the ability to go back and read over the material again. "I was able to go back. Class has many students and the teacher may not be able to treat you alone special" and "You could go back in this CAI but you can't ask the teacher to explain things to you again and again" were some of the responses of the students with regards to the pace of learning when CAI is used by students. This agrees with the observation made by Morrell (1992) that students learn at their own pace when instructed with CAI. Generally, the students indicated that the material was exciting and interesting. Response like "it was exciting, I liked the illustrations" and "it was exciting and interesting" came from the students during the interview. Though they acknowledged that it was their first time of learning a lesson on the computer, they were nevertheless excited and expressed their interest in the material. Thus, the students showed interest in the CAI. Both Cotton (1991) and Selwyn (1999) agree that CAI improve attitude towards science positively.

The only problem of the CAI as far as the students were concerned was the absence of a teacher. Students were particularly not happy with the lack of opportunity to ask questions when they encountered any difficulty. So they indicated that they wished a teacher was around for them to ask questions. This seems to be the major complaint of students when CAI is used alone without the presence of a teacher (Morrell, 1992). This therefore seems to agree with Cotton (1991) and Ornstein and Levine (1993, p. 551) that the best use of CAI is when it is used as a supplement to teacher-directed instruction. One can therefore reason that the poor performance of the students in the experimental group after being instructed with CAI could be due to the absence of a teacher whom they could contact in case they needed help. This is because the students in the conventional approach group were taught by a biology teacher. The biology teacher beside following the lesson plan gave relevant examples and the students in that group had the opportunity to interact with the teacher and asked questions in areas where they encountered difficulties and this made their learning meaningful (Ausubel, 1980).

The result of this study has also shown that when CAI is used to teach students the performance of the low achievers in the group is enhanced and thus at the end of the day both the low and high achievers will perform better. This finding is in contrast to Tabassum (2004) who indicated that CAI is more effective for high achievement level students. However, the outcome of this study is consistent with Cotton (1991) who indicated that CAI is more effective with lower-achieving students than with higher-achieving ones. This outcome implies that even though the CAI group did not perform better than the traditional instruction group, the low achievers in the CAI group did perform better when they were introduced to the CAI. Cotton (1991) attributes the performance of low achievers after introduction to CAI to some characteristics of CAI- the exercises, privacy, that is the ability to learn at their own pace, the immediate feedback and the ability to read over the material again. This gives the indication that CAI holds great promise to low achieving students, teachers and parents. Therefore, CAI can be used to help low achieving students to improve their performance.

10. Conclusions

It can be concluded from the results of this study that the use of CAI is not superior to the conventional approach. However, it has been seen that CAI has that ability to improve the performance of low achievers within a class. Moreover, it can be concluded that CAI has positive effect on students and that students have shown interest in learning with CAI. Thus, it can be said that CAI could provide new skills in using technology in the learning process.

10.1. Implication for science education

The issue of integration of technology in education especially the computer to Ghana should revolve around looking for factors and practices that can be applied to teaching and learning rather than just teaching about computers because the increasing growth of technology provides new opportunities for delivering instruction (Karper, Robinson, & Cassado, 2005). However, it should be noted that the computer cannot and is not the panacea to the problems in science education. Moreover, it will be very naive to think that the computer can replace the teacher as the study has indicated that the conventional approach of teaching is not defective. On the other hand, it has been

seen that the computer hold great promise for low achievers. Therefore for better and greater benefit to be derived from the computer, it should be used as a teacher support instrument rather than taking over the teaching process as a whole.

It is being recommended that similar study should be replicated with a larger sample since the sample size of this study was not that large. Moreover, effectiveness of a teacher directed instruction supplemented by CAI as against the conventional approach can also be investigated. This when done can alleviate the problem of the absence of the teacher as encountered in the CAI alone situation.

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