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Effect of Computer Based Instruction on Secondary School Learners' Academic Achievement in Biology


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Abstract

Purpose: This study investigated the effect of computer based instruction (CBI) on secondary school learners' academic achievement in Biology.

Methodology: The study was carried out in four schools, using quasi experimental research design and was guided by systems theory. The target population was 40, 564 secondary school Biology learners. Sampling was by purposive sampling and simple random sampling. The sample comprised of 161 learners. These were obtained from four form two streams in four secondary schools that had learners of mixed gender. Each secondary school contributed a stream, which gave four intact groups. Data collection was by use of questionnaires and achievement test. The collected data was analysed using descriptive statistics such as frequencies, percentages and means and inferential statistics such as analysis of covariance (ANCOVA) and analysis of variance (ANOVA), using the Statistical Package for Social Sciences (SPSS). The data was then presented in the form of tables and a graph. The significance level of the difference between the variables was done at the alpha value of 0.05.

Findings: Findings of the study indicate that learners who were taught using CBI had superior scores compared to those who were taught conventionally. The ANCOVA to explore whether or not there was a statistically significant difference between the groups of learners indicated that indeed there was a statistically significant difference between the groups. Consequently, CBI improves learners' academic achievement in Biology. However, there was no effect of gender on the way CBI influenced the performance.

Unique Contribution to Theory, Practice and Policy: The study was guided by systems theory Schools should therefore enhance computer integration in the teaching and learning process.

Keywords: *Academic Achievement, Computers, Instruction*

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INTRODUCTION

Biologists, like other scientists, engage in careful observation; collect, organize and analyse data; measure, graph and understand spatial relations; pay attention and regulate their own thinking; and know when and how to apply their knowledge to solve problems (Santrock, 2004). These skills, which are essential to the practice of science, are not routinely taught in schools. Therefore, it is hoped that as they interact with computers, learners can intentionally or inadvertently acquire them. Indeed, the most commonly used methods of establishing whether or not the objectives of teaching have been achieved is through tests and examinations. However, just like other sciences, and in addition to mathematics, performance by secondary school learners in Biology examinations is generally poor as compared to non-science subjects. This implies that the objectives of including Biology in the curriculum are not being achieved. The poor performance could be due to unsuitable teaching techniques employed by teachers (Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA), 2012; Republic of Kenya, 2012).

As at the time of this study in 2011, poor performance in Biology examinations was not unique to any single country. For example, Ryan and Cooper (1998) argued that American youth did not know much science. When science is referred to, Biology is included. This was echoed by Sadker and Sadker (2000) who argued that the scores of American learners on international tests, especially in mathematics and science were low. Indeed, Grossel (2007) argued that there was a traditional failure rate in Biology in America. Consequently, schools were seen not to meet America's economic and technological needs. Apart from America, secondary school learners' performance in Biology in Turkey was also poor. For example in the statistics from the University Entrance Examination in Turkey, learners answered on average 12.77 out of 30 (42.6%) science questions correctly. When average answers per subject were examined, the percentage correct for Biology was 38.1%, which was the lowest among all the sciences (Atilla, 2012). Among the reasons given for this poor performance was that Biology was generally based on memorization. Computers, being quite versatile and multimedia in nature, can enhance meaningful learning.

Academic performance in Biology in some African countries was also poor. In South Africa, for example, although the mean mark in life sciences (formerly Biology) improved from 35% in 2009 to 38% in 2010, the mark was still below average (Basic Education, n.d.). In November 2016, the Trends in International Mathematics and Science Study (TIMSS), a quadrennial test sat by 580, 000 pupils in 57 countries, had South Africa at or near the bottom of its various rankings (Macha and Kadakia, 2017). These low averages could be due to the very low level of practical work at school level (Laugksch, n.d.).

In Kenya, the national Biology performance in Kenya Certificate of Secondary Education (KCSE) examination had and has always been below average, fluctuating and on a downward trend, as shown in Table 1 below.

Table 1: Kenya National Percentage Scores in Biology by Year

Year	National percentage mean score
1998	29.79
1999	31.21
2000	27.81
2001	27.49
2005	29.63
2006	27.45
2007	41.95
2008	30.32
2009	27.43
2011	32.44
2012	26.21

Source: Kenya National Examination Council (KNEC) (2002, 2007, 2008, 2010), Nation Correspondent (2013)

The data in Table 1 above shows that all the Kenya national mean scores in Biology were below average. The poor performance in science (Biology included) was a national concern and was articulated in the Session Paper Number 1 of 2005 (Ministry of Education, Science and Technology (MOEST), 2005b). The Kenyan government had put in place strategies such as Strengthening Mathematics and Science Education (SMASE) in-service training for teachers, content reduction and re-organisation, employment of more teachers and provision of teaching and learning materials to schools. However, these interventions had not remedied the situation.

