Effect of 7E Learning Cycle Model on Students' Academic Achievement in Biology in Secondary Schools in Chesumei Subcounty, Kenya

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Abstract

The objective of the study was to compare the effect of 7E Learning Cycle Model and Conventional Instructional Method on students' academic achievement in Biology. Quasi experimental design was adopted in this study. A sample size of 346 form three students was selected using stratified sampling and simple random sampling techniques. Data collection instrument was Biology Achievement Test. Validity of the instrument was determined by two experts in Biology Education. Test- retest technique was used to determine the reliability of the instrument. A reliability coefficient of 0.83 was obtained. Mean, standard deviation and t-test were used to analyze data. The results were presented using tables. Results of the study revealed that the mean score of the students in the experimental group was higher than those in the control group. The study also found that there was a statistically significant difference between the mean scores of those taught using 7E Learning Cycle Model and those taught using Convectional Instructional Method. The study concluded that 7E Learning Cycle Model has the potential of improving students' academic achievement. It was therefore recommended that Biology teachers should employ such constructivist approach as 7 E learning cycle model in teaching. In addition, Kenya Institute of Curriculum Development should organize and conduct capacity building on teachers on the adoption of 7E LCM during instruction.

Keywords: 7E Learning Cycle Model, students, Biology Academic Achievement & Conventional Instructional Method

INTRODUCTION

Education is one of the instruments with the capacity to deal with challenges of the 21st century. Before the 21st century, education systems across the world have been mainly focusing on students' acquisition of content and knowledge. During the late 20th century and early 21st century, the society underwent great changes in terms of economy and technology. This led to an era of scientific revolution which has been significantly defined by science and technology. Scientific revolution in our society can be seen all around us from development of new vaccines to advancement of HIV cure to discovery of water on mars to carrying out of face transplants among others. Learners should therefore develop 21st century skills that will enable them participate in these global issues. Learners with these skills are expected to be able to think critically, communicate, collaborate with others and be creative. Science education

should therefore be modified so as to meet the demands and needs of the society. This can be achieved by improving the existing instructional methods in science curriculum.

Education and training have been identified by the Kenyan government as one of the ways of transforming itself into an industrialized country by 2030 (Ministry of Devolution and Planning, 2013). In order to become an industrialized country, Kenya Secondary School curriculum has placed emphasize on science, technical and practical education. In the Kenyan curriculum, Biology is among the science subjects offered in secondary schools. The study of Biology intents to equip the learner with knowledge, skills and attitudes vital in enabling the learner protect and conserve the environment, population control, combating diseases and improvement of food production. In addition, Biology enables students enter into career sectors such as education, health, agriculture and environment. The Kenyan government and education stake-holders have the responsibility of equipping schools with infrastructure, providing instructional resources and sound curriculum so as to ensure that efficient instruction process takes place. Schools have also been given the responsibility of ensuring that classrooms have been equipped with instructional resources, provide conducive instructional environment and facilitate student participation in co-curricular activities.

Problem Statement

Kenya Certificate of Secondary Education (KCSE) performance of students in Biology has been poor (Kenya National Examination Council, [KNEC], 2018, 2019, 2020). Table 1 shows KCSE performance in Biology as compared to Mathematics, Chemistry and Physics in the years 2017, 2018 and 2019.

Table 1: National Mathematics, Biology, Chemistry and Physics mean scores in percentages from 2017-2019

Year	Subjects mean scores (%)			
	Mathematics	**Biology**	**Chemistry**	**Physics**
2017	25.48	18.93	24.05	35.05
2018	26.44	25.69	26.88	34.27
2019	27.54	25.50	26.09	32.59

Source: KNEC, KCSE Annual reports, 2017, 2018, 2019

Data in table 1 shows that KCSE national mean scores between the years 2017-2019 in Biology ranges from 18.93% to 25.50%, those of mathematics ranges from 25.48% to 27.54%, those of chemistry ranges from 24.05% to 26.09% and those of physics ranges from 32.59% to 35.05%. It is evident that Biology performance was relatively lower as compared to Mathematics, Chemistry and Physics. In 2017, Biology was recorded among the worst performed subjects in KCSE (KNEC, 2018). This prompted this study. In Chesumei Subcounty, students' academic achievement in Biology has been equally poor. Table 2 shows Chesumei Subcounty Biology performance in the years 2017, 2018 and 2019.

