



COMPUTER-ASSISTED INSTRUCTION (CAI) AS AN ALTERNATIVE INSTRUCTIONAL TOOL FOR IMPROVING THE TEACHING AND LEARNING OF BLOOD CIRCULATION IN HUMANS

Ameyaw, Y. & Agbotse, S.

Department of Biology Education, Faculty of Science Education, University of Education, Winneba, Central Region, P. O. Box 25, Ghana.

ABSTRACT

The integration of CAI into the teaching and learning of the circulation of blood in humans in Kpando Senior High School in the Volta Region of Ghana was investigated. Action research design was used, and seventy eight (78) students were purposively selected from classes 3C1 and 3C2, in addition to twenty (20) selected teachers from the school. Achievement tests on Deoxyribonucleic Acid (DNA), Ribonucleic Acid (RNA) and protein synthesis” were used to assess the students, and also structured interview guides were used to collect data from the teachers. The data gathered were analysed using SPSS to find out whether the levels of the two classes were equivalent in terms of their performances in the lessons taught using the traditional method and the interventional tool, CAI. The result of the study revealed a statistically significant increase in the achievements or performance of the students that received the computer based lesson. In addition, the research revealed that the use of ICT in the teaching and learning increased the academic successes of the students, and also changed the concept from abstract to concrete making it easier for the students to understand. The results further showed that the teachers although have access to ICT but the lack of technical support and expertise were the prominent factors that hindered their readiness and confidence to apply the use of ICT in their teaching and learning. Therefore, emphasis must be placed on the pedagogical use ICT in the teaching and learning process. A well equipped ICT laboratory, with internet connectivity should be established in all S.H.Ss, to enhance proper integration of ICT into teaching and learning environment.

KEYWORDS: Computer-Assisted Instruction, Achievement, Traditional Method.

INTRODUCTION

According to Butzin (2000) and Erickson and Lehrer (2000), the use of computer information technology in education, more especially in the teaching and learning process will definitely result in academic improvements globally. As a result, there is concern for those who have had little or no experience with computer technology, most of whom are in the developing countries (Cawthera, 2003), such as Ghana. The advent of computers and the internet is an indication of a new phase in the instructional technology. By the mid 1980s, the internet had gained acceptance in business and was finding its way into education in the United States (Daniel, 1999). In addition to the internet, instructional materials such as CD-ROMs and other computer associated programmes have been introduced and are widely used in education. Computer mediated instruction and programs have introduced a level of interactivity and immediate response that most instructional television and radio do not offer. Computer-based technology allows teachers to move from the role of dispenser of knowledge to a facilitator or coach, allowing the teacher to encourage and guide students in becoming active learners. David (1991) stated that “teaching must change from dispensing information and rewarding right answers to the creation of activities that engage students’ minds and present complex problems with multiple solutions”. Computer-based technology will permit the teacher to present more complex material and expect more from the students (OTA, 1995). The computer allows the

teacher to easily keep track of grades, and individual student report can be generated very quickly. There are several perceptions by teachers in the use of computer-based technology that seem to be significant: (a) technology do support superior forms of learning (Collis, Betty, Antionette & Sherra, 1988), (b) computer-based technology can change the way teaching and learning occurs (OTA, 1995; Comppeau & Higgins, 1995), (c) computer-based technology helps teachers to accomplish things that they cannot do by themselves (Wild, 1995), (d) computer-based technology enhances teacher and student productivity (OTA, 1995), and (e) computer-based technology prepares students for the work world (Yuen & Ma, 2002).

Teachers who hold the above perceptions tend to be the most successful in adopting and using computer-based technology. The perception that technology supports superior forms of learning comes from cognitive psychology (Veen, 1993). Advanced skills of comprehension, reasoning, and experimentation are acquired through the learners’ interaction with content. Drawn from the constructivist view of learning, teaching basic skills within authentic contexts (hence more complex problems), for modeling expert thought processes, and for providing for collaboration and external supports to permit students to achieve intellectual accomplishments which they could not do on their own, provides the wellspring of ideas for many of this decade’s curriculum and instruction reform efforts by: (1) a move from the teacher as the

dispenser of knowledge to the teacher as a facilitator or coach, (2) teachers expected more from students and presented more complex material, (3) more opportunity for individualized instruction, (4) spend less time lecturing to the whole class, (5) more comfortable with small-group activities, (6) team teaching, (7) interdisciplinary project-based instruction, and (8) altering the master schedule.

Factors that Hinder Computer Technology Integration in the Schools

There are many factors which may serve as hindrance to integration of computer technology in high schools. Pelgrum (2001) presents a list of ten such factors that impede ICT integration in schools. Out of the ten impediments he identified four major ones, namely (1) personal ideas about the contribution that technology can make to the processes of teaching and learning, and classroom management, (2) teachers' lack of knowledge and skills, (3) insufficient number of computers and ICT infrastructure, and (4) the difficulty in integrating ICTs instruction in the classrooms. In a related study, Ely (1993) distinguishes three major conditions, relevant to ICT integration in classrooms as (1) dissatisfaction with the status quo, (2) existence of knowledge and skills, and (3) availability of resources. The three categories more or less, address the same issue. Ely's existence of knowledge and skills relates to Pelgrum's factor relating to teachers lack of knowledge and skills while Ely's availability of resources is similar to Pelgrum's insufficient number of computers and ICT infrastructure.

