

## Relative Effects of Experiential Computer Assisted Instruction on Secondary School Students' Self-Concept in Biology in Bomet County, Kenya

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**Abstract:** The overall students' achievement in Biology in Kenya Certificate of Secondary Education (KCSE) has remained low for several years. Among the factors that may lead to this low achievement is the learners' self concept while studying the subject. This paper sought to shed light on the effects of Experiential Computer Assisted Instruction on learners' self concept in Biology. A study was conducted using Solomon's Four Non Equivalent Control Group Research Design in Bomet County. Four Sub County secondary schools were purposively sampled. The four schools were randomly assigned of our groups, two experimental and two control groups. Students in all the groups were taught the same Biology content. Teachers of the experimental groups taught using Experiential Computer Assisted Instruction (ECAI) while teachers of the control groups taught using the regular methods. The study focused on the Genetics topic and involved sample of 163 Form Four students in the County. For data collection, the researchers used the Students' Biology Self Concept Questionnaire (SBSCQ). The instrument was validated by five experts in Educational Research of Egerton University. Reliability of SBSCQ was estimated using Cronbach's alpha coefficient. Reliability co-efficient of 0.719 was obtained. Data collected were analyzed using ANOVA, t-test and ANCOVA. The hypothesis was tested at alpha level of 0.05. The findings indicate that learners taught using ECAI had significantly higher cores in SBSCQ compared to those taught using the regular methods. It is recommended that the Kenya Institute of Curriculum Development (KICD) should in corporate ECAI during review of secondary school Biology curriculum. Educators and designers of information communication and technology programmers should also be encouraged to use ECAI to enhance learning. Teacher education trainers should also incorporate ECAI to enhance biology teaching.

**Key words:** Experiential Computer Assisted Instruction, Students' Self Concept, Secondary School Students, Learning Biology.

### 1. INTRODUCTION

In Kenya, there has been a low achievement in Biology by secondary school learners, (Kenya National Examinations Council (KNEC) 2018). Table1 shows achievement in KCSE in Biology for the period 2014-2018.

**Table1.** Achievement of Students in KCSE Biology from2014-2018

Year	2018	2017	2016	2015	2014
Meanscore%	25.69	18.93	29.19	34.80	31.83

Source: KNEC (2018)

Table 1 shows that percentage achievement scores ranged from 18.93 to 34.80. Their achievement is even poorer when results from Bomet County are considered. Table 2 shows Bomet students achievement between 2014 and 2018.

**Table2.** Achievement in KCSE Biology in Bomet County from2014-2018

Year	2018	2017	2016	2015	2014
Meanscore%	20.13	19.15	20.65	20.82	19.63

(KNEC, 2018)

Table 2 shows achievement ranging from 19.15% in 2017 and 20.82% in 2015.

A student's self concept in learning a subject is linked to their achievement. This self concept may be

influenced by the teaching method that a teacher adopts while teaching (Mugiria, Wachanga & Mbugua, 2015).

According to Marsh (1996), students' Biology self-concept refers to students' self-evaluation of self-perceived personal Biological skills, ability, Biological reasoning ability, enjoyment and interest in the subject.

In pursuit of achieving the goals of secondary school education and to improve on achievement, various interactive instructional approaches have been explored in Kenya. It has been demonstrated that cooperative concept mapping approach enhances learners' motivation in Biology (Keraro, Wachanga & Orora, 2007). Keter and Wachanga (2013) observed that cooperative mastery learning enhanced learners' motivation in learning Chemistry. Wambugu and Changeiywo (2008) found that mastery learning enhanced students' achievement in Physics. Mugiria, Wachanga and Mbugua (2015) found that Advance organizer teaching approach enhanced students' self-concept in Chemistry. It has also been demonstrated that use of advance organizers enhances learners' motivation in learning Biology (Shihusa & Keraro, 2009). Kinya and Wachanga (2015) also observed that experiential concept mapping teaching strategy enhanced student's motivation in chemistry. Thus, a teaching method can be used to change a learner's self concept in learning a subject. This study aimed at investigating the effect of Experiential Computer Assisted Instruction on learners self concept in Biology.

Experiential learning is a method of teaching through which learners create sense out of direct experience. From an experiential standpoint, learning is a mechanism in which the transforming experience generates knowledge (Kolb, 1984; Kaagan, 1999). Optimum learning happens when learners can associate previous experience with new ideas they want to study (Kolb, 1984).