Vihiga is one of the Kenyan counties that performs poorly in Biology, both in pre-KCSE assessment (formerly called mock examination) and final examination at the end of form four. For example, in addition to a Vihiga county KCSE mean score of 4.63 in 2008 (Kwega, 2009) and 4.36 in 2012 (Republic of Kenya, 2012), the Biology mean scores in Vihiga County pre-KCSE assessments were as shown in Table 2 below.

Table 2: Vihiga County Biology pre-KCSE Mean Scores by Year

Year	Vihiga county Biology mean scores in pre-KCSE assessment out of 12 points
2004	3.74
2005	4.36
2006	4.18
2007	4.37
2011	4.08
2013	4.60

Source: Vihiga District (2007), Republic of Kenya (2011, 2013)

All the mean scores in Table 2 above were below average on a 12 point scale. Hence, there was need to put in place strategies that could remedy the situation. One of such strategies could be the use of computers in teaching and learning.

The use of technology is not new to education. In early 1800, a technological innovation, the blackboard, was introduced to classrooms and had a profound impact on teaching and learning (Ryan and Cooper, 1998). During the prehistoric time, communication was through signs and

later became verbal after the invention of language (Shelly, Cashman, Vermaat and Walker, 2000). Verbal communication, without technology, would require the two parties to interact closely. Ellis (1997) argues that learners in ancient Athens were often called peripatetic (a word that means walking around because they were frequently seen strolling the city, engaged in heated philosophical debate). Later on writing was invented, making people to communicate through written messages. The first widely used textbook with pictures, called *Orbus pictus* or *The world in pictures*, was produced by a Czeck educator called Comenius in 1658 (Selwyn, 2010). Then there was the invention of the telephone, radio, television (TV) and then computers.

Computers are the most sophisticated multimedia tools that can engage a variety of senses (Awais, Bilal, Usman, Wagas and Sehrish, n.d.). Jaffer, Ng'ambi and Czerniewicz (2007) point out that educational technology has a key role to play as one of the strategies for addressing teaching and learning concerns. The computers as a technology can enhance communication between a teacher and a learner, a learner and a learner, and a teacher and another teacher. It can also enhance communication between the ministry of education authorities and the other educational stakeholders. Therefore, if well used, the technology can increase the efficiency and effectiveness of learning.

Initially communication was through signs, then speaking and then writing (Shelly *et al*., 2000). Therefore, teaching initially involved verbal communication between the teacher and the learner (Ellis, 1997). Later on audio technology, visual technology and then audiovisual technologies were adopted in education with the aim of enhancing learning. One of the audio technologies, the radio, and the audiovisual technologies, the TV, had had great impacts on education. In 1960s educational TV was considered in the United States of America as a possible method of handling teacher shortage caused by the baby boom (Schmidt and Vandewater, 2008). This technology could bring instruction into classrooms and homes – even the most remote. Nevertheless, although the TV was seen to teach more effectively and at a lower cost than human teachers, it was less interactive and less multimedia than computers (Ahiatrogah, Madjoub and Bervell, 2013) and was also blamed for decline in test scores (Sadker and Sadker, 2000). This could be because it was not well used for instruction, and that learners would have focused on news and entertainment programs than the programs relevant to the curriculum. Exposure of children to programs designed around an education curriculum is associated with cognitive and academic enhancement whereas exposure to pure entertainment and violent content is associated with poor cognitive development and lower academic achievement (Kirkorian, Wartella and Anderson, 2008). Indeed computers have a variety of software and hardware, which can affect the education of learners positively or negatively, depending on how they are used. Consequently, as a result of the problems associated with the earlier mass media tools adopted in education, such as TVs, investigations needed to be done in order to determine whether or not CBI could enhance the learning of Biology.

The use of computers in education is categorized into three groups: learning about computers; learning with computers, where learners use computers as a tool; and learning through computers which involves use of computers as an aid for the teachers to do their presentation (Serin, 2011). The computers may be used to deliver instruction or as objects of instruction to teach about computers, manage instruction and for producing reports or handouts (Geisert and

Futrel, 2002). Teaching about computers is done in Computer Studies, Computer Science and computer literacy classes. In Kenyan secondary schools, teaching about computers is done in a subject called Computer Studies. However, some learners or teachers may learn about them in computer literacy classes or inadvertently while interacting with the computers.

The mode of teaching in which the computer is used to assist the teacher teach more effectively is called computer based instruction (CBI) and the learning that is brought about by CBI is called computer based learning (CBL) (Jonassen, 1988). Cotton (1997) argues that CBI is broad and refers to any kind of computer use in education, including drill and practice, tutorials, simulations, instructional management, supplementary exercises, programming, database management, writing using word processors and other applications. These terms may refer either to stand alone computer learning activities or to computer activities which reinforce material introduced and taught by the teachers. Among the advantages of CBI are that some of them offer individualized learning, in order to enable learners to learn at their own pace (Collins, Deck and McCrickard, 2008). It also motivates learners because it can turn practice into an entertainment game (Kulik and Kulik, 1991; Kulik, Kulik, and Bangert-Drowns, 1985). Furthermore, it builds confidence in learners as it can help timid learners to become comfortable and active. However, not all CBI deserves praise. This is because some of it gives inappropriate feedback, allows learners to practice mistakes and discourage them from moving into new material (Beekman, 2001).