Finally, Ely's dissatisfaction with the status quo is directly related to what Zhao and Cziko (2001) term as discrepancies that activate the individual. The problem of teachers' confidence in their ICT competence as a major factor for integrating technology in teaching is reported in other studies as well. Mooij and Smeets (2001) explain that if teachers are not confident in their ability or competence to handle computers this may hinder their willingness to introduce technology in their classrooms. In their study Cox, Preston and Cox (1999) also reported that the most important reason teachers gave for not using ICT was that they were not familiar with ICT or they felt unsure about it. The ICT competence factor is the same as that of Zhao and Cziko (2001) which they refer to as Control Principle. Some other important factors significantly influenced ICT use in schools. Teachers claiming to follow more innovative educational practices such as the use of inquiry, project-oriented work and hands-on activities, are more likely to use new technologies than those who stick to the more traditional instructional approaches (Myhre, 1998). According to Mooij and Smeets (2001), school manager's policy and budgetary decisions and in general the attitude of school manager (their commitment and decisions) are expected to be relevant to the ICT innovation process.

Teachers' attitudes and beliefs in the use of computer technology

International experience has shown that teachers play an important role in diffusing and utilizing ICT in classrooms. Teachers' attitudes and beliefs affect the way technological innovation is applied in education. They tend to use technology in ways that will shape their own personal perspectives on the curriculum and on their pedagogical practices (Cohen, 1987; Cuban, 1986;

Czerniak & Lumpe, 1996; Lai *et al.*, 2001). Bullock (2004) noted that teachers' attitudes' were a major enabling or disabling factor in the adoption of technology. Similarly Kersaint, Horton, Stohl and Garofalo (2003) found that teachers who have positive attitudes toward technology feel more comfortable using it and usually incorporate it into their teaching. Woodrow (1992) asserts that any successful transformation in educational practice requires the development of positive user attitudes toward the new technology.

The development of teachers' positive attitudes toward ICT is a key factor not only for enhancing computer integration but also for avoiding teachers' resistance to computer use (Watson, 1998). Research has shown that many educational reform initiatives have failed precisely because they did not influence the beliefs or the practices of the teachers (Cohen & Ball, 1990).

Teachers knowledge and skills in computer technology

The effective use of computers by teachers depends not only on their attitudes, but also on the training they have received (Clark & Peterson, 1986). Teachers' competence in ICT presupposes: positive attitudes to ICT, understanding of the educational potential of ICT, ability to use ICT effectively in the curriculum, ability to manage ICT use in the classroom, ability to evaluate ICT use, ability to ensure differentiation and progression and technical capability (Grossman, Wilson, & Shulman, 1989; Beck, 1997). In-service training is a key factor in cultivating positive attitudes towards the use of computer (Kara & Yakar, 2008). Quality in-service training can change teachers' thinking and practice to recognise that teaching is a difficult, complex and multifaceted process (Wood & Bennett, 2000). A decisive factor in the effective integration of computer use in the school curriculum is the provision of appropriate in-service training to the teachers, training to show them how to use the new tools in their everyday teaching practice. In-service training should not only focus on the technical, but on the pedagogical and didactic aspects of ICT use in the classroom (Lai *et al.*, 2001; Pelgrum & Plomp, 1996).

Many recent research studies on the state of ICT's integration in schools also show that many institutions are failing to integrate technology into existing context. Sarfo and Elen (2007) stated that although teachers were having sufficient skills, were innovative and easily overcame obstacles, they did not integrate technology consistently both as a teaching and learning tool. Reynolds, Treharne and Tripp (2003) also underlined continuing problems in the adoption of ICTs by teachers, and stated the need for further research on how ICT can improve education.

Utilization of Computer technology facilities by Teachers and students

Tabassum (2004) reveals that one fundamental problem facing ICT integration in schools is the lack of computer infrastructure. Bybee *et al.*, (2008) reveal that appropriate access to technology infrastructure is another key factor in the effective technology integration process. Access to ICT infrastructure is one of the effective means to integrate ICT in classrooms (Yildirim, 2007). ICT potentially helps to improve young peoples' access to educational opportunities as well as to enhance the quality of that education through the new modes. Through ICT, curricula can be more easily updated, adapted, enriched

and personalized to satisfy a broad range of learning needs. Within more traditional learning environments, ICT will assist in changing the way the classrooms operate; the integration of multimedia subject presentations, online research, changing teacher-student dynamics, and innovative project approaches are making the learning process more interactive and participatory.

Waite (2004) indicates that even though teachers show great interest and motivation to learn about the potential of ICT, in practice, the use of ICT is relatively low and focus on a narrow range of applications, with word processing being the predominant use. The use of other ICT tools such as video conferencing, emailing and the internet are rarely used. The lack of ICT infrastructure is one of the factors for non-usage of those tools. Another research study suggests that ICT as a tool to promote learning is not generally well embedded in teachers' practice (Cox *et al.*, 1999; Dynaski *et al.*, 2007; Zhao & Cziko, 2001), that information technology in the classroom will be used in an ineffective way and may prove difficult to integrate within traditional curriculum settings (Van Belle & Soetaert, 2001).