Experiential learning utilizes experience in an exceedingly distinctive context to facilitate information acquisition and creation. Learner engaged in experiential learning is in direct contact with the topic being studied (Kolb, 1984). During experiential learning, learners are ready to merge their understandings and new discoveries with their own previous concrete experiences to construct ideas and relationships actively in their own minds. Kolb (1984) perceives experiential learning as a four stage cycle. These are Concrete experience, reflective observation, abstract conceptualization and active experimentation. Learners begin with a concrete experience, where they actively participate in a new experience. This is followed by reflective observation, where learners watch around and take into account numerous experiences. Following this period of reflective observation, is abstract conceptualization. Learners weave their thoughts along to make theories and conclusions concerning experience. Once developed, learners actively check their theories and conclusions to search out whether they are correct or not (active experimentation) which successively, results in new experiences and renews the learning cycle (Barker, Jensen & Kolb, 2002).

In this study each of these four components were incorporated as follows:

- (i) To foster concrete experience, practical activities and supplemental computer simulations were reemployed.
- (ii) To foster reflective observation, questions, brainstorming activities and lesson tutorials were reused.
- (iii) To foster abstract conceptualization, questions related to the experience were administered.
- (iv) To engage active experimentation, discussions and teacher clarification were employed.

Experiential learning strategies are notably helpful for ability development and as a result they supply learners with a chance to apply their skills and mirror on the experience (Feldon, 2007). Experiential learning has been applied in various fields (Kayes, 2002). As study by Adoye (2014) on the effects of experiential and observational learning techniques on secondary school Biology students' attitude towards environmental education observed a significant effect on students' attitude which in turn enhances achievement. Millenbah and MillsPaugh (2007) observed that using experiential learning in wildlife courses improves retention, problem solving and decision making. Furthermore, students' bear in mind solely a fraction of what they hear but a majority of what they actively do (Borg & Stranahan, 2002). Learning is viewed as the product of practical, personal, thoughtful, lived experience. According to experiential learning theory, real learning happens once students apply ideas by having to figure them out in different situations and experience the issues first hand. Experiential

learning makes the student a stakeholder in learning, and this improves the ability to integrate new concepts learned.

Computer assisted instruction (CAI) involves instructional activities that use a computer as the primary teaching tool. Literature reveals that it is an effective approach in that it provides personalized instruction and learning happens at learners' own pace and time frame (Curtis & Howard, 1990). CAI enhances learning and improves retention rate, it motivates and develops sense of efficacy (Cotton, 2001). It also allows a learner to interact with a computer (Chabay & Sherwood, 1992). Because of this, it is not possible for a learner to assume the role of a mere observer (Lockard, Abrams & Many, 1987). A study by Ronoh, Wachanga and Keraro, (2013) on the effects of computer based mastery learning on secondary school students' achievement in Biology, revealed that learners taught using computer based mastery learning out performed their counterparts taught using regular teaching methods. Wekesa, Kiboss and Ndirangu (2006) in their study on Improving Students understanding and perception of cell theory in school Biology using a Computer Based Instruction simulation programme, observed that Computer Based Instruction improved students' understanding and perception of cell theory in school Biology. Yusuf and Afolabi (2010) on their study on the effects of Computer Assisted Instruction (CAI) on Secondary School Students' performance in Biology observed that CAI enhanced secondary school students' achievement in Biology. Thus, it is worthwhile to investigate the learners' self concept when CAI is used in teaching the genetics topic in Biology.

In this study Computer Assisted Instruction simulation was used to supplement experiential learning, simulations provide interactive learning experiences, through the supply of feedback or the opportunities for experimentation (Canhorto & Murphy, 2016). It is referred to as Experiential Computer Assisted Instruction (ECAI). It was used to teach the Biology topic on Genetics. In view of the fact that this hybrid approach took advantage of the benefits of CAI and experiential learning, it investigated its effectiveness in enhancing self-concept in Biology.

## 2. STATEMENT OF THE PROBLEM

In an attempt to address the poor achievement of secondary school learners in Biology, a focus has been put on the teaching methods that teachers use while teaching. However, the effects of Experiential Computer Assisted teaching on learners' Self Concept in learning Biology has not been determined. This study sought to address this issue.