Table 2: Chesumei Subcounty Biology performance mean scores in percentage from 2017-2019.

Year	Percentage mean scores
2017	18.33
2018	22.17
2019	23.58

Source: Chesumei Subcounty Education Report, 2020

Data in table 2 shows KCSE Biology performance in Chesumei Subcounty in the years 2017, 2018 and 2019 was below average. There have been efforts by the Ministry of Education to improve Biology performance through organizing for teachers' workshops, seminars and SMASSE projects. Despite all these, there has been continued poor performance of the subject. The challenges associated with Mathematics and science subjects including Biology, have been reported as: negative attitude towards the subjects (Kingaru, 2014; Oduol, 2018; Wamkota & Masibo, 2017; Wekesa 2013), insufficient teaching and learning resources (Auwal, Mohd & Mohammad, 2014; Kingaru, 2014; Oduol, 2018; Wekesa, 2013), inadequate qualified teachers (Auwal, Mohd & Mohammad, 2014; Wekesa, 2013), chronic absenteeism (Kingaru, 2014), large class sizes (Wamkota & Masibo, 2017), low understanding of scientific concepts (Wamkota & Masibo, 2017; Wekesa, 2013) and poor instructional methods (Oduol, 2018; Jepketer, 2017).

KNEC, (2018) report pointed out poor instructional methods as one of the major causes of poor performance in Biology. This informed this study. The report recommended that teachers should embrace broader teaching and testing in such topics as Ecology, Genetics, Reproduction, Classification, Excretion, Evolution and Transport among others so as to inculcate critical environmental issues of the 21st century. KNEC, (2020) report recommended that learners should be instructed using inquiry-based learning as it promotes deeper understanding of scientific concepts, promotes creativity and enable them apply learnt concepts to daily life experiences. This calls for re-examination of the instructional methods used in teaching Biology in secondary schools. Such instructional methods should train students to develop skills such as creative thinking, manipulative and problem-solving skills. To achieve this, 7E LCM which is one of the inquiry-based approaches was used as a basis for this study.

Purpose of the study

The purpose of the study was to examine the effect of 7E Learning Cycle Model on students' academic achievement in Biology among secondary schools in Chesumei Sub-county, Kenya.

Objective of the study

To compare the effect of 7E Learning Cycle Model and Conventional Instructional Methods on students' academic achievement in Biology.

Hypothesis

H_O1: There is no significant difference on the mean scores in Biology Achievement Test between students taught using 7E Learning Cycle Model and those taught using Conventional Instructional Methods.

Limitations of the study

1. The 7E LCM instructional manual developed by the researcher might not have been utilized effectively by the teachers in the experimental group. This might have influenced the results hence the findings may not be generalized to other studies.
2. The study was only limited to a form three topic: Classification, therefore the findings might not be generalized to other topics.
3. The study was limited to form three students in Chesumei Sub-county-Nandi County; hence the findings of this study may not be generalized to other classes or other counties.

LITERATURE REVIEW

Constructivism is based on the notion that learners construct meaning from experience. There are many variants of constructivism among them are cognitive and social constructivism. Piaget (1952) viewed individual cognitive development as a process that takes place due to biological maturation and interaction with the environment. Individual cognitive theory of Piaget (1952) laid out two approaches to construction of knowledge. First, schemas which are building blocks of knowledge, responsible for adaptation process: assimilation, accommodation and equilibrium which are the same as the use prior knowledge in knowledge construction. Assimilation and accommodation require an active learner in order to discover problem-solving skills (Piaget, 1952). Secondly, knowledge construction occurs when an individual passes through four cognitive development stages: sensory-motor, preoperational, concrete operational and formal operational. Concrete and formal operational stages have been applied in constructivist teaching. At concrete stage, learning takes place through manipulation of objects, ideas and events that leads to the beginning of logical thinking and eventually can lead to learners constructing meaningful concepts. This leads to development of logical abstract reasoning at the formal operational stage.