Using Computer technology to teach biology

Usage of ICT in schools is so diverse that it is almost impossible to list all possible applications. Taylor (2003) recognized three roles of computers in a classroom as tutor, tool, and tutee. Introduction of ICT in biology lessons will raise not only the level of knowledge but students attitudes toward biology as well (Kubiakto & Halakova, 2009). Biology (science) teachers distinguish between generic applications which is used in all subjects, like word-processing, searching for information, communication using e-mails, and multimedia presentations. In this case, if a science teacher does not use ICT in a classroom, the damage to the students will be limited because they can achieve missing skills with their work in other subjects at home (Kuhlemeier & Hemker, 2007). The other applications are adapted or developed to be used in science teaching (McFarlane & Sakellariou, 2002), like imaging systems in microscopy (McLean, 2000; Fiche, Bonvin, & Bosman, 2006), virtual dissections (O'Byrne, Patry, & Carnegie, 2008), simulations (Ramasundaram, Grunwald, Mangeot, Camerford & Bliss, 2005), virtual laboratory (Jenkins, 2004), and real laboratory exercises with data acquisition systems (Conway & Zhao, 2003). The most important difference among these two groups of applications is that if a science teacher does not use such applications in teaching students in most cases will not be able to compensate loss with work in other subjects or at home. The introduction of computers into the teaching and learning in Slovenian Secondary Schools has followed the introduction of the compulsory subjects, Computer Science and/or Informatics, into the curriculum. The second approach involved the use of computers in a rainbow of different subjects. The introduction of computers into student work in other subjects is encouraged by the government, but the final decision about their use in teaching is left to the discretion of the teachers.

Cox *et al.* (2004) indicates that many teachers are integrating ICT into Science teaching in a way that motivates pupils and enriches learning or stimulates higher level thinking and reasoning. These teachers tend to be those with an innovative pedagogical outlook. ICT for

Biology teaching can support both the investigative (skills and attitudes) and more knowledge based aspects (concepts) of biology teaching.

To achieve successful integration of ICT into biology teaching and learning, it must depend on an appropriate pedagogy and clear and concrete curriculum focus which supports and enhances teaching and learning with the use of ICT in various schools.

Computer aided instruction

Computer aided instruction (CAI) has a rich history and developed concurrently with the development of electronic computers (Daniel, 1999). CAI began in the mid-1950s as collaboration between Stanford University and IBM but grew slowly until the arrival of personal computers in the 1980s. Today there are few schools in the United States that do not have computers available for student use, and don't use some form of CAI on those computers.

While educational effectiveness and implementation issues have been common, CAI has remained popular among educators who maintain a belief that it is a useful supplement to classroom activities. A number of studies have reported that it can be successful in raising exam scores, improving student attitudes, and reducing the time needed to master course materials (Canham, Geoffrey, Rayner & William, 1986; Collis, Betty, Antoinette & Sherra, 1988). Again, it has been shown that students like the mode of presentation (Brown, 1995), that it is viewed as a positive experience (Deardoff, 1986), and that it is suitable for individual learning needs (Parr, 1999).

However, Kulik and Kulik (1989) have stated that more well-designed research is needed before any real conclusions about the effectiveness of CAI can be drawn. Cherry (1991) found that there was no significant difference between CAI and conventional traditional method as an effective teaching technique. Garrett (1995) reported mixed results when comparing CAI and conventional traditional method of teaching. Thus, while educational effectiveness may exist for specific applications, it is difficult to conclude that such effectiveness is common across a large range of disciplines.

Biology which is an integral part of science and which focuses on living things (plants and animals), is a highly popular subject amongst Senior High Students in Ghana. In the Ghanaian educational system, it is compulsory that every science student in the Senior High School studies offer at least Biology or Geography in addition to Chemistry, Physics and Elective Mathematics. Over the years, the trend has been that most students choose Biology over Geography in the field of science. The performance of students in Biology has, however, been very poor. Investigations have revealed quite a number of reasons; one is that some concepts are very difficult to teach as well as for students to learn and understand (Bordens & Abbot 2002; Bangkok, 2004). Some of these concepts include circulatory system of human, DNA, RNA and protein synthesis, and they end up being neglected by teachers (Ertmer, 2003). Other studies have shown that difficulty of learning circulatory system in human is a common phenomenon, because the concept is abstract and the processes involved are not physically observable (deMarrais & Lapau, 2004). Therefore, their teaching and learning tools should be provided to make learning biological concepts easier and concrete. One of such tools

is computer animation, a package designed to teach Senior High School students concepts in biology.

The purpose of this research is to make CAI an instructional alternative in the teaching and learning of blood circulation for science students of Kpando Senior High School in the Volta Region of Ghana.

Research Questions

The study was guided by the following research questions:

1. What is the significant difference between the mean achievement scores of students that were instructed through CAI and those instructed through the conventional approach of teaching?
2. What impact does computer technology has on the teaching and learning of biology in Kpando Senior High School?
3. What are the obstacles to the integration of CAI to the teaching and learning process of blood circulation?

METHODOLOGY

The study was carried out in Kpando Senior High School (Kpasec) in the Volta Region of Ghana. The population for the study was made up of Biology students and teachers of Kpasec and Biheco in Kpando District of the Volta Region. The students were chosen from form three (3) classes while all the Biology teachers including the Heads of Science Departments and some selected teachers from other Departments were also chosen for the study. The sample population for the study comprised 78 Senior High School (SHS) year three science students selected purposively into two classes C_1 and C_2 of Kpasec made up of 40 and 38 students designated as experimental and control groups respectively. Year three students were chosen because they had done most of the topics in the syllabus which serve as the background knowledge to the concept under study.