## 3. OBJECTIVE OF THE STUDY

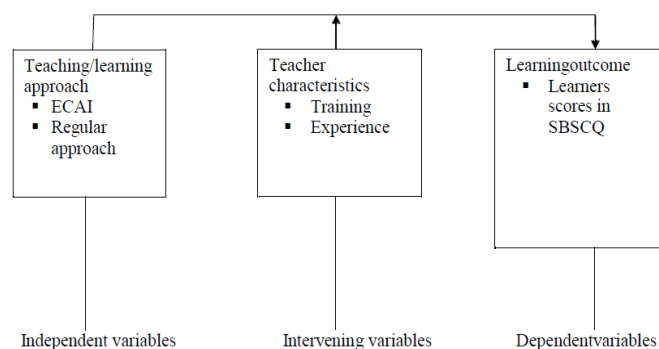
The study sought to determine whether there was a difference in learners' self concept in Biology between those exposed to ECAI and those exposed to regular teaching methods.

### 3.1. Hypotheses of the Study

To achieve the objective of the study the following null hypothesis was tested.

HO1: There is no statistically significant difference in learners' Biology self-concept between learners exposed to ECAI and those exposed to regular teaching methods.

### 3.2. Conceptual Framework



**Figure1.** Shows the conceptual framework which guided the study.

The conceptual framework shows the relationship among the independent, dependent and intervening

variables. The intervening variables were controlled by involving trained teachers who had a teaching experience of at least three years.

**4. RESEARCH METHODOLOGY**

**4.1. Research Design**

Secondary school classes exist as intact groups and school authorities do not allow them to be dismantled for research purposes. Therefore, the study used the Solomon's Four Non Equivalent Control Groups Design. Four classes were assigned to four groups as shown in Figure 2.

GroupI	O <sub>1</sub>	X	O <sub>2</sub>	Experimental groupE <sub>1</sub>
.....				
GroupII	O <sub>3</sub>	-	O <sub>4</sub>	Control groupC <sub>1</sub>
.....				
GroupIII	-	X	O <sub>5</sub>	Experimental groupE <sub>2</sub>
.....				
GroupIV	-	-	O <sub>6</sub>	Control groupC <sub>2</sub>
.....				

**Key:**

Pre-tests: O1 and O3

Post- tests: O2, O4, O5 and O6

Treatment: X

**Figure2.** Solomon's Four Non Equivalent Control Group Design

**4.2. Sampling Procedures and Sample Size**

Four Schools which had computers and have had similar KCSE Biology mean scores in the years 2014-2018, were purposively sampled for the study. Each school gave one class as shown in Table 3.

**Table3.** Number of students per Group

Group I	No. of Students
.....	
E <sub>1</sub>	43
.....	
E <sub>2</sub>	35
.....	
C <sub>1</sub>	39
.....	
C <sub>2</sub>	46
.....	
Total	163

Therefore, the sample size was 163 learners.

**4.3. Instrumentation**

The researchers used the Students' Biology Self Concept Questionnaire (SBSCQ) to measure learners' self concept. It was adopted from the tool developed by Gifford (2014). The items were modified before they were used to measure the constructs in question. The slight modifications involved the use of a five point Likert- scale. The choices include: Strongly Agree, Agree, Undecided, Disagree and Strongly Decided. All the choices were abbreviated as: SA, A, U, D & SD respectively.

The instrument was validated by five research experts from Egerton University. Its reliability was established through piloting and determining Cronbach's alpha coefficient. It had an alpha value of 0.719.

#### 4.4. Development of Instructional Materials

The researchers developed an instructional module for the students and a manual for the teachers involved in the use of ECAI. The manual focused on objectives, content to be covered in the topic and teaching/learning activities. The manual was based on revised Kenya Institute of Education (KIE) (2002) Biology syllabus. Teachers of the experimental groups were trained by the researcher for one week on how to use ECAI. This was to enable them master the skills of using ECAI approach.

#### 4.5. Data Collection Procedures

The researchers visited the selected schools before hand for acquaintance with targeted respondents (learners). Upon familiarization, data were then collected from the respondents. This was done by administering a pre-test SBSCQ to groups I and group II. Intervention period was six weeks. After the end of intervention period a post-test was administered to all the four groups. The class subject teachers in each school administered the research instrument. The researchers scored the SBSCQ. Quantitative data from the scores were generated for analysis.

#### 4.6. Data Analysis

A t-test was used to test differences between the pre-test mean scores because of its superior quality in detecting differences between two group means (Borg & Gall, 2003). ANOVA and ANCOVA were also used. For ANCOVA, the learners scores in Kenya Certificate of Primary Education (KCPE) examination were used as covariates (Keter, Wachanga & Anditi, 2017).

