Adoption of the Constructivist Learning Approach in Secondary Schools in Kenya: Focus on Learner Achievement in Biology by Class Category

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Learner achievement is influenced by the instructional methods adopted during the learning process. Different class categories and individual levels present varied learning contexts determining the application of a mixture of appropriate instructional methods, which can enhance knowledge retention and application. Available studies in Kenya have focused on the general achievement of students. This study examined the linkage between instructional methods and learning achievement in different class categories. The study design was quasi-experimental non-equivalent groups with a pre-test and a post-test. Primary data were obtained from four boys’, four girls’, and four mixed schools with a total of 477 students. Data were analyzed descriptively using mean and standard deviation values while t-tests and analysis of variance (ANOVA) tests were used to test for significance in difference between group means at α = 0.05 level. The study found out that learner achievement in the control group was characterized by poor mean gain (Boys’ classes = 7.51; Girls’ classes = 7.69; and Mixed classes = 7.07) as compared to the experimental group (Boys’ classes = 9.30; Girls’ classes = 40.13; and Mixed classes = 23.30), implying that the constructivist instructional approach positively improves learner achievement. Comparison of the mean gain revealed that girls’ classes improved by 40.13, mixed sex classes by 23.30, and boys’ classes by 9.30. This implies that learner achievement in girls’ classes improves when the constructivist instructional approach is used. All the learners instructed through the constructivist approach registered marked improvement in achievement. We recommend that biology teachers, especially those in girls’ secondary schools, should consider using the constructivist instructional methods for enhanced learner achievement. Further, investigations into constructivist learning using some other assessment strategies other than the 5Es (i.e., engagement, exploration, explanation, elaboration, and evaluation) instructional model as well as effects of constructivist instructional approaches in different study locations should be explored in other studies. Finally, we recommend that the Ministry of Education, Science and Technology in Kenya through the Kenya Institute of Curriculum Development (KICD) come up with policies to guide the application of appropriate learning approaches for different classroom categories as applicable.

Keywords: constructivist approach, class categories, constructivist learning, learner achievement, knowledge, comprehension, application, analysis, synthesis, and evaluation

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Introduction

Science education has in the past four decades attracted great expectations from educators and the general public who continuously advocate for increased performance in scientific inventions and ability to apply and communicate scientific understandings (Mintzes & Wandersee, 1998). In America, the desire to improve science education was anchored in the report, *A Nation at Risk*, by the National Commission of Excellence in Education (Mintzes & Wandersee, 1998), which detailed falling standards in America’s science education due to teachers using ineffective methods of teaching that do not promote higher-order thinking and creativity in youth. In Australia, weak performance in mathematics and science education led to the establishment of a centre for science and mathematics education to promote improvement in teaching of mathematics and science (Fraser & Walberg, 1995). Similar sentiments on the need to improve performance in mathematics and science have been raised in the United Kingdom by Talbot-Smith, Abell, Appleton, and Hanuscin (2013) in the *Handbook of Research in Education*. Some of the factors identified as indicators for poor performance in science education include use of ineffective instructional methods, gender imbalance in science education, negative attitude of students towards learning of science and science-related careers, and lastly unavailability of facilities for learning sciences in secondary schools (Trowbridge, Bybee, & Powell, 2004).

In Kenya, conventional methods of instruction marked by teacher lecturing dominate classroom practices (Amollo, 2005). Conventional methods of teaching, though popular, have generated a lot of negative and positive thoughts. For instance, Perkins (1993) warned that conventional teaching often gives pseudo impression that proper learning has occurred when students confirm comprehension of rote memorized material but hold many misconceptions about the same materials when tested at application levels of learning. Similarly, Zakaria (2009), as well as Wingate, Andon, and Cogo (2011), argued that the conventional method of instruction as applied in Australia encourages passive learning. Amollo (2005) also found conventional methods, particularly lecturing strategy to be characterized with lack of planning, poor time management, unstructured presentation and content overload, and less innovative and inconsistency in delivery resulting into students getting bored, confused, and less motivated, and so only few concepts are learned in a lesson.