The quasi-experimental design was applied, since the subjects were not assigned randomly to groups. Though the sample students were not selected by the random method, the selection into control and experimental groups (C_1 and C_2) was made by flipping a coin. The aim was to evaluate the effects of CAI on Kpando Senior High School science students' academic performance in biology after they were taught human blood circulatory system as specified in the West Africa Secondary School Certificate Examinations (WASSCE) biology syllabus.

This study employed two different treatments. The treatment for the experimental group (C_1) was the tutorials of the computer-assisted instruction mode while the control group (C_2) was taught by conventional method of teaching with the content taught and learnt the same for the two groups; it was the modes of delivery that were different. The pretest-posttest non-equivalent group design was used to collect quantitative data to find out any significant difference between the academic achievements of students taught by CAI and those taught by the traditional or conventional approach. The topic treated in biology was the human blood circulatory system. The Computer Assisted Instruction (CAI) method was used to teach the experimental group (C_1) and the conventional approach for the control group (C_2). The performance of the students was the dependent variable while the teaching

strategies (Conventional approach and CAI) were the independent variables.

Three lesson plan instructional strategies comprising lecture, discussion, and intermittent questions and answers were used to present the content material to the students. For the experimental group, the CAI was developed based on the suggestions of Alessi and Trollip (2001), for the development of effective learning software with the assistance of a computer programmer based on the content used to develop the lesson plan. The software included graphics, text, and hyperlinks enriched with voice package. An animation of the concept was presented at the end of the lesson. The format of the CAI tutorial was such that concepts were presented, questions asked and students were encouraged to progress. There were two quizzes of five (5) multiple choice questions and four (4) essay test items each in this material. It was done based on the definition of tutorials by Kausar *et al.* (2008), that "tutorials are designed to introduce unfamiliar subject matter. The instruments used for the study were pretest and posttest (test items), and semi-structured interview constructed by the researcher. Before the commencement of the teaching, a pretest was conducted in both classes. Both the experimental and control groups read the concept of human blood circulatory system for a week after which the students were tested to ascertain their performance before putting in the interventions. This was done to ascertain the level of significant impact of the teaching methods on the students in relation to their previous performance. It served as a bench mark or the base line to compare the effects of the intervention on the student's performance.

For the posttest, the experimental and control groups were exposed to the same concept simultaneously, using different methods and taking place on different campuses to prevent interaction effect between the groups. During the pretest and posttest, the lesson was projected on the screen in the presence of the teacher-researcher.

The two groups were taught simultaneously for two weeks totaling twenty four (24) periods with each, a period lasting forty (40) minutes. All the groups (C_1 and C_2) were administered the posttest, immediately after the completion of the interventions.

A series of semi-structured interviews with a range of selected teachers were used for the purpose of finding their perceptions on the integration of Computer-Assisted Instruction into the classroom. The teacher interviewing process included selecting ten teachers from the different Departments in the school with priority given to all biology teachers in the school to be part of the study. 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.

The data obtained from the questionnaire and the observation checklists were tabulated onto an electronic spreadsheet (Microsoft Excel Software) and statistically analyzed. Both quantitative data and qualitative data analysis were used. To achieve homogeneity of groups before treatment, results of the independent sample t-test for each group was compared in addition to the mean scores, standard deviations, t-values and p-values. Means

and percentages were used to analyze the data collected. Some of the data analyzed statistically in percentage score values were plotted into graphs.

RESULTS

Interpreted results, evidence-based answers to the research questions, and inferential statistical evidences needed for making conclusions have been presented.

Pre-test achievement scores obtained by groups

The pre-test mean scores of the two classes – C₁ and C₂ obtained before the introduction of the interventions were compared. The independent sample t-test was used in the comparison assessment. The outcome of the analysis is shown in Table 1.

TABLE I. Analysis of Independent sample t-test of Groups' (Classes) Pre-test Scores

Group	N	X	S	Sd	T	P(significance)
Control	40	33.12	7.97	76	-0.929	0.356
Experimental	38	34.57	5.56			

* $p < 0.05$

The value in Table 1 ($t(76) = -0.929$; $p > 0.05$) proves that there is no significant difference between the pre-test mean scores at 95% confidence interval level. This result shows that students' concepts achievement in human blood circulatory system was approximately the same before the application of interactions. Therefore both groups had equal concept knowledge before the interactions.

Analysis of variance between pre-and post test scores of the control group

The pre-and post test mean scores of the control group obtained before and after the introduction of the intervention were compared. The independent sample t-test was used in the comparison assessment. Table 2 shows the outcome of the analysis.

TABLE 2: Analysis of variance of the pre and post-test students' achievement score of the control group

Test	N	X	S	Sd	t	p(significance)
Pretest	40	33.12	7.97	39	-0.126	0.900
posttest	40	33.37	7.46			

* $p < 0.05$

According to Table 2, there is no significant difference between the pre-test and post-test achievement scores of students' in the control group ($t(39) = -0.126$; $p < 0.01$). The mean score of students' pre-test in the achievement test is = 33.12, and the post test score is = 33.37. This result reveals that traditional approaches used on the control group did not enhance students' achievement.