According to social constructivist theory by Vygotsky (1978), learning takes place when an individual builds knowledge based on socio-cultural environment. In social constructivist classrooms, learners are allowed to construct knowledge collaboratively with peers and teachers.

Among the constructivist instructional approaches are the learning cycles. According to Ozbek, Celik, Ulukok and Sari (2012), learning cycles can help a student learn science concepts, correct misconceptions and apply knowledge in their day-to-day lives. Various types of learning cycles have been developed over the years. These include: 3E (Karplus and Thier, 1967), 5E (Bybee, 1997) and 7E (Eisenkraft, 2003). As science curriculum is quite dynamic, the highly successful 5E instructional model was expanded to 7E Learning Cycle Model. Eisenkraft (2003) extended the 5E learning model into 7E learning Cycle Model (7E LCM), with elicit and extend at the beginning and at the end respectively. This was not to make it complex but to ensure that teachers do not skip important elements for learning. 7E LCM is vital as it ensures that students' prior knowledge and experience are prompted. It also emphasizes "transfer of learning" which is the most important part in science education.

7E LCM is organized in seven successive stages. These stages are: Elicit, Engage, Explore, Explain, Elaborate, Evaluate and Extend (Eisenkraft, 2003). Balta and Sarac (2016) suggested that science teachers should embrace 7E LCM in teaching as it leads to improvement of students' academic performance. After new knowledge has generated, existing learning model ought to be modified to maintain its usefulness (Eisenkraft, 2003). 7E LCM stages are interconnected and planned in such a manner that the leaner carries out scientific inquiry by exploring instructional material and applying a learnt idea or a principle in a new situation. The 7E LCM steps are described as follows:

In elicit phase, the leaners' prior knowledge is prompted to ascertain what they know about a concept to be taught (Eisenkraft, 2003). Existing knowledge forms a base for construction of new knowledge likely to be applied to new areas (Adesoji & Idika, 2015). When misconceptions are not addressed, learners may develop ideas that are different from the ones the teacher intended. A teacher may prompt prior knowledge by asking questions such as "what do you think" and posing scenarios at the beginning of learning session (Naade, Alamina & Okwelle, 2018). From the learners' responses, the

teacher will ascertain what they already know and any misconception will be corrected during the learning process. During this phase, the learners actively participate in trying to relate the given concept with their prior knowledge hence convey their own opinions.

Engage is a phase that is planned to capture learners' attention on what is to be learnt (Eisenkraft, 2003). This is achieved through the use of short activities that stimulates their thinking, thereby increasing their interest and eagerness to learn new concept (Naade et al., 2018). The teacher ensures all students are given opportunities to express their opinions to their peers by use of techniques such as "think-pair-share".

Explore is a phase where "learners are provided with the opportunity to observe and record data, isolate variables, design and plan experiments, create graphs, interpret results, develop hypotheses and organize their findings." (Eisenkraft, 2003, p. 57). Learners get to work collaboratively in developing skills and concepts. During this phase, the teacher directs learners' investigation and ensures that the learners are involved in building new concept.

During the explanation phase, "the teacher guides students toward coherent and consistent generalizations, helps students with distinct scientific vocabulary, and provides questions that help students use this vocabulary to explain the results of their explorations." (Eisenkraft, 2003, p58). The teacher motivates the learners to describe concepts using their words at the same time listening critically to their peers. Learners are given the opportunity to construct their own knowledge as the teacher assesses their growing understanding of the new concepts.

Elaborate phase aids in expanding learner's conceptual understanding. The learner applies learnt concepts to new areas through additional activities. "Transfer of learning" takes place as the leaners apply learnt ideas to new context (Thorndike, 1923). Their practical skills are refined leading to deeper understanding of the concept.