Based on the increasing negative effects of conventional teaching methods on quality of education and learner performance in science-based subjects, it is necessary that constructivist approaches be explored so as to find ways through which learner acquisition of knowledge and skills can be enhanced. In this period of time, Brown (2005) suggested that the constructivist approach is accepted as the most relevant view of learning and that education policies, education models, and education practices should focus on constructivist learning. Similarly, Duit and Treagust (2003) considered the constructivist approach as the most powerful framework for improving learning and teaching of sciences. Spector, Ifenthaler, Isaia, Kinshuk, and Sampson (2010) defined the constructivist approach of learning as a learning process based on the understanding that knowledge is constructed by the knower based on his/her internal mental process. The learning theory focuses on strategies that promote interaction between individual and the environment, thus making learning a reflective and meaningful process (Huang, 2002; Ally, 2004).

Enrolment and achievement of female students in science-based subjects has also been another challenge facing Kenyan education sector. According to the Kenya Education Sector Support Programme (2005-2010), few numbers of females compared to males enroll and pursue further studies in science subjects and science-related courses. The report further details that female students perform relatively dismally compared to
males in science subjects. For example, in year 2008 Kenya Certificate of Secondary Education (KCSE) examination, analysis of the biology results revealed that boys had a percentage mean score of 32.01 while girls had a mean score of 29.08. Similarly in year 2009, the biology performance nationally in KCSE by gender revealed that boys had a percentage mean score of 28.49 while girls had a mean score of 25.15.

This disparity in performance could only be explained as a result of poor instructional methods. Some factors which have been identified as responsible for low performance of girls in science education include culture, religion, attitudes of the girls, and the instructional methods used in science classrooms (Glover & Law, 2002). Dewey in 1972 had espoused that learning results from cognitive dissonance rather than reinforcement of behaviour as proponents of behaviourist learning suggest. When students encounter new learning tasks they have not met before, they are forced to adjust their understanding to accommodate the new experiences and are therefore involved in cognitive rather than behavioural response. It is therefore imperative that the instructional methods will determine the quality of instruction offered. When doing a project work, students get the opportunity to reflect on what they have learned earlier there by helping them to solve new learning tasks they encounter in the project. The students always involve in both individual and group reflection exercise. Use of interactive methods of instruction eliminates disparities in achievement between boys and girls while use of lecture methods can promote disparity in learning achievement between boys and girls (Miheso-O’Connor, 2002). Students’ attitude towards sciences or methods of instruction in science classrooms can be a contributing factor on performance of sciences in secondary schools. For instance, Lin (1998) found attitude of high school students towards learning biology to be characterized by less motivation when teacher-centered methods of teaching were used compared to when interactive methods were used. The constructivist method of instruction, as Brown (2005) suggested, is an example of interactive method of learning.

Due to the challenges facing the students as highlighted above, to improve learner achievement, students should be enabled to learn and use higher-order thinking skills in order to be relevant in a fast technologically changing world. To achieve this, teachers should use instructional methods that provide the opportunity for learners to construct knowledge by themselves. Also, teachers should encourage formulation of instructional objectives and assessment procedures that reflect learning at higher-order thinking skills. The present study therefore decided to investigate the effect of constructivist instruction on learning in different classroom categories and at different cognitive skill levels.

The Constructivist Approach and Learner Achievement

Studies comparing learner achievement in constructivist classrooms and conventional classrooms have indicated better results in favour of the constructivist learning. In a study conducted by Becker and Maunsaiyat (2004), constructivist-instructed students had higher scores on the post-test and the delayed post-test, compared to those of the traditionally instructed students. This finding showed that the mode of instruction could greatly influence learner achievement. In another study conducted by Akar (2003), there were no statistically significant differences in learner achievement in short structured questions between the constructivist-instructed students and the conventionally instructed students. However, the study found a statistically significant difference in the learner achievements knowledge retention and essay type questions between the constructivist and conventional groups. In the study, the constructivist-instructed students best retained knowledge in achievement test as compared to those instructed through the conventional methods. The constructivist-instructed students equally performed better in essay type questions. This finding is in line with the preposition made by Daloğlu, Baturay,
and Yildirim (2009) that constructivist learning is effective in the retention of knowledge. Similarly, in a study conducted by Bimbola and Daniel (2010), the results indicated that there was improvement in academic performance of students in the constructivist group on pre-test and delayed post-test. Their scores in topic specific topics considered, at the post-test level, were higher than their scores at the pre-test levels and that this was different from score obtained by colleagues in the conventional lecture group. When the same groups of students were subjected to a delayed post-test stage, students in the constructivist group were able to retain about 80% of the concepts taught compared to their colleagues in conventional lecture group, who could only retain about 10% of the concepts taught.