Analysis of variance after applying the interventions

The independent sample t-test was used to assess whether there was or not significant difference between the achievement scores of experimental group of students who used the CAI approach and the control group of students who used the conventional method in teaching the concepts in human blood circulatory system. The results are presented in Table 3.

TABLE 3: Analysis of variance of the post-test achievement scores between the control and the experimental groups

Group	N	X	S	Sd	T	P(Significance)
Control (C ₂)	40	33.37	7.46	76	-3.301	0.001
Experimental (C ₁)	35	38.15	5.03			

* $p < 0.05$

As shown in Table 3, there is a significant difference between the post-test achievement scores of the control and experimental groups ($t(76) = -3.301$; $p < 0.01$). The mean score of experimental group (= 38.15) was higher than the achievement score of the control group achievement (= 33.37) score. The result shows that the treatment (CAI) used on the experimental group enhanced the students' achievement.

Analysis of variance between pre-and post test scores of the experimental group

The pre-and post test mean scores of the experimental group obtained before and after the introduction of the intervention were compared. The independent sample t-test was used in the comparison assessment. The outcome of the analysis is shown in Table 4.

TABLE 4: Analysis of variance of the pre- and post-test students' achievement score of the experimental group

Test	N	X	S	Sd	T	P(significance)
Pret test	38	34.57	5.56	37	-2.806	0.008
Post test	38	38.15	5.03			

$p < 0.01$

In Table 3, there is a significant difference between the pre- and post-test scores of the experimental group ($t(37)$

= -2.806; $p < 0.01$). The mean score of students' pre-test score is =34.57, and the post-test score is =38.15.

This result shows that the treatment (CAI) used on the experimental group enhanced the students' achievement. Therefore, it can be concluded that the method applied positively affected the conceptual success of the students.

What are teachers' views on the usage of computers in teaching and learning?

The twenty (20) teachers' responses to the various questions posed as problems and difficulties encountered by them in the use of computers in the teaching and learning of the circulation of blood is presented in Figure 1.

All the 20 teachers, who took part in the investigation, were asked to state if they had problem with the use of computers. This question was asked because numerous research sources suggested that teachers often faced problems when they wanted to use computers in the teaching and learning process. The overall response from the teachers indicated that there were some problems that prevented them from using the computers any time they want to do so (Fig. 1).

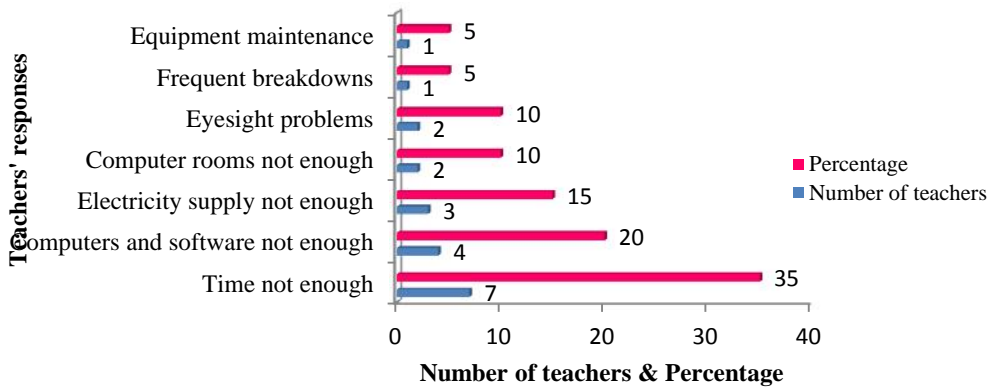


FIGURE 1: Problems & difficulties encountered in computer usage

Figure 1 shows that the most common problem rated high by the teachers was that the time allocated to students and teachers to use computers was not enough (35%) while computers and software were also not enough (20%). Inadequate electricity (15%) was another major concern of the teachers. There were other issues indicated by the teachers but the problem of inadequate time allocation agrees with similar findings by Kozma (1994), and Ertmer *et al.* (1999).

Factors that promote the use of computers in the teaching and learning process

The factors that influenced teachers' decision to use computers in teaching and learning were investigated. Teachers were asked to determine which factors were the most important for prompting teacher's initiatives and at the same time served as a demand from both parents and students.

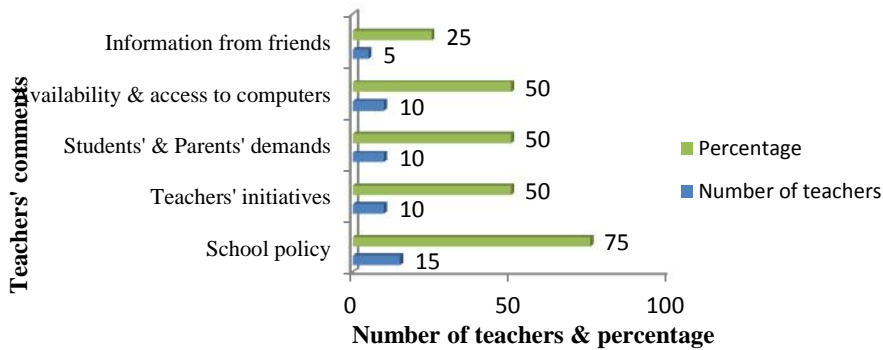


FIGURE 2: Factors that promote usage of computers

In Figure 2, the highly rated factor that promoted the usage of computers by teachers was school policy, which recorded 75% of the respondents as against 50% each for the teachers' initiatives, students' and teachers' demands, as well as availability and access to computers.