Several experimental studies have been done to explore the effect of CBI on learning. For example, a meta-analysis done on 28 and 254 studies by Kulik *et al.* (1985) and Kulik and Kulik (1991), respectively, found that learners from CBI classes received better exam scores than those from the conventional classes. Cotton (1991) analysed 59 research reports on CBI and found that CBI produced achievement effects superior to those obtained with traditional instruction alone. Other researchers who had found that CBI impacts positively on academic achievement are Tekbiyik and Akdeniz (2010), Mwei, Too and Wando (2011), Ahiatrogah *et al* (2013), Serin (2011), Bakac, Tasoglu and Akbay (2011), Adegoke (2011), Kiboss, Wekesa and Ndirangu (2006), Achuonye (2011), and Akwee, Toili and Palapala (2012). Apart from improvement on academic achievement, the studies by Kulik and Kulik (1991) and Robinette (n.d.) found that CBI improved learners' attitude towards learning.

Although the above studies showed improved academic performance in the context of CBI, there were some variations. For example, Christmann and Badgett (1999) in Odera (2011) found that CBI was more effective among learners in urban areas, then sub-urban areas and then rural areas. Tekbiyik and Akdeniz (2010) and Kulik and Kulik (1991) found that the effect of CBI depended on educational level. Indeed, while Kulik and Kulik (1991) and Kulik et al (1985) found the effect of CBI to be higher at elementary school level followed by secondary school level then university level, Tekbiyik and Akdeniz (2010) found higher effect in elementary school level followed by university level and then secondary school level. Tekbiyik and Akdeniz (2010) also found greatest effect to be in general science then Physics, Chemistry and then Biology. Cotton (1991) points out that CBI is more effective in science and foreign languages, followed in descending order by Mathematics, reading, language arts and English. Apart from the variations, Owusu, Monney, Appiah and Wilmont (2010) in their study in Ghana found that the students that were taught Biology by conventional approach performed better on post-test than those taught by use of computers. Kirkorian *et al*. (2008) argue that influences of electronic media on academic achievement can be for good and for ill. Additionally, although there were a lot of studies on the effect of CBI on learners' academic

achievement, there were few in science education (Tekbiyik and Akdeniz, 2010). Furthermore, because it was more effective in primary schools than higher levels and for factual than higher order cognitive skills, there was need to do more investigations on its effect on the learning of secondary school Biology.

In Kenya, the importance of computers in education is acknowledged in the National ICT policy, and the Kenya Vision 2030 and one of the flagship projects in education and training is the establishment of a computer supply program that would equip learners with modern information technology (IT) skills (Kenya Vision 2030, 2007; Glen, 2007). This supply programme is stipulated in Kenya Education Sector Support Programme (KESSP), which states that the government would make education the avenue for equipping the nation with ICT (MOEST, 2005a). One method used by the Kenya Government to increase learners' accessibility to computers was by supplying computers to schools. For example, there was a computer supply program to selected secondary schools in each constituency through the economic stimulus program (ESP). In the year 2016 the government supplied Tablets and laptops to all public primary schools. Furthermore, the increased installation of electricity in rural areas is likely to make many people to access computers, making them to become part of our lives (Laudon, Laudon and Brabston, 2002). In addition, advertisements thrust to both education and parents are that people should invest in as much computers as early as possible or learners would be left hopelessly behind. This makes some educational stakeholders to put pressure on schools to integrate computers in their curriculum (Noll, 2005). This study, therefore, investigated the effect of computer based instruction (CBI) on secondary school learners' academic achievement in Biology. To address this objective, the null hypothesis which states that: There is no significant difference between the academic achievement of Biology learners taught by CBI and those taught conventionally was tested.

Statement of the Problem

There is concern over the learners' continued poor performance in Kenya Certificate of Secondary Education (KCSE) examination in Biology. Interventions such as the SMASE in-service training for teachers, content reduction and re-organisation, employment of more teachers and provision of teaching and learning materials to schools had failed to remedy the situation. The government was advocating for ICT integration in teaching and learning since it was hoped that this would help deal with the problem. However, although some researchers had demonstrated that CBI influences academic performance positively, others had shown that it influences academic performance negatively. Hence, there is a division among researchers on the academic benefits of computers. In addition to providing information that would contribute towards showing the effect of computer use on learners' performance in Biology, this study would also contribute towards shedding light on the academic benefits of computers. Consequently, this study set out to investigate the effect of computer based instruction on academic achievement in Biology.