At the evaluation phase, the teacher assesses learners' conceptual understanding both formatively and summatively. The teacher does this through assessing the extent to which instructional objectives have been met. Students are also encouraged to evaluate themselves. The teacher can assess students through questions, mind maps and interpretation of data (Sharma, 2018). In 2016, Balta and Sarac suggested that during the evaluation phase students can be evaluated through puzzle as well as questions.

Finally extend phase was added to elaboration phase with the sole purpose of ensuring that science teachers implement "transfer of learning". Transfer of learnt concepts in a novice area helps learners retain ideas for a longer period of time. In this phase, students apply knowledge in a new context as well as to their everyday life. (Kajuru & Kauru, 2011).

Existing literature on effect of a learning cycle on students' academic achievement in Mathematics and sciences in Kenya were majorly on 5E Learning Cycle Model (Mwanda, Odundo & Midigo, 2017; Majiwa, Njoroge & Cheseto, 2020; Opara & Waswa, 2013; Njoroge, Changeiywo & Ndirangu, 2014). No Study had been conducted on effect of 7E Learning Cycle Model on students' academic achievement in Biology in Kenya. This study aimed at filling this gap. 7E LCM has a series of class activities that promote creativity among the learners and enable them apply learnt concepts in their daily lives. This may lead to improving students' acquisition of skills, knowledge and competencies in Biology. This study therefore investigated the effect of

7E LCM as an instructional approach that might improve Biology academic achievement in Chesumei Subcounty, Kenya.

METHODODOLGY

Research design

The design of the study was quasi-experimental design. This design was utilized since students who participated in the study were found in intact classes, making random assignment to treatment groups impossible. Students were assigned into two treatment groups: experimental and control groups. A pre-test was administered to all the students to determine their cognitive levels. Thereafter, treatment was administered to the participants where the experimental group participated in the 7E LCM while the control group participated in CIM. 7E LCM Instructional manual prepared by the researcher was used by the experimental group as a guide during the instruction process. Lesson activities planned in the 7E LCM Instructional Manual were designed on the format of 7E LCM developed by Eisenkraft (2003). Each lesson progressed through seven stages. These stages are; Elicit, Engage, Explore, Explain, Elaborate, Evaluate and Extend. At the end of the instruction period, a post- test was administered. The data obtained from both groups were analysed both descriptively: means and standard deviation and inferentially: t-test.

Study Area

The study was carried out in Chesumei Subcounty located in Nandi County, in the Northern part of Rift Valley in Kenya. Nandi County occupies an area of about 2,884.4 square kilometers. Chesumei is one of the six Subcounty in Nandi County that occupies an area of 472.10 square kilometers. It borders Emgwen Subcounty to the South and Mosop Subcounty to the North. The study was conducted in Chesumei sub-county due to poor Biology performance in KCSE that they have been persistently registered over the years (See table 2).

Target population

The target population for the study was 3421 Form Three Biology students within Chesumei Subcounty, Kenya. Classification was one of the topics pointed out by (KNEC, 2018) that required broader teaching and testing. This topic is taught in form three hence the choice of the form three students to participate in the study.

Sampling Procedures.

The number of students who participated in the study was determined using Krejcie and Morgan (1970) table used for determining sample size for research studies. The sample size determined was 346 students from a target population of 3421.

From 45 schools within Chesumei Subcounty, simple stratified sampling was used to categorized them into four strata namely; National, Extra county, County and Subcounty schools. This was to ensure that all school categories were represented in the sample. Six schools were selected from the strata using simple random sampling. Simple random sampling was further utilized to choose 3 schools to be assigned to the experimental group and 3 to the control group. Eventually, 171 students were assigned to the experimental group and 175 students were assigned to the control group.

Validity

Face validity and content validity of the Instructional manual and Biology Achievement Test (BAT) was established by having their format and appropriateness critiqued by two experts in Biology Education. Instructional objectives in accordance

with Biology Syllabus were considered in designing the BAT, so as to improve its content validity.