The findings in the above studies therefore indicate that constructivist instructional methods consistently produced better learner achievement. This study compared the effects of constructivist and conventional instructional methods on learner achievement in different class categories among secondary school students in Homa Bay County.

**Bloom’s Taxonomy of Cognitive Levels**

Bloom’s taxonomy of cognitive levels was designed by a committee of educators under the leadership of Benjamin Bloom in the 1940s and 1950s (Felder & Brent, 2004). Since then, the taxonomy has been used in the education sector and especially for learner evaluation. The taxonomy outlines various levels of learning and application of retained knowledge in six major taxonomies (Biggs & Collis, 2014). When learners develop the capacity to apply understanding, use knowledge in new situation, and construct own knowledge, they are considered to have developed sufficient skills implied in effective learning. The six levels of cognition according to Bloom’s taxonomy are knowledge, comprehension, application, analysis, synthesis, and evaluation. According to Biggs and Collis (2014), Bloom’s taxonomy of cognitive levels can be used to evaluate the quality of learning. The following explanations of the taxonomy is based on Guskey’s (2012) review of Bloom’s taxonomy.

**Knowledge**

Knowledge involves recalling memorized information as presented or self-acquired. This may involve recalling a wide range of materials which may include specific facts as well as complete theories. This cognitive level requires that the learner is able to bring to the mind appropriate information prior acquired. This represents the lowest level of learning outcomes in the cognitive domain. Learning objectives at this level require that learners get acquainted with common terms, specific facts, methods and procedures, and basic concepts and principles. In assessing learner achievement at this level, learners are asked to define, list, state, identify, label, and name.

**Comprehension**

This comprehension level requires learners to develop the ability to grasp the meaning of material. Learners should be able to translate materials from one form to another, interpret material appropriately, and to be able to predict future trends, effects, and consequences. At this stage, learners are expected to go one step beyond the simple remembering of material. Learning objectives at this level require the learners to be able to understand facts and principles, interpret and translate verbal materials in their domain, interpret charts and graphs, estimate the future consequences implied in facts presented, and rationalize methods and procedures. Learner evaluation at this level is achieved by asking questions, such as explain, clarify, predict, interpret, infer, summarize, review, convert, translate, give example, account for, deduce, etc..
Application

The application stage implies the ability to use learned material in new and concrete situations. It involves the development of the ability to apply rules, methods, concepts, principles, laws, as well as theories. Learners at this level are required to apply concepts and principles to new situations, apply laws and theories to practical situations, solve scientific problems, construct graphs and charts, and demonstrate the correct usage of a method or procedure. Learner assessment is constructed on questions such as how would you show, make use of, modify, demonstrate, or solve.

Analysis

At this stage, learners are supposed to demonstrate their ability to break down material into its component parts. Learning outcomes here require an understanding of both the content and the structural form of the material. Learning objectives at this level require the learners to recognize unstated assumptions and propositions, distinguish logical misconceptions in reasoning, distinguish between facts and insinuations, and evaluate the relevancy of data. Learners are asked questions requiring them to differentiate, compare, and contrast.

Synthesis

Synthesis refers to the ability to put parts together to form a new whole. It involves the production of a unique communication, plan of operations, or a set of abstract relations. Learning outcomes in this area stress learners’ creative behaviours and emphasize on the formulation of new patterns or structure. At this level, learners should be able to write a well-organized paper, give a well-organized speech, propose a plan for an experiment, integrate learning from different areas into a plan for solving a problem, and formulate a new scheme for classifying objects. Learner evaluation at this level requires demonstration of the ability to design, construct, develop, formulate, imagine, create, change, and label the elements.