Theoretical Framework

This study was guided by the systems theory, which emerged during and after World War II (Banathy, 1968). The best known of the systems theorists is Ludwig von Bertalanffy. In 1940s and 1950s, he proposed a theory of general systems that would explain the behavior of all levels of science from that concerned with a single cell to the study of society (Schermerhorn, 1986). His work largely focused around the interconnections among the components of a system (subsystems), the logic that the whole is greater than the sum of its parts. According to this

theory, given an input, all the subsystems within the system take part in the processing to give rise to the final product. Systems approach is the systematic application of educational technology to an educational or training problem, starting with the input (entry behavior) to the output (terminal behavior) and determining how best to progress from the former to the latter (processing) (Percival and Ellington, 1988; Sigh, 2009). The purpose of systems approach is to ascertain that the behavior of an individual is controlled in a way which is consistent with the total demands of the environment. This implies that the evaluation of the effect of CBI on learning should be done within a broad framework (Cox and Webb, 2004)

Biology teaching and learning is composed of various subsystems, one of which is the content. The content is organized into various topics. The topics have sub-topics which are taught in various lessons. This study focused on the sub-topic of '*The structure and function of the kidney*'. The lesson subsystem is composed of lesson topic, lesson objectives, subject matter, evaluation, learners, the teacher, instructional methods and resources (Mukasa-Simiyu, 2001). For the lesson objectives to be achieved, then the subsystems selected for the lesson must be compatible with the objectives. For example, the right instructional material must be used by the right teacher in the right way to the right learners. Indeed, if well used, computers can enhance the teaching and learning of Biology. However, if not well used the computers can affect the learning of Biology negatively (Kirkorian *et al*., 2008).

METHODOLOGY

This study used quasi experimental research design. According to Ndagi (1984) experimental research is a process that provides a systematic and logical procedure of identifying and evaluating the relationship between variables that create a particular state of affairs under controlled conditions. In education the state of affairs a researcher would like to create is the condition of learning. The variable that provided the condition of learning in this study was computer use.

There are various types of quasi experimental research designs. However, the one that was adopted in this study was the Solomon four group design. In this design there are two experimental groups and two control groups. One experimental group and one control group were pre-tested and then the four groups were post-tested. Moreover, because only half of the groups were pre-tested, this study determined the effect of the treatment when the pre-test was given and when it was not given (Ndagi, 1984). For this reason the results of the experiment can be generalized beyond the groups that took part in the experiment, which guarantees the external validity of the results.

The experimental groups were taught using CBI while the control groups were taught conventionally. Threats to internal validity such as mortality and history were controlled by having a relatively shorter study duration (Ahiatrogah *et al.*, 2013). The study was done in October 2011 and took three lessons within one week. The lessons were synchronized and took place on Monday and Tuesday of the same week. The learners were then notified of the test, which took place on Friday afternoon in the same week. There was no threat of mortality since the group sizes remained constant throughout the study duration. The research design was represented as follows:

Group I (E1)	O_1	X	O_2
Group II (C1)	O_3	___	O_4
Group III (E2)	___	X	O_5
Group IV (C2)	___	___	O_6

Where: E: Experimental group

C: Control group
O_1 and O_3 are pre-tests
O_2, O_4, O_5 and O_6 are post-tests
X is treatment where learners were taught by use of CBI
___ is neither pre-test nor treatment where learners were not pre-tested and were taught using conventional teaching methods
---------- indicates non-equivalent groups

Group I is the experimental group, which received the pre-test (O_1), the treatment (X) and the post-test (O_2). Group II is the control group which received the pre-test (O_3), followed by the control condition and finally a post-test (O_4). Group III received the treatment (X) and post-test (O_5) only, but did not receive the pre-test. Group IV received post-test (O_6) only and was taught using the conventional teaching method.

Vihiga County, where the study was carried out, was the most densely populated rural county in Kenya (Republic of Kenya, 2010). High population density is associated with social and economic problems such as unemployment, faster spread of diseases, social conflicts, immorality and environmental degradation. Some of these problems can be solved by knowledge of Biology. The target population was as shown in Table 3 below.

Table 3: Number of Schools and Learners in Vihiga County as at May 2011

Sub-county	Number of schools	Number of form ones	Number of form twos	Number of form threes	Number of Biology learners in form 3	Number of form fours	Number of Biology learners in form 4
Emuhaya	31	2608	2854	2952	2863	2353	2283
Hamisi	36	3543	3271	3163	3068	2327	2257
Sabatia	28	3322	2570	2616	2538	2111	2048
Vihiga	19	2425	1748	1779	1726	1484	1440
Total	**114**	**11898**	**10443**	**10510**	**10195**	**8275**	**8028**
Number of Biology learners		**11898**	**10443**		**10195**		**8028**
Grand total number of Biology learners							**40564**

Source: (Ministry of Education, 2011 a, b, c and d)

Table 3 above shows that the target population was 40564 learners. Some form 3 and form 4 learners proceed with Biology while others drop it at the end of form 2. Consequently, Form 1 and 2 classes were similar because Biology was compulsory. Form 3 and 4 were also similar because in these classes Biology was elective (MOEST, 2003). Moreover, in the year 2009 it was only about 97% of the Vihiga County form 4 learners who registered for Biology in KCSE (Vihiga District Joint Pre-KCSE Assessment, 2009). In this study it was assumed that 97% learners did Biology in Form 3 and 4 in the year 2011. The accessible population was therefore 40564 learners.

