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

K.A. Owusu [a,*], K.A. Monney [b,1], J.Y. Appiah [a,2], E.M. Wilmot [a,3]

[a] Department of Science & Mathematics Education, University of Cape Coast, Cape Coast, Ghana
[b] School of Biological Sciences, Department of Entomology & Wildlife, University of Cape Coast, Cape Coast, 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).

* Corresponding author. Tel.: +233 243306601, +233 208879599.
E-mail addresses: kofiacheaw@yahoo.co.uk (K.A. Owusu), kamonney@yahoo.co.uk (K.A. Monney).
[1] Tel.: +233 209032393.
[2] Tel.: +233 208182365.
[3] Tel.: +233 240835305.

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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