Evaluation

For the learning process to be complete, learners should develop the ability to judge the value of material for a given purpose. The judgments should be based on definite criteria, which may be internal (organization) or external (relevance to the purpose). Students may determine the criteria or be given them. Learning outcomes in this area are highest in the cognitive hierarchy because they contain elements of all the other categories, plus conscious value judgments based on clearly defined criteria. Learning objectives at this level require the learners to demonstrate their ability to judge the logical consistency of written material, judge the adequacy with which conclusions are supported by data, judge the value of a work by the use of internal criteria, and judge the value of a work by the use of external standards of excellence.

Problem Statement

Teaching and learning of biology in many secondary schools in Kenya has generally taken a pattern where teachers mostly use conventional methods of instruction characterized by lectures and few demonstrations (Kenya National Examination Council [KNEC], 2005; 2010). With the use of the conventional methods of instruction, students are exposed to minimal practical activities and group discussions, and are hardly taken on educational trips. Consequently, overall performance of biology in KCSE examination has been poor. This has been characterized by low mean score and high standard deviations. In Homa Bay County, in the year 2010, a total of 196 secondary schools in Homa Bay County presented candidates for KCSE examinations and only 26
schools managed to obtain a mean score of 6.4 and above in biology. The majority of the schools (113) did not even obtain a mean score of 4.5 (mean grade D+) in biology. This implies that in the year 2010, the biology mean grade for most schools in the county was D+ and below. This result was not any different in the year 2013. According to the county education office, the average mean score for biology in all the schools in the county in the year 2013 was 5.707625.

This dismal performance is further segregated along gender with most female students appearing at the lower end. Studies reveal that girls and boys have different approaches to learning (Geist & King, 2008; Eliot, 2013). In the same way, it would be expected that different classroom categories present different challenges for learners. The poor performance calls for reconsideration of instructional methods used in secondary schools for teaching biology and specifically the topic of ecology. While there are several instructional methods, the most common one is the conventional, lecture method. This method, however, is teacher-centered and has been shown to produce poor results. Alternative to the conventional method is the constructivist instructional method which is student-centered.

**Purpose and Objectives**

The purpose of this study is to determine the effect of the constructivist instructional approach on learner achievement in different class categories. Understanding the effects of the constructivist instructional approach is expected to extend the horizons of constructivist theory of learning by outlining the effect of constructivist theory on learning biology amongst students in different classroom categories as boys’, girls’, and mixed classrooms. Biology teachers can make use of the revealed differences in learning achievement of learners in different classroom categories in relation to constructivist instruction to organize effective and appropriate learning strategies. The Kenya Institute of Curriculum Development (KICD) should recommend for its use, based on the results of the study, in teaching and learning entire secondary biology course or for teaching specified topics in the biology curriculum for secondary schools. Textbook publishers and media developers can take advantage of the findings to incorporate constructivist language and activities in the content of biology materials to facilitate teachers and students’ use of constructivist learning methods. Application of constructivist instruction might improve performance in biology by eliminating large performance gaps that exist in biology results in KCSE examination. The study was specifically conducted to determine the differences in learner achievement in the pre-test at post-test evaluation exams among students of different class categories instructed through the conventional methods, to evaluate the differences in learner achievement in the pre-test and post-test evaluation exams among students of different class categories instructed through the constructivist approach and to compare the differences in mean gain between learners in different class categories instructed through the conventional and the constructivist approaches.

**Theoretical Context**

Learning is a guided process of acquiring knowledge, which requires appropriate methods aimed at increasing knowledge retention and application (Laurillard, 2013). Since instructors have a mandate of driving the learning process, they often adopt a method that they deem appropriate. The present study is based on the concepts of individual constructivist theory of Piaget (1991) and social constructivist theory of Vygotsky (1978). Individual constructivist theory of Piaget (1967) provides a two pronged approach to knowledge construction. First, Piaget’s cognitive structures (schema) responsible for adaptation processes of assimilation,
accommodation, and equilibrium are similar to use of prior-learning experiences in aiding new knowledge constructions. Second, learning occurs when an individual passes through four stages of cognitive developments as sensory-motor, pre-operational, concrete, and formal operational stages. Concrete and formal operational stages are implied in constructivist learning. At the concrete stage, learning is by manipulation of objects, ideas, and events, which later transforms to formal reasoning. In constructivist learning, repeated manipulation of objects and ideas enables learners to construct meaningful concepts that can be transferred to logical abstract reasoning in a formalized manner.