Four schools were purposively selected for the study. The four schools were those that had not yet taught the content area under this study but would teach it within the study period. This study investigated the teaching and learning of '*The structure and function of the kidney'*. Preference was given to schools with learners of mixed gender and had computers. Preference was given to schools that had computers so as to have learners who were more familiar with computers. Schools that had learners of mixed gender were preferred because the study intended to compare the effect of CBI in relation to gender. In each school, it was only one Form 2 stream that was involved in the study. In the schools that had more than one stream, simple random sampling was used to select the stream to be included in the study. The teachers who taught the learners were selected purposively. The criterion for selecting the teachers was on the basis of the streams they taught. The Biology teacher of the stream that took part in the study is the one who was selected and trained to teach the learners. Table 4 below shows the teaching strategy for each group of learners.

Table 4: Teaching Strategy for Each Group of Learners

Group	No of learners	Steps		
Experimental group I	41	Pre-test	CBI	Post-test
Control group I	42	Pre-test	Conventional	Post-test
Experimental group II	52		CBI	Post-test
Control group II	26		Conventional	Post-test

Table 4 above shows that two streams were taught using CBI and the other two streams were taught conventionally. The number of learners was taken as they were in the sample streams. The four streams that took part in the study gave a total sample size of 161 learners. This was considered to be an adequate sample because Gall Gall, Borg, and Gall (1996), and Kathuri and Pals (1993) recommend a minimum sample size of 15 cases for experimental study. Form two was considered to be relevant for the study because it is in this class that the content related to the kidney is taught (Republic of Kenya, 2002).

The data collection instruments that were used in this study were Biology Lesson Learners' Questionnaire (BLLQ) and Biology Lesson Achievement Test (BLAT). Lesson notes and lesson plans were used to guide the lessons. The instruments for data collection were piloted in order to assess their appropriateness. Mugenda and Mugenda (1999) recommend a pilot sample of between 1% and 10%. Piloting was done in a school that did not take part in the study. The pilot school was chosen purposively from Nandi County in Kenya. In this study Cronbach's coefficient alpha was used to estimate reliability. Cronbach's coefficient alpha is the average split-half correlation based on all possible divisions of the measuring instrument into two parts. Cronbach's coefficient alpha was considered appropriate for this study because it is suitable for both open ended and closed items (Gall *et al.,* 1996; Salvia & Ysseldyke,

2001). Instruments in this study had both open-ended and closed items. The reliability coefficients for the tools were 0.73 for BLAT and 0.80 for BLLQ. In this study, experts from Masinde Muliro University of Science and Technology judged the content and face validity of the instruments. They determined the extent to which the items in the instruments measured what they purported to measure and whether or not they were arranged in the required order. Their comments were incorporated in designing the drafts to be piloted. After piloting, the instruments were refined in order to make them more effective in data collection. Both descriptive and inferential statistics were used for data analyses. The descriptive statistics that were used for data analysis were frequencies, percentages and means. These were summarized using tables and graphs. The inferential statistics that were used for data analysis were analysis of covariance (ANCOVA) and analysis of variance (ANOVA). The significance of the statistical tests was done at the alpha value of 0. 05. The analyses of the data were done using Statistical Package for Social Sciences (SPSS).

RESULTS DISCUSSIONS

This study set out to determine the effect of CBI on achievement in Biology. In addition, the attitude of the learners towards CBI was explored. CBI involved the use of animations to teach about '*The structure and function of kidneys'*. The animations were downloaded from http://www.katherinepmanuel.com/humanbody/. The experimental group was taught using the animations while the control group was taught using the conventional teaching methods. The Biology learners' achievement was the scores attained by them in a test (BLAT) that was administered after the teaching. The attitude of learners towards the lessons was explored by the use of the BLSQ. The BLAT was used during pre-test and post-test. The means and standard deviations of the pre-test and post-test results are shown in Table 5 below.

Table 5: Summary of the Learners' Pre-Test and Post-Test Scores

Group	Pre-test results			Post-test results		
	N	Mean (%)	SD	N	Mean (%)	SD
Control group (I)	42	0.6667	1.0969	42	27.1905	14.1770
Experimental group (I)	41	0.7073	1.0306	41	34.9268	16.6304
Control group (II)				26	25.2308	12.5102
Experimental group (II)				52	28.2692	12.9177

As shown in Table 5 above, the pre-test mean scores were 0.67 for Control Group 1 and 0.71 for Experimental Group 1. To test whether or not there was a statistically significant difference between the pre-test scores, an independent samples t-test was performed and the results were as presented in table 6 below.

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Table 6: Independent Samples T-Test on the Pre-Test Scores

		Levenes Test for Equality of Variances		t-test for Equality of Means						
Pre-test		F	Sig.	T	Df	Sig.(2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval Of Mean	
									Lower	Upper
	Equal variance assumed	.000	.986	-.174	81	.862	4.07E-02	.2337	-.5057	.4244
	Equal variance not assumed			-.174	80.884	.862	4.07E-02	.2336	-.5054	.4241

Table 6 above indicates that there was no significant difference between the two means ($t_{(81)}$ = -0.174, p>0.05). This implies that the two groups were equivalent before treatment.

