Imperial Journal of Interdisciplinary Research (IJIR)
Vol-3, Issue-10, 2017
ISSN: 2454-1362, http://www.onlinejournal.in

Application of Constructivist Instructional Approach in Kenya; Focus on Learner Achievement in Different Class Categories

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Abstract*: The study investigated application of constructivist instructional method in teaching biology among leaners in different class categories in Homabay County, Kenya. The hypotheses formulated for the study compared the effects of constructivist and conventional methods of instruction on learning Biology in different classroom categories. The study design was quasi-experimental non-equivalent groups with a pre-test and a post-test. The experimental group was assigned to constructivist method of instruction while the control group, conventional methods of instruction. Target population for the study was 61,115 students enrolled in 196 secondary schools of Homabay County. Participants were purposively assigned into the two instructional groups. Instruments used in the study were; a constructivist instruction manual, a pre-test, a post-test and an attitude questionnaire. Data collected for the study was analyzed descriptively using mean and standard deviation values while t-tests and ANOVA-tests were used to test for significance in difference between group means at α=0.05 level. Findings of the study were as follows: constructivist method of instruction is more effective in learning biology compared to conventional methods. The study recommends that biology teachers be encouraged to use constructivist method of instruction in order to improve students' performance. Also a similar study can be done in urban areas to reveal the attitude of students in urban schools towards constructivist learning.*

Key words: *Constructivist, Classroom categories, cognitive levels, learner achievement*

1. Introduction

The need for increased performance in science based disciplines has in the past four decades attracted great expectations from educators and general public (Noor and Hamidon, 2016). In America, the desire to improve science education was anchored on a report by National Commission of Excellence in Education (Mintzes and Wandersee, 1998) which detailed falling standards in America's science education due to teachers using ineffective methods of teaching that do not promote high order thinking and creativity among the youth. In Australia, poor performance in mathematics and science education led federal Government to establish a centre for science and mathematics education to promote improvement in teaching of mathematics and science (Fraser, and McRobbie, 1995).Similar sentiment has been raised by Talbot-Smith, Abell, Appleton, & 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 unavailability of facilities for learning sciences in secondary schools Fraser, and McRobbie, 1995; Ejakait et al., 2011).

In Kenya, conventional methods of instruction marked by teacher lecturing dominate classroom practices (Mwanda .G et al., 2016). Conventional methods of teaching, though popular, have generated a lot of negative and positive thoughts. For instance, Keshta and Harb (2013), warns that conventional teaching often give 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. Odundo and Gunga (2013), also found conventional methods, particularly lecturing strategy to be characterized with; lack of planning, poor time management, unstructured presentation and content overload, less innovativeness 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 the 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), suggest that constructivist is accepted as the most relevant view of learning and that education policies, models and practices should focus on constructivist learning. Churchill, King & Fox (2013) describes the constructivist approach as a theory of learning based on the ideals that knowledge is constructed by the leaner and this is based on learner's 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.

The policy document, Kenya Education Sector Support Programme (KESSP) of 2005 – 2010, indicates that secondary education is characterized by poor performance in mathematics and sciences in national examinations. In the same document, it is indicated that the poor performance in mathematics and science is due to lack of enough trained teachers, equipment and teaching and learning materials. Similarly, Kenya National Examination Council (KNEC) in KCSE examination reports of year 2006, 2007 2008, 2009, 2010, 2011 and 2012 blame poor methods of instruction used by teachers as responsible for poor performance in sciences.

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

2. Problem Statement

Higher learner achievement, and more so in science based disciplines has been the desire of both learners and educationists across the world. As a result, studies have been aimed at finding out the best instructional model for different learner categories. Whiles studies have revealed general success for constructivist instructional model, different factors may influence its implementation. This study considered class category as a factor predictive of learner achievement in constructivist instructional model.