The social constructivist learning theory propounded by Vygotsky (1978) considers learning as socially mediated exercise where a person constructs knowledge based on interactions with social and cultural environment. Knowledge formed by a learner is influenced by environment (context) and prior knowledge held by the learner (Borich, 2011). Therefore, in social constructivist learning, teachers should provide learners with an opportunity to negotiate meaning and to collaborate with peers and adults including teachers in knowledge construction (Straits & Wilke, 2007). The 5Es (i.e., engagement, exploration, explanation, elaboration, and evaluation) constructivist model adopted in the study is a social constructivist approach to learning and provides learners with an opportunity to construct knowledge at individual and at social levels during group discussions.

**Conceptual Framework**

This study has been conceptualized with constructivist and conventional instruction methods as the main independent variables while learner achievement at different cognitive levels forms the dependent variables. Figure 1 illustrates how the independent variables interact with the intervening variables resulting into different dependent variables.

![Figure 1. Conceptual framework.](image-url)
Methodology

The study adopted quasi-experimental non-equivalent group design with a pre-test and a post-test (Fraenkel & Wallen, 2006). Participants in the study were divided into two groups: experimental and control groups. The experimental group participated in the constructivist method of instruction while the control group participated in the conventional method of instruction. Activities of the experimental group formed the main focus of the study. Participants in the experimental group used the constructivist instructional manual prepared by the researcher to guide in delivery of the lessons. Lesson activities planned in the constructivist manual were designed on the format of the 5Es constructivist instruction model developed by Bybee (Trowbridge et al., 2004). Each lesson or double lessons progressed through five stages of activities. The stages are engagement, exploration, explanation, elaboration, and evaluation. Here follows a brief explanation of the activities that took place in the various stages during the lesson(s).

The control group mostly adopted direct instruction procedures like lecture, demonstrations, direct use of textbooks in class, and use of other supplemental reading assignments. The instruments used for collection of data in the study included a constructivist instruction manual and a pre-test and a post-test achievement exam. The study used descriptive statistics and statistical tests of significance to analyze and compare data from different treatment groups.

Findings and Discussion

Presented in this section are the findings from the students from the control and the experimental group. Data were collected from a total of 477 students (245 boys and 232 girls). The majority of the girls were aged 14 while the majority of the boys were aged 15. Figure 2 below represents the ages of the students.
Learner Achievement of the Control Group

The control group comprised of a total of 246 students from boys’ school (74), girls’ schools (91), and mixed schools (81). Learner achievement was assessed both at the pre-test and post-test levels. Table 1 below represents the pre-test and the post-test achievement results.

Table 1
Pre-test and Post-test Results of the Control Group

<table>
<thead>
<tr>
<th>Class category</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Post-test/Pre-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M_1$</td>
<td>SD</td>
<td>$M_2$</td>
</tr>
<tr>
<td>Boys ($n = 83$)</td>
<td>40.20</td>
<td>19.97</td>
<td>47.71</td>
</tr>
<tr>
<td>Girls ($n = 84$)</td>
<td>27.31</td>
<td>21.97</td>
<td>35.00</td>
</tr>
<tr>
<td>Mixed ($n = 79$)</td>
<td>30.97</td>
<td>13.20</td>
<td>38.04</td>
</tr>
</tbody>
</table>

As shown in Table 1, the analyzed pre-test results of participants in the control group show that boys ($M = 40.20; SD = 19.97$) performed better than participants in the mixed sex classes ($M = 30.97; SD = 11.90$) and girls’ classes ($M = 27.31; SD = 21.97$). The pre-test exam was taken before the participants received the instructional information and all the items in the pre-test were testing understanding at the six cognitive levels of knowledge as per Blooms’ classification of cognitive knowledge (Bloom, Engelhart, Frost, Hill, & Krathwohl, 1956). The pre-test results therefore seem to suggest that before instruction, participants in boys’ classes had more knowledge of facts and concepts of the topic ecology than participants in mixed sex classes and girls’ classes.