The mean marks on post-test scores for the four schools were 27.19, 34.93, 25.23, and 28.27, for Control group (I), Experimental group (I), Control group (II) and Experimental group (II), respectively (Table 5). The highest mean score was attained by Experimental group (I) followed by Experimental group (II) then Control group (I) and lastly Control group (II). The schools that were taught using CBI had higher scores than the schools that were taught using the conventional teaching method. This is consistent with the literature on CBI. This is because other researchers such as Achuonye (2011), Kiboss *et al.* (2006) and Akwee *et al.* (2012) demonstrated that the experimental groups that used CBI performed better in selected Biology content areas than the control groups that used the conventional teaching methods. The post-test results are illustrated graphically in Figure 1 below.

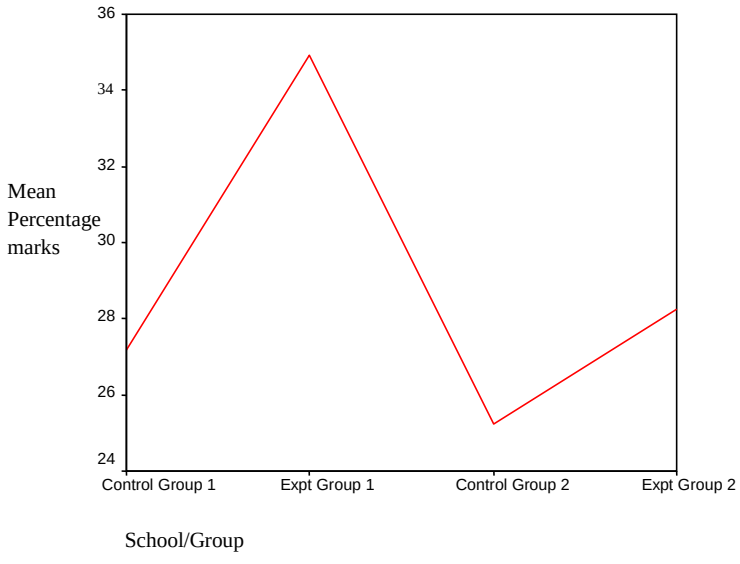

Figure 1: Post Test Results

As shown in Figure 1 above, Experimental group 1 performed better than the other groups. It was followed by Experimental group 2, then Control group 1 and lastly Control group 2. Control group I and Experimental group I could have scored better than Control group II and

Experimental group II, respectively, because of the influence of the pre-test. One-way between-groups analysis of covariance (ANCOVA) was performed to explore the effect of the treatment on performance in Biology. However, before the comparison was done, preliminary studies were conducted to find out whether or not there was violation of the assumption of normality, assumption of linearity, assumption of homogeneity of regression slopes and the assumption of homogeneity of variances The assumption of normality was tested and it was found that the Kolmogorov-Smirnov statistic for the scores was less than 0.0005, which indicates that the distribution of the scores on the dependent variable was not normal. Pallant (2007) argues that with large enough sample sizes (30+) the violation of this assumption should not cause any major problems. The distribution had a positive skewness and kurtosis of 1.091 and 1.008, respectively. The distribution was not normal partly because sampling was not randomly done. The result for the test of the assumption for homogeneity of regression slopes is shown in Table 7 below.

Table 7: Test of between Subjects Effects between Post Test Scores and the Covariate

Source	Type III Sum of Squares	Df	Mean Squares	F	Sig.
Corrected Model	11848.669	7	1692.667	11.855	.000
Intercept	1848.630	1	1858.630	12.947	.000
School	192.214	3	64.071	.449	.719
PRIMX100	8028.855	1	8028.855	56.23	.000
SCHOOL*PRIMX100	78.514	3	26.171	.183	.908
Error	21846.362	153	142.787		
Total	170900.0	161			
Corrected Total	33695.031	160			

The results in Table 7 above show that the test of the assumption for homogeneity of regression slopes gave a significance value of 0.908. Being greater than 0.05, this value shows that the study did not violate this assumption. Consequently, it can be argued that there was no interaction between the covariate and the experimental manipulation. Moreover, the Levene's test of equality of error variances gave a significance value of 0.130. As this value was greater than 0.05, it showed that the study did not violate the assumption of homogeneity of variances. This could be due to the fact that all the schools that took part in the study were of the same category (sub-county schools according to the Kenyan classification) and hence they admitted similar learners.

A one-way between-groups ANCOVA was performed to explore the effect of treatment on Biology learners' performance, using Kenya Certificate of Primary Education (KCPE) examination marks as the covariate, and the results were as shown in Table 8 below.