Reliability

Reliability coefficient of BAT was determined by use of test-retest technique and analysed by use SPSS. In this study, test 1 was administered to the participants, thereafter, test 2 was re-administered after three weeks to the same group of participants. In test 2, the participants were given same test as test 1 but in different order of questions. The scores of the test 1 and test 2 were correlated and reliability coefficient obtained was r = 0.83. BAT was also developed with clear instructions for its administration so as to generate uniformity in understanding requirements of the test by those who participated in the study.

Administration of the research instruments

All schools that participated in the study were visited by the researcher. Teachers in the experiment group were adequately inducted on how to use 7E LCM Instructional Manual. Teachers were also inducted on how to administer BAT. During the first week of the study, pre-test was administered to experimental and control groups. After administration of pre-test, instructional programs that took seven weeks were implemented where the topic classification was taught. Experimental group were taught by use of 7E LCM while control group were taught using CIM by their regular teachers. Post-test was administered by the regular teachers after completion of the instructional program. The researcher thereafter collected pre-test scores and post-test scores.

Data analysis

Data was analysed using both descriptive and inferential statistics. Descriptive statistics was used to summarize, compare and explain results from experimental and control groups in terms of mean score and standard deviation. Inferential statistics; t -test, was used to determine if the two groups differ significantly among themselves at $\alpha = 0.05$.

RESULTS

Pre-test Scores

Pre-test was administered at the beginning of the study to both experimental and control group. Table 3 shows the results.

Table 3: Students' mean and standard deviation in pre-test

Type of Group	N	Mean	SD
Experimental group	171	11.95	5.07
Control Group	175	12.36	5.73

As indicated in table 3, students in the experimental group had a mean score of 11.95 while those in the control group had a mean score of 12.36. The findings indicate that the two groups were slightly different in terms of their pre-test scores.

Pretest scores were subjected to t-test so as to determine whether there was a significant difference between the groups. Table 4 presents the results.

Table 4: T-test for comparing groups in terms of pre-test

t-value	Df	P-value	Level of significance
0.715	344	0.475	0.05

The results are as follows: t (344) = 0.715; P=0.475 at α=0.05 significance level. Since the P value (0.475) was greater than α = 0.05, the null hypothesis not rejected. This meant, at pre-test, Biology performance of students in the two groups, that is, experimental and control groups was similar.

Post Test Scores

Post-test was given to the participants after the instructional period. Table 5 presents the results.

Table 5: Students' mean and standard deviation in post-test

Type of Group	N	Mean	SD
Experimental Group	171	49.44	11.59
Control Group	175	26.08	9.99

Results in Table 5 reveal that the students in the experimental group had a higher mean score of 49.44 than those in the control group who had a mean score of 26.08.
The hypothesis was tested by conducting a t-test on post-test scores. Table 6 presents the results.

Table 6: T-test for comparing groups in terms of their post-test

t- value	Df	P-value	Level of significance
-20.08	**344**	**0.00**	**0.05**

The results presented in table 6 are as follows: t (344) = -20.08; P= 0.00 at α = 0.05. Since, P (0.00) value was less than α = 0.05, the null hypothesis was rejected. This meant, at post-test, Biology performance of students in the two groups, that is, experimental and control groups was significantly different.

DISCUSSION

Pre-test scores analysis revealed that students in the experimental and control groups were equivalent. In addition, t-test result showed that there was no significant difference in the mean scores between the experimental and the control groups since the p value of 0.475 was greater than α=0.05 significance level. These results imply that the two instructional groups were equivalent before treatment, which was very significant to the study. On the other hand, post-test scores indicated that students in the experimental group taught using 7E LCM had a higher mean score than those in control group who were taught using CIM. T-test also revealed that there was a statistically significant difference in post-test achievement among the two groups at α = 0.05 significance level.

The 7E LCM was found to have a positive effect on students' academic achievement in Biology probably due to its two vital components: elicit and extend, that is unique to this model. Elicit phase, was crucial for understanding learners' prior knowledge in order to determine what they know (Eisenkraft, 2009). If there were any misconceptions they can be assessed and corrected so that the learners do not develop concepts that the teacher did not intend. Learners construct knowledge based on prior understanding and experiences (Adesoji & Idika, 2015). In addition, extend phase which supports the process of "transfer of learning", an important component in science education, ensures that the learners apply learnt concepts to new contexts and real-life situations. Furthermore, learners in the experimental group had a higher

achievement in Biology probably due to the fact that they were actively involved in knowledge construction through a series of short activities that were done individually and in groups setting. These activities prompted their curiosity and eagerness to learn leading to efficient acquisition of knowledge and skills.