### 5. RESULTS

#### 5.1. Analysis of Pre-Test Scores

Table 4 shows the analysis of students scores in SBSCQ based on Group I and Group II

##### Independent Samples t-test of Pre-test Scores on SBSCQ based on Groups I and II

Scale	Group	N	Mean	SD	df	t-value	p-value
SBSCQ (maximum= 5)	E1	43	2.73	0.36	86	7.637	0.000*
	C1	39	3.37	0.42			

\* Significant at .05 level

Table 4 shows that the t-test analysis revealed that the difference in Group I and II was significant.  $t = 7.64, p < 0.5$

Therefore, the groups were different at the beginning. Thus, the study required the use of analysis of covariance (ANCOVA).

#### 5.2. Effects of ECAI Approach on Learners' Self-Concept in Biology

To determine the difference in biology self-concept between students exposed to ECAI and those taught using regular approaches, an analysis of students' post-test mean scores in SBSCQ was carried out. Table 5 shows post-test SBSCQ mean scores obtained by students in the four groups.

**Table5.** Post-test SBSCQ Mean Scores Obtained by Students in the Four Groups

Group	SD	N	Mean
E1	43	3.96	0.34
E2	35	3.53	0.32
C1	39	3.65	0.45
C2	46	3.61	0.44

Maximum Score = 5.0

Results in Table 5 show the different mean scores for the four groups. In order to determine whether the mean scores were significantly different, an analysis of variance was carried out.

**Table6.** One way ANOVA of the Post-test SBSCQ mean scores

Scale	Sum of Squares	df	Mean Square	F- ratio	P-value.
Between Groups	3.950	3	1.317	8.228	0.000
Within Groups	26.240	164	0.160		
Total	30.190	167			

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\* Significant at 0.05 level

The results in table 6 indicate that the difference in self-concept between the four groups were significant,  $F(3, 164) = 8.228$ ,  $p < 0.05$ . Since results of pre-tests indicated need for analysis of covariance using Kenya Certificate of Primary Education (KCSE) scores, this was done as shown in Table 7 and Table 8

**Table7.** Adjusted SBSCQ Mean Scores Obtained by Students

Group	Mean	SD
E1	3.96	0.06
E2	3.64	0.06
C1	3.54	0.06
C2	3.65	0.05

Analysis of covariance was carried out on these adjusted mean scores shown in Table 8.

**Table8.** ANCOVA of the Post-test SBSCQ Mean Scores with KCPE Marks as the Covariate.

Scale	Sum of squares	df	Mean squares	F	P-value
Learning approach	3.960	3	1.320	9.671	0.000*
Error	21.428	157	0.136		

Results in Table 8 reveal that the differences in mean scores of the four groups are significant,  $F(3, 157) = 9.671$ ,  $p < 0.05$ . To determine where the differences occurred, a post hoc multiple comparison was carried out. The results are shown in Table 9.

**Table9.** Post-Hoc Multiple Comparison of the Post-test SBSCQ Means for the Four groups

Groups	Mean difference	p-value
E1 Vs E2	0.419*	0.000
C1	0.322*	0.000
C2	0.304*	0.000
E2 Vs E1	-0.419*	0.000
C1	-0.097	0.269
C2	-0.115	0.169
C1 Vs E1	-0.322*	0.000
E2	0.115	0.269
C2	-0.018	0.826
C2 Vs E1	-0.304*	0.000
E2		0.169
C1	0.018	0.826

The results in Table 9 show that the pairs of SBSCQ mean scores of groups E1 and C1, E2 and C2, were significantly different. Therefore,  $H_0$  is rejected.

## 6. DISCUSSION OF RESULTS

The findings of the study show that ECAI improved student scores in self-concept compared to those taught using regular approaches. This study supports a study by Linda, Yong, Edward, Hiram, Alexander and Rena (2009) on self-concept, gender and information technology. The findings indicated that technology use predicted a positive dimension of self-concept with video game playing. A study by Chebii, Wachanga & Anditi (2018) showed that computer skills enhanced student self-concept and self efficacy. Furthermore, a study by Milli (2016) on the effects of experiential learning on self esteem, resilience and tolerance for disagreement observed an increase in means of self esteem of students. These studies relate well with the present investigation which shows that students self concept can be enhanced through experiential learning done through ICT.

## 7. CONCLUSION

The findings of this study lead to the conclusion that use of ECAI in teaching enhances learners self concept in Biology. Therefore incorporating this method in the teaching of Biology may lead to improved achievement in the subject. Including this method in the teacher education curriculum may help in strengthening the teachers' training.

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