However, during discussions with teachers from the rural areas, one male teacher reported that he was encouraged to use computers by the school administration because; the chairman of the school board was computer literate. He

encouraged the school to introduce computers in the school and used them in the teaching and learning process. Another male teacher from an urban area also reported that parents felt that modern world was becoming computerized, and therefore students should be brought to fit into it.

DISCUSSION

The analysis of the study revealed no significant difference between the mean scores of the control (33.12) and experimental groups (34.57) of the pretest as indicated in Table 1. After the introduction of the intervention, the mean of the post-test achievement scores of the control (33.37) and the experimental (38.15) groups showed a marked significant difference. It shows that the CAI method of teaching students was far better than the Conventional Traditional Approach.

Further analysis into the groups' pre-test and posttest (34.57) scores of the experimental (38.15) group achievement tests indicated a significant difference (Table 4). It again clearly shows that the (CAI) intervention used on the experimental group tremendously improved students' performance. The conventional approach during both the pre-test and post-test of the control group did not record any significant difference as indicated in Table 2. Hence, the conventional approach used on the control group did not enhance the students' achievement.

The revelations about CAI were in line with many educators belief that the intervention was very useful supplement to classroom activities. Many educators had reported that it could be successful in raising exam scores, improving student attitudes, and reducing the time needed to master course materials (Canham & Dickie, 1986). It has also been shown that students like the mode of presentation (Anderson-Harper, Mason, & Popovich, 1988; Brown, 1995), and this is viewed as a positive experience (Deardoff, 1986), which is suitable for individual learning needs (Dobson, 1995).

CONCLUSIONS

In conclusion, the finding of this study is that the use of CAI is far more productive than the use of the conventional traditional approach. It has been shown that CAI has the ability to improve the performance of low achievers within a class. CAI has also a positive effect on students who show interest in learning with that instructional tool.

CAI as an instructional tool developed the students' interest in studying biology because it improved the performance of the students in the concepts they considered difficult, and also activated their participation in the classroom. It made students attendance in class regular and punctual. It also made lessons more practical oriented and reduced abstract lessons to a minimal level.

RECOMMENDATIONS

Based on the results of this study, it is recommended that the use of computer animation, which is capable of transforming students from passive recipients of knowledge into active learners, should be used to teach biology and other related science subjects. Science teachers and software developers should be encouraged to collaborate to develop relevant and interesting animations for teaching, especially for complex concepts like blood circulatory system in humans and DNA, RNA, and protein synthesis. Teacher training programmes also need to include courses on the use of computer-based tools and strategies in developing the curriculum. Where these courses already exist, it is important that teacher trainees be exposed to new and emerging tools and softwares that are relevant for the classroom, and can motivate students,

thereby increasing their achievement levels, especially in Biology. In addition, there is the need also to provide technical support to schools in terms of installation and maintenance of ICT infrastructure. There appears an under estimation of the magnitude of effort needed for the large-scale installation and maintenance of hardware, software, and networking equipment for an effective integration of ICT into school pedagogy. An extensive network of skilled technicians must be trained to support schools, administrators, teachers, and students.

ACKNOWLEDGEMENTS

We are much grateful to the staff and students of Kpando Senior High School for their contributions and support.

REFERENCES

- Anderson-Harper, F., Heidi, M., Holly, L., Mason, S., Nicholas, G. & Popovich, K. (1988) Developing, Implementing and Evaluating Microcomputer Instruction in a Nonprescription Drug Course. *American Journal of Pharmaceutical Education*, 52(20), 259-266.
- Alessi, S.M. & Trollip, S.R. (2001) *Multimedia for learning: Methods and development* (3rd ed.). New York: Allyn and Bacon.
- Bangkok, U. (2004) *Integrating ICTs into Education*. Retrieved July 18, 2011, from <http://www.unescobkk.org/index.php>.
- Beck, J. (1997) Teacher education and IT: national perspective. *European Journal of Teacher Education*, 20(1), 93-99.
- Bordens, K.S. & Abbot, B.B. (2002) *Research design and methods*. Boston: McGraw Hill.
- Brown, A. (1995) Evaluation of Teaching and Learning Processes in a Computer-Supported Mechanical Engineering Course. *Computers Education*, 25, 59-65.
- Bullock, D. (2004) Moving from theory to practice: an examination of the factors that preservice teachers encounter as they attempt to gain experience teaching with technology during field placement experiences. *Journal of Technology and Teacher Education*, 12(2), 211-237.
- Butzin, S. M. (2000) Project child: A decade of success for young children. *Technology Horizons in Education Journal*, 27, 11-12.
- Bybee, A., Smith, K., Williams, D., Conway, L., Robinson, W. & Franks, F. (2008) *Teaching secondary school: Strategies for developing scientific literacy* (9th ed.). Sydney: Pearson Prentice Hall.
- Canham, J., Geoffrey, W., Rayner, Y. & William, D. (1986) The Development of a Computer-Assisted Drill Program. *Journal of Computers in Mathematics and Science Teaching*, (4)5, 46-47.
- Cawthera, A. (2003) *Computers in secondary schools in developing countries*. Retrieved July 25, 2011, Available at: <http://imfundo.digitalbrain.com>