This disparity could be explained by the fact that boys’, girls’, and mixed class categories present different learning challenges and that it is also possible that participants in boys’ classes were somehow motivated to “read a head” for an impending test. All participants in the study were informed of the pre-test examination in
advance. And since all the participants had not received any instruction on the topic at the time pre-test was taken, the better performance of boys can only be explained on the basis of a more organized revision boys made for the announced test. This finding is consistent with a study conducted by Obiekwe (2008) on the effects of constructivist instructional approach on students’ achievement in basic ecological concepts in biology, which revealed a significant difference in the pre-test exams scores for girls and that of boys.

Table 1 indicates that in the post-test achievement test, boys’ classes attained the highest mean score and standard deviation (\(M = 47.71; SD = 13.40\)), followed by participants in the mixed sex classes (\(M = 38.04; SD = 14.46\)) and lastly participants in girls’ classes (\(M = 35.00; SD = 10.62\)). All the participants took the post-test after receiving instructional information for a period of five weeks. The results suggest that the amount of learning achievement registered by participants in the three categories of classes was not the same. Post-test analysis of variance (ANOVA) results also reveal a significant difference in the mean score values between the participants in the three class categories (\(F(3,660) = 22.01; p = 0.001\) at \(p = 0.05\) level of significance). The pre-test to post-test mean gains (\(M_2 - M_1\)) indicate that girls in girls’ single sex schools had the largest mean gain of 28.16% followed by participants in the mixed classes with mean gain of 22.63% and lastly boy’s classes with a mean gain of 17.78%. Girls’ registered the highest pre-test to post-test mean gain compared to participants in mixed sex classes or boys’. It can be reasoned from the results that learners in girls’ school had less prior knowledge of concepts under instruction as compared to those in the mixed and boys’ classes. It can be argued that the poor achievement of girls in pre-test may have motivated them to focus more on objectives of the instruction. This line of reasoning is supported by Glover and Law (2002) who stated that “girls have higher self-expectation and work harder to compensate for what they believe are personal inadequacies” (p. 133).

**Learner Achievement of the Experimental Group**

The pre-test and post-test results of the experimental group were analyzed and presented by use of descriptive statistics of mean and standard deviation values. T-test was also used to find out significance in mean difference in performance between different class categories. The analyzed pre-test and post-test results for the three categories of participants in the constructivist group are presented in Table 2. In the table, post-test and pre-test mean differences for the three categories of participants are also presented.

### Table 2

**Pre-test and Post-test Results of the Experimental Group**

<table>
<thead>
<tr>
<th>Class category</th>
<th>Pre-test</th>
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<tbody>
<tr>
<td></td>
<td>(M_1)</td>
<td>(SD)</td>
<td>(M_2)</td>
</tr>
<tr>
<td>Boys (n = 71)</td>
<td>29.15</td>
<td>13.53</td>
<td>38.45</td>
</tr>
<tr>
<td>Girls (n = 78)</td>
<td>14.14</td>
<td>11.32</td>
<td>54.27</td>
</tr>
<tr>
<td>Mixed (n = 82)</td>
<td>20.93</td>
<td>11.90</td>
<td>44.23</td>
</tr>
</tbody>
</table>

As shown in Table 2, the analyzed pre-test results of participants in the experimental group indicate that boys (\(M = 29.15; SD = 13.53\)) performed better than participants in the mixed sex classes (\(M = 20.93; SD = 11.90\)) and girls’ classes (\(M = 14.14; SD = 11.32\)). The pre-test was taken before the participants received the instructional information and most items in the pre-test were testing understanding at the level of knowledge as per Blooms’ classification of cognitive knowledge (Bloom et al., 1956). The pre-test results therefore seem to suggest that before instruction, participants in boys’ classes had more knowledge of facts and concepts of the
To explain the disparity, it is possible to reason that participants in boys’ classes were somehow motivated to “read a head” for an impending test. All participants in the study were informed of the pre-test examination in advance. And since all the participants had not received any instruction on the topic at the time pre-test was taken, the better performance of boys can only be explained on the basis of a more organized revision boys made for the announced test. Otherwise, the study expected all the three groups of participants to have similar results.