Similar studies conducted by other researchers are in agreement with these findings. Research conducted by Balta & Sarac, (2016) found that 7E Learning Cycle had enhanced educational effects in science teaching. Students instructed using 7E Learning Cycle performed better than students instructed through conventional methods. Results from a study conducted by Kajuru & Kauru, (2011) showed that the mean score of students exposed to 7E LCM in teaching of trigonometry in Polytechnique students was higher than those exposed to the traditional methods in terms of their achievement and retention of concepts. Similarly, studies carried out by Polyiem, Nuangchalerm & Wongchantra, (2011) showed that ninth grade students instructed by 7E learning cycle in Thailand showed gains in learning achievement. A study conducted in India by (Sharma, 2018) showed that 7E LCM was more effective than CIM as it enhanced students' critical thinking skills, and positive attitude towards science. Students taught using 7E Cycle Model developed better understanding and retention of scientific concepts (Gok, 2014). In other study, critical thinking abilities of Junior High School students taught using 7E instructional approach was enhanced (Rahmayani, Jatmiko & Susantini, 2016). According to the study conducted by Shaheen & Kayani (2015), treatment group showed more skills in solving science related problems than control group. The researchers further concluded that students subjected to 7E LCM performed better on Post-test scores than those taught using teacher centered methods. Students' scientific literacy skills of elementary students instructed using 7E learning cycle model increased significantly over those instructed using conventional methods (Fatima and Anggrisia, 2019). Moreover, studies conducted by Gyampon, Aido, Nyagbblosmase, Kofi & Amoako, (2020) in Ghana showed that students in the experimental group taught using 7E instructional model showed higher performance than those in the control group. The study also found that the students in the experimental group showed better understanding of scientific concepts. Turgut, Colak & Salar, (2016) concluded that high school students effectively built concepts by use of course materials developed according to 7E instructional model. Marfilinda, Rossa & Apfani, (2020) study found that 7E LCM improves student's ability to learn basic science concepts. Their study also concluded that 7E LCM improves student's critical thinking skills. 7E LCM provides a learning environment where students' prior knowledge is elicited and transfer of learning is emphasized. Students gain valuable skills that can be applied to their daily lives. Finally, 7E LCM improves students' acquisition of knowledge and improves their critical thinking skills than conventional methods.

Educational Implication

The major finding of this study is that 7E Learning Cycle Model was found to be more effective than Conventional instructional method. The findings of this study will be applicable to learners, teachers, the government and other education stake-holders. Learners taught using 7E Learning Cycle Model construct knowledge actively through minds-on and hands-on activities. This gives the them opportunity to collaborate with peers and teachers. Through interaction, learners are able to learn effectively and develop critical thinking skills. Teachers need to incorporate 7E Learning Cycle Model in teaching of Biology. This model requires students to have access to instructional resources such as science apparatus, materials and equipment. The government and other education stake-holders should ensure that infrastructure and instructional

resources are available in schools. 7E learning Cycle Model provides an opportunity to learners to actively construct knowledge hence necessity these instructional resources.

CONCLUSION

From the findings of this study, the use of 7E Learning Cycle model is effective in improving students' academic achievement in Biology than Conventional instructional method. Students taught using 7E Learning Cycle model are motivated, their interest aroused, are able to think critically and eager to learn. This creates high understanding of Biological concepts.

RECOMMENDATIONS

i. Biology teachers should employ such constructivist approach as 7 E learning cycle model in teaching.
ii. Kenya Institute of Curriculum Development should organize and conduct capacity building on teachers on the adoption of 7E LCM during instruction.

Suggestions for Further Studies

The study recommends studies be done on the effect of 7E Learning Cycle Model on students' critical thinking skills.

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