Table 8: One Way between Groups ANCOVA for the Post-Test Scores

Source	Type III Sum of Squares	Df	Mean Squares	F	Sig.	Eta. Squared
Corrected model	11770.155	4	2942.539	20.937	.000	.349
Intercept	2046.406	1	2046.406	14.561	.000	.085
PRIMX100	9801.227	1	9801.227	69.738	.000	.309
School	3767.474	3	1255.825	8.935	.000	.147
Error	21924.876	156	140.544			
Total	**170900.0**	**161**				
Corrected Total	**33695.031**	**160**				

Table 8 above indicates that there was a statistically significant difference between the treatment and performance in Biology at the alpha value of 0.05 for the 4 groups: F (3,156) =8.935, P<0.0005, with a large effect size shown by a partial eta squared value of 0.147. Learners in the schools that used the CBI teaching strategy had better scores than those in the schools that used the conventional teaching method (Table 5 and Figure 1). This is consistent with the literature on CBI. For example Collins *et al*. (2008); Kulik and Kulik (1991); Kulik *et al*. (1985); Tekbiyik and Akdeniz (2010); Achuonye (2011); Adegoke (2011); Kiboss *et al*. (2006); and Akwee *et al*. (2012) did research and found that the experimental groups that were taught using CBI scored better than the control groups that were taught using the conventional teaching methods. This is corroborated by the learners' responses to the questionnaire item which required them to indicate the amount of the lesson they thought that they had understood. The results are shown in Table 9 below.

Table 9: Frequency and Percentage of Learners in Each Group for Each Percentage of the Lesson Perceived To Have Been Understood

Treatment	0-25%	26-50%	51-75%	75-100%	Total
Experimental group I		9(21.95%)	18(43.90%)	14(34.15%)	41
Control group II	2(7.69%)	14(53.85%)	10(38.46%)		26
Control group I		11(26.19%)	19(45.24%)	12(28.57%)	42
Experimental group II		8(15.38%)	30(57.69%)	14(26.92%)	52
Total	**2**	**42**	**77**	**40**	**161**

According to Table 9 above, it can be observed that a higher frequency (proportion) of learners in the experimental groups (32(78.05%) and 44(84.61%) from experimental group I and II, respectively) were found in the upper half than the lower half of the scale which had more learners from the control groups (16(61.54%) and 11(26.19%) learners from control groups II and I, respectively)

A one-way between groups ANOVA was performed to compare the effect of the treatment on the enjoyment and understanding of the lesson as perceived by the learners. The results are shown in Table 10 below.

Table 10: One Way between Groups ANOVA for the Four Groups on the Enjoyment and Understanding of the Lesson

		Sum of Squares	Df	Mean Squares	F	Sig.
Enjoyment	Between groups	1.898	3	.633	2.574	.056
	Within groups	38.574	157	.246		
	Total	**40.472**	**160**			
Much understood	Between groups	13.564	3	4.521	9.314	.000
	Within groups	76.213	157	.485		
	Total	**89.776**	**160**			

Results in Table 10 above show that there was a statistically significant difference between the treatment and the amount of the lesson the learners thought that they had understood at the alpha value of 0.05 for the four groups: F (3, 157) =9.314, P<0.0005. The result in Table 10 above is also consistent with the literature on CBI. For example Bearden and Hinkle (n.d.); Bakac et al (2010) and Serin (2011) did research and found that the learners that were taught using CBI improved their attitudes towards learning. Table 10 also shows that due to the significance value of 0.056, which is greater than 0.05, then there was no significant difference in the enjoyment of the lessons between the four groups. This could be due to the fact that teachers in the lessons that used the conventional teaching strategy improved their teaching because of the knowledge of participating in the experiment. Alternatively, learners were more interested and keen because of the same reason. This is called Hawthorne effect (Best and Kahn, 2000; Kulik and Kulik, 1991). However, some learners in the lessons that were taught using the CBI teaching strategy could have had problems with the computers. This is because while responding to the question requiring them to indicate whether or not they would like other lessons to be taught like the lessons in this study, some learners indicated that they would not wish other lessons to be taught the way the lessons in this study were taught. This is shown in Table 11 below.

Table 11: Whether Learners Would Want Other Lessons to Be Taught the Way Lessons in the Study were Taught

School	Whether wants other lessons taught like the lessons in the study		Total
	Yes	No	
Experimental group I	39(95.12%)	2(4.88%)	41
Control group II	26(100%)		26
Control group I	41(97.62%)	1(2.38%)	42
Experimental group II	49(94.23%)	3(5.77%)	52
Total	**155(96.27%)**	**6(3.73%)**	**161**

The results in Table 11 above show that 2(4.88%) and 3(5.77%) learners in Experimental groups I and II, respectively and 1(2.38%) learner and none in Control groups I and II, respectively, indicated that they would not wish other lessons to be taught the way the lessons

in this study were taught. This indicates that all learners may not have gained from computers. However, the fact that a higher proportion of learners in the control groups wished that other lessons were taught the way the lessons in this study were taught implies that teachers could have improved their teaching due to the knowledge of participating in the experiment. Among the reasons given by the learners for liking or not liking the lessons are shown in Table 12 below.