- Cherry, J.M. (1991) An Experimental Investigation of Two Types of Instruction for OPAC Users. *Canadian Journal of Information Science*, 16, 2-22.
- Clark, C.M. & Peterson, P.L. (1986) Teachers' thought process. In M.C. Wittrock (Ed.), *Handbook of research on teaching*. New York: Macmillan.
- Cohen, D.K. (1987) Educational technology, policy and practice. *Educational Evaluation and Policy Analysis*, 9(2), 153-170.
- Cohen, D.K. & Ball, D.L. (1990) Policy and practice: *Educational Evaluation and Policy Analysis*, 12(3), 347-353.
- Collis, R., Betty, W., Antoinette, O. & Wes Sherra, F. (1988) An Evaluation of Computer- Based Instruction in Statistical Techniques for Education and Social Work Students. *Journal of Educational Technology Systems*, 17, 59-71.
- Comppeau, G. & Higgins, J. (1995) Computer self-efficacy: *Development of a measure and initial test*, 23(2), 198-211.
- Conway, P. & Zhao, Y. (2003) From luddites to designers: Portraits of teachers and technology in political documents. In Y. Zhao (Ed.), *what should teachers knowabout technology? Perspectives and practices* (pp. 15-30). Greenwich, CO:Information Age Publishing
- Cox, M., Preston, C. & Cox, K. (1999) *What factors support or prevent teachers from using ICT in their classrooms?* Available at: [www.leeds.ac.uk /educol/ documents/01 304. htm](http://www.leeds.ac.uk/educol/documents/01304.htm).
- Cuban, L. (1986) *Teachers and machines: The classroom use of technology since 1920*. New York, NY: Teachers College Press.
- Czerniak, C.M., & Lumpe, A.T. (1996) Relationship between teacher beliefs and science education reform. *Journal of Science Teacher Education*, 7(4), 247-266.
- Cox, M., Preston, C. & Cox, K. (1999) *What factors support or prevent teachers from using ICT in their classrooms?* Retrieved February 20, 2011 from [http://www. leeds.ac. uk/ educol/documents/01304.htm](http://www.leeds.ac.uk/educol/documents/01304.htm)
- Daniel, J.I. (1999) Computer-Aided Instruction on the World Wide Web: The Third Generation. *Journal of Economic Education*, 2(15), 163-174.
- Deardoff, W.W. (1986) Computerized Health Education: A Comparison with Traditional Format. *Health Education Quarterly*, 13, 61-72.
- deMarrais, K. & Lapan, S.D. (Eds.) (2004) *Foundations for research: Methods of inquiry in education and the social sciences*. Mahwah, N.J.: Lawrence Erlbaum Associates, Inc., Publishers.
- Dobson, E.L. (September 1995) An Evaluation of the Student Response to Electronics Teaching Using a CAL Package. *Computers Education* 25: 13-20.
- Dynaski, G., Mazzeo, B., Raffeld, P., Checketts, T., Druesne, B. & Muhl-Stein, L. (2007) *Effectiveness of reading and mathematics software products; Findings from the first year students cohort*. Washington DC: Institute of Education Sciences, US Dept of Education.
- Ely, D.P. (1993) Computers in schools and universities in the United States of America. *Educational Technology*, 33(9), 53-57.
- Erickson, J. & Lehrer, R. (2000) What's in a link? Student conceptions of the rhetoric of association in hypermedia composition. In S. P. Lajoie (Ed.), *Computers as cognitive tools*, (pp.197-226). Mahwah, NJ: Lawrence Erlbaum Associates.
- Ertmer, P. (2003) Transforming Teacher Education: Visions and Strategies. *Educational Technology Research and Development*, 51(1), 124-128.
- Ertmer, P., Addison, P., Lane, M., Ross, E. & Woods, D. (1999) Examining Teachers' Beliefs about the Role of Technology in the Elementary Classroom. *Journal of Research on Computing in Education*, 32 (1), 54-72.
- Fiche, M., Bonvin, R., & Bosman, F. (2006) Microscopes and computers in small- group pathology learning. *Medical Education*, 40(11), 1138-1139.
- Garrett, R. L. (1995) Computer-assisted instruction in 2-year colleges: Technology for innovative Teaching. *Community College Journal of Research and Practice*, 19 (6), 529-536.
- Grossman, P.L., Wilson, S.M. & Shulman, L. (1989) Teachers of substance: Subject matter knowledge for teaching. In M.C. Reynolds (Ed.), *Knowledge base for the beginning teacher* (pp. 23-36). Oxford: Pergamon Press.
- Jenkins, R. (2004). VirtualUnknown Microbiology. *Journal of Biological Education*, 38(4), 197-197.
- Kara, I. & Yakar, H. (2008) Effects of computer supported education on the success of students on teaching of Newton's Laws of Motion, *World Applied Sciences Journal*, 3 (1), 51-56.
- Kausar, T. Choudhry, B.N., & Gujjar, J.J. (2008) A comparative study to evaluate the effectiveness of computer assisted instruction (CAI) versus classroom lecture (CRL) for computer science at ICS level: *The Turkish Online Journal of Educational Technology*, 7(4), 11-21. Retrieved May 05, 2011 from [http:// www. tojet. net](http://www.tojet.net)
- Kozma, R.B. (1994) Will media influence learning: reframing the debate. *Educational technology research and development*, 42(2), 7-19.
- Kubiatko, M. & Halakova, Z. (2009) Slovak high school students' attitudes to ICT using in biology lesson. *Computers in Human Behaviour*, 25(3), 743-748.
- Kuhlemeier, H. & Hemker, B. (2007) The impact of computer use at home on students' Internet skills. *Computers & Education*, 49(2), 460-480.
- Kulik, J. A. & Kulik C.C. (1989) Effectiveness of Computer-Based Instruction. *School Library Media Quarterly*, 17, 156-159.