Data in Table 2 indicate that in the post-test, performance of the participants in the constructivist group took a different pattern. Participants in girls’ classes attained the highest mean score and standard deviation ($M = 54.27; SD = 14.69$), followed by participants in the mixed sex classes ($M = 44.23; SD = 14.60$) and lastly participants in boys’ classes ($M = 38.45; SD = 11.96$). All the participants took the post-test after receiving instructional information for a period of five weeks. The same piece of information was given to all the participants. However, the results suggest that the amount of learning achievement registered by participants in the three categories of classes was not the same. This implies that improved learning outcomes occurred differently in different class categories. Post-test ANOVA results also reveal a significant difference in the mean score values between the participants in the three class categories ($F_{(2,228)} = 25.0393; p = 0.001$ at $p = 0.05$ level of significance). The null hypothesis was rejected and the conclusion made was that the constructivist method of instruction produces different learning effects in different class categories. Students in girls’ single sex schools learn significantly better than boys or students in mixed sex classes when teachers use the constructivist method of instruction. The pre-test to post-test mean gains ($M_2 - M_1$) indicate that girls in girls’ single sex schools had the largest mean gain of 40.13%, followed by participants in mixed sex classes with mean gain of 23.30%, and lastly boys’ with a mean gain of 9.3%. Participants in girls’ classes registered the highest mean score in the post-test, and at the same time, the highest pre-test to post-test mean gain compared to participants in mixed sex classes or boys’. It can be reasoned from the results that girls readily customized the constructivist method of instruction, and therefore, gained from it more than participants in mixed sex class or boys. Miheso-O’Connor (2002) found girls to be more positive and to readily customize interactive methods of instruction. Newby, Stepich, Lehman, Russell, and Ottenbreit-Leftwich (2010) argued that a pre-test focuses learners on important aspects of instruction and may be girls took advantage of the pre-test and used it better than boys or participants in mixed sex classes to recognize and remember some concepts during the instruction process. Also, the poor performance of girls in pre-test may have motivated them to focus more on objectives of the instruction. This line of reasoning is supported by Glover and Law (2002), who stated that girls have higher self-expectation and work harder to compensate for what they believe are personal inadequacies.

Mean Gain Between the Control and the Experimental Groups

The mean gain in achievement results for both the control and the experimental groups were computed and compared. Figure 3 below represents the mean gain in learner achievement between the experimental and the control groups.

Mean Gain Between the Control and the Experimental Groups

The mean gain in achievement results for both the control and the experimental groups were computed and compared. Figure 3 below represents the mean gain in learner achievement between the experimental and the control groups.
From Figure 3 above, the study revealed that girls’ schools had the highest mean gain of 32.44, followed by the mixed secondary schools (23.3), while boys’ schools had the least mean gain (1.79). This finding leads to an understanding that the experimental group registered better mean gain as compared to the control group. It is possible that the learners in the experimental group experienced better knowledge retention as compared to their counterparts in the control group. Similar findings have been highlighted by Daloğlu et al. (2009). This finding concurs with a study conducted by Becker and Maunsaiyat (2004), which found out that the constructivist-instructed students (the experimental group) had higher scores on the post-test and the delayed post-test, compared to those of the traditionally instructed students (the control group).

**Conclusion and Recommendations**

The results revealed that girls attained higher mean scores followed by participants in mixed sex class and lastly boys’. When pre-test and post-test mean gains were compared, girls had the highest mean gain followed by participants in mixed sex class and lastly boys with the lowest mean gain. ANOVA test runs on the mean difference revealed a significant difference in favour of girls. The study therefore concludes that when instructed through the constructivist approach, learners in different class categories register better achievement as compared to those instructed through the conventional methods. The differences in mean gain for different class categories also lead to the conclusion that learners in girls’ class category register better learner achievement when instructed through the constructivist approach.

The following recommendations are therefore made based on the findings of the study:

1. Biology teachers should consider using the constructivist instructional methods in order to improve learner achievement in different class categories.
2. Further investigations should be conducted into constructivist learning using some other assessment strategies other than the 5Es instructional model. Similar studies should be conducted in schools located in
urban areas to compare attitude of students in rural and urban schools since this study was conducted in a rural setting.

3. The government of Kenya through the KICD should develop a framework through which appropriate instructional methods be employed in bridging the disparities in learner achievement in science-based disciplines and across the different class categories.

References