Table 12: Biology Learners' Reasons for Liking or Not Liking Lessons in This Study

Reasons for liking or not liking lessons	Frequency of learners by group							
	Expt I		Control II		Control I		Expt II	
	Yes	N/A	Yes	N/A	Yes	N/A	Yes	N/A
Stimulates memory	2	39		26		42		52
Interesting	10	31	6	20	4	38	13	39
Enjoyable	14	27	9	17	11	31	19	33
Confusing		41		26	5	37		52
Did not understand		41	2	24	7	35	1	51
Easy to remember	8	33	2	24	4	38	12	40
Students were involved and alert	13	28	2	24	1	41	16	36
Teacher was quite serious		41		26	6	36		52
Was well understood	12	19	5	21	8	34	12	40
Teacher was friendly	3	38	9	17		42		52
Simplifies complex things	4	37		26		42	6	46
Makes learning real	7	34		26		42	9	43
Lesson was not good		41		26	5	37		52
Poor sight	2	39		26		42	3	49
No sound		41		26		42	1	51

Key:

N/A - Stands for not applicable, meaning that these are the learners who did not indicate the reason indicated in column one of the table

Yes - This indicates the number of learners who indicated the reason indicated in column one of the table

According to the results in Table 12 above, the lessons were more interesting to the learners in the Experimental Groups than in the Control Groups. This is because a higher proportion of learners 10 (24.39%) and 13 (25%) in Experimental Group I and Experimental Group II, respectively, than 6 (23.08%) and 4 (9.52%) learners in Control Group II and Control Group I, respectively, indicated that lessons were interesting. In addition, the lessons that were taught using computers captured learners' attention by involving them, were easier to remember, simplified complex things and made learning more real than the lessons that were taught without using computers. Bakac *et al.* (2011) and Tekbiyik and Akdeniz (2010) also indicate that CBI simplifies complex things and makes learning more real than the lessons that are taught using the conventional methods of teaching. Some of the problems with the CBI teaching strategy were poor sight and lack of sound. Some learners in the lessons that used computers could have failed to see clearly what was projected on the screen, either due to their seating position or sight problem. Moreover, although there was need to explain clearly what

was projected on the screen, the teachers who used the animations to teach could have failed to make clear explanations. Collins *et al.* (2008) argue that some CAI software are difficult to implement and use. This implies that some learners need animations that contain sound. Hence, teachers need to be sensitive to the individual learner's needs as they adopt computers in their teaching.

A two-way between groups ANCOVA was conducted to explore whether or not the effect of the treatment depended on whether or not the learner was male or female. The results are shown in Table 13 below.

Table 13: A Two-Way between Groups ANCOVA for the Four Groups

Source	Type III Sum of Squares	Df	Mean Squares	F	Sig.	Eta. Squared
Corrected model	12434.887	8	1554.361	11.113	.000	.369
Intercept	1829.648	1	1829.648	13.081	.000	..079
PRIMX100	8922.591	1	8922.591	63.792	.000	.296
School	4048.097	3	1349.366	9.647	.000	.160
Gender	133.070	1	133.070	.951	.331	.006
School*Gender	508.984	3	169.661	1.213	.307	.023
Error	21260.145	152	139.869			
Total	**170900.0**	**161**				
Corrected Total	**33695.031**	**160**				

The results in Table 13 above indicate that the interaction effect between gender and treatment has a significance value of greater than 0.05, which implies that there was no significant interaction effect, F (3,152) =1.213, P=0.307, with a small partial eta squared of 0.023. This is in line with Cotton (1991) and Achuonye (2011) who found no significant differences in the effectiveness of computers in relation to gender. However, although there was no significant main effect for gender, F (1,152) =0.951, P=0.331, eta squared =0.006, there was a significant main effect for treatment, F (3,152) =9.647, P<0.0005, eta squared=0.160. The large effect size of the treatment implies that it had a great effect on the scores.

CONCLUSION AND RECOMMENDATIONS

This study showed that the learners who were taught using CBI had better scored than those who were taught using the conventional teaching methods. A one-way-between groups ANCOVA performed to explore the effect of treatment on Biology learners' performance indicated that indeed there was a statistically significant difference between the treatment and performance in Biology at the alpha value of 0.05 for the four groups. Consequently, the null hypothesis that: There is no significant difference between the academic achievement of Biology learners taught by CBI and those taught conventionally was rejected and the alternative hypothesis that: There is a significant difference between the academic achievement of Biology learners taught by CBI and those taught conventionally was accepted. Moreover, this study showed that the effect of CBI on learning did not depend on the gender of the learner. Since the experimental groups, which applied CBI, had superior scores than the control groups, this study recommends that the application of CBI in the teaching and learning of Biology should

be intensified. This can be achieved if teachers are equipped with skills to apply computers in their teaching. Learners also need basic skills for computer use. Additionally, schools should be equipped with more ICT resources that can promote CBI. They should also be supplied with digital content which is aligned to the country's syllabus.

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