- Kersaint, G., Horton, B., Stohl, H. & Garofalo, J. (2003) Technology beliefs and practices of mathematics education faculty. *Journal of Technology and Teacher Education*, 11(4), 549–577.
- Lai, K.W. Pratt, K. & Trewern, A. (2001) *Learning with technology: evaluation of the Otago secondary schools technology project*. Otago: Dunedin Press.
- McFarlane, A. & Sakellariou, S. (2002) The Role of ICT in Science Education. *Cambridge Journal of Education*, 32(2), 219-232.
- McLean, M. (2000) Introducing computer-aided instruction into a traditional histology course: student evaluation of the educational value. *Journal of Audiovisual Media in Medicine*, 23(4), 153-160.
- Mooij, T. & Smeets, E. (2001) Modeling and supporting ICT implementation in secondary schools. *Computers & Education*, 36, 265–281
- Myhre, O.R. (1998) I think this will keep them busy: computers in a teacher's thought and practice. *Journal of Technology and Teacher Education*, 6(23), 103-106.
- O'Byrne, P.J., Patry, A., Carnegie, J.A. (2008) The development of interactive online learning tools for the study of anatomy. *Medical Teacher*, 30(8), 260-271.
- Office of Technology Assessment (OTA) (1995) *Teachers and technology: making the connection*. Washington, DC: US Government Printing Office.
- Parr, J. M. (1999) Going to school the technological way: Co-constructed classrooms and student perceptions of learning with technology. *Journal of Educational Computing Research*, 20(4), 365-377.
- Pelgrum, W.J. (2001) Obstacles to the integration of ICT in education: results from a worldwide educational assessment. *Computers & Education*, 37, 163-178.
- Pelgrum, W.J. & Plomp, T. (1996) Information technology and children from a global perspective. In B. A. Couis, G. A. Knezek, K. W. Lai, K. T. Miyashita, W. J. Pelgrum, T. Plomp.V. & T. Sakamoto (Eds.) *Children and computers in school* (pp.23-25). Mahwah: Bantam.
- Ramasundaram, V., Grunwald, S., Mangeot, A., Camerford, N.B. & Bliss, C. M. (2005) Development of an environmental virtual field laboratory. *Computers & Education*, 45, 21-34.
- Reynolds, D., Treharne, D. & Tripp, H. (2003) ICT the hopes and the reality. *British Journal of Educational Technology*, 34(2), 151-167.
- Sarfo, Q. & Elen, J. (2007) Developing technical expertise in secondary/technical schools: The effect of 4C/ID learning environments. *International Journal of Learning Environments*, 30(25), 27-41.
- Taylor, R.P. (2003) Reflection on The Computer in the School. *Contemporary Issues in Technology and Teacher Education*. 3(2), 253-274.
- Tabassum, R. (2004) Effect of computer assisted instruction (CAI) on the secondary school student achievement in science. PhD Thesis, Rawalpinda, Pakistan: University of Arid Agriculture. Retrieved on 20/04/12. Prr.hec.gov.pk/thesis/235.pdf
- Van Belle, G.C. & Soetaert, R. (2001) Breakdown into the virtual user-involved design and learning. *Journal of Technology and Teacher Education*, 9, 31–42.
- Veen, W. (1993) The role of beliefs in the use of information technology: implications for teacher education, or teaching the right thing at the right time. *Journal of Information Technology for Teacher Education*, 2 (2), 139-153.
- Waite, S. (2004) Tools for the job: A report of two surveys of information and communications technology training and use for literacy in primary schools in the West of England. *Journal of Computer Assisted Learning*, 20, 11–21.
- Watson, D.M. (1998) Blame the techno centric artifact! What research tells us about problems inhibiting teacher use of IT? In G. Marshall, & M. Ruohonen (Eds.), *Capacity building for IT in education in developing countries* (pp. 185–192). London: Chapman & Hall.
- Wild, C. J. (1995) Continuous improvement of teaching: A case study in a large statistics course. *International Statistical Review*, 63, 49-68
- Wood, E. & Bennett, N. (2000) Changing theories, changing practice: exploring early childhood teachers' professional learning. *Teaching and Teacher Education*, 16(5/6), 635-647.
- Woodrow, J.E. (1992) The influence of programming training on the computer literacy and attitudes of pre-service teachers. *Journal of Research on Computing in Education*, 25(2), 200–219.
- Yildirim, S. (2007) Current Utilization of ICT in Turkish Basic Education Schools: A Review of Teacher's ICT Use and Barriers to Integration. *International Journal of Instructional Media*, 34(2), 171-86.
- Yuen, A., & Ma, W. (2002) Gender differences in teacher computer acceptance. *Journal of Technology and Teacher Education*, 10 (3), 365-382.
- Zhao. Y. & Cziko, G.A. (2001) Teacher adoption of technology: a perceptual control theory Perspective. *Journal of Technology and Teacher Education*, 9, 5–30.