3. Literature Review

3.1The 5Es Constructivist approach

The 5 E's model of instruction was proposed by Roger Bybee for the teaching of sciences in schools. The model was developed under the Biological Science Curriculum Study (BSCS) project. The model is based on the five stages of learning namely; Engage, Explore, Explain, Elaborate and Evaluate. The rationale behind the model is that learners have capacity to build own understanding of new ideas based on prior experience and knowledge. The aim of the engagement stage is to help learners make connections between past and present learning experiences. Learners at this stage are involved in encountering and processing information, formulation of hypotheses, and making decisions while relying on their cognitive structure (Ongowo, Richard, Indoshi & Ayere, 2015). At the exploration phase, learners identify and develop concepts, processes, and skills by actively exploring their environment and manipulating learning materials. The aim of the phase is to enable learners establish real world connections and provide a common base of experiences from which to grow and learn. The explanation phase helps learners uncover the content surrounding the concepts they have been exploring. The learners are accorded the opportunities to verbalize their conceptual understanding, encounter new content material or demonstrate new skills . The phase also provides opportunities for teachers to introduce primary content materials such as formal terms, definitions, and other content information. The implementation of this phase provides the learner with opportunities to identify skills and behavior in order to both experience and discover content that may be useful in context (Ergin, 2012).

At elaboration phase, learners are guided to extend their conceptual understanding in areas of skills and behaviours. In a constructivist framework, the educator provides opportunities in which learners can practice and refine their skills and behaviours in authentic contexts (Hannafin, Hill, Land & Lee, 2014). They are further given opportunities to deepen and broaden their knowledge base and integrate that knowledge into their conceptual understandings and actions, both inside and outside of the classroom. Evaluation phase requires learners to assess their own understanding and abilities and allows the teacher to evaluate students' understanding of key concepts and skill development. As such, students learn to assess their own abilities, identify areas of mastery that they now possess, and strengthen developing understandings (Quinn et al.,2012). This provides opportunities for the teacher to evaluate students' performance of new knowledge integration through presentations or demonstrations (Rudolf, 2012).

3.2 Effectiveness of Constructivist Instructional Method

Studies comparing learner achievement in constructivist classroom and the conventional classrooms have indicated better results in favour of the constructivist learning. In a study conducted by Becker & 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 was no statistically significant difference in learner achievements in short structured questions between the constructivists 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 student's 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 Daloglu, Baturay & Yildirim (2009) that 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 constructivist group on pretest and delayed posttest. Their scores in topic specific topics considered, at the post test level, were higher than their scores at the pretest 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 posttest stage, students in 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 achievements. This study compared the effects of constructivist and conventional instructional methods on learner achievement among secondary school students in Homabay County.

3.3 Class category differences constructivist application

Class categories are considered in terms of gender compositions of the learners. A class with only female learners is for the purposes of this study considered to be girls class category, those of boys, boys class category and those of mixed boys and girls, mixed class category. Gender is a socially ascribed attribute which differentiate feminine from masculine (Chinwe and Chinyere, 2010). Difference in biology achievement due to gender has caused a lot of concern to educationist. In some instances, it has been argued that girls do not perform better in mathematics and sciences as compared to the boys. Some of these differences have been attributed to gender discriminations that are believed to be exhibited by the nature of teaching materials and environments as well as the dominant patriarchal worldviews in most societies. (Wai & Watt, 2009).Some scholars have concluded that girls think and learn differently as well as interact with equipment differently from boys. These differences occurs also in the teaching and learning of biology. Studies reveal that girls and boys have different approaches in learning (Eliot, 2013).

A study conducted by Chinwe & Chinyere (2010) on the effects of constructivist instructional approach on students' achievement in basic ecological concepts in biology revealed that while there was no statistical difference in the students achievement tests in the post-test evaluations between boys and girls, the pre-test exams revealed differences in the scores for girls and that of boys. From their study Chinwe & Chinyere (2010) concluded that constructivist instructional methods enabled the girls to achieve better learning outcomes. Earlier, Aiyedun (2000) who discovered that difference in the achievement of male and female students could be taken care of by using good methods, material and appropriate teaching strategies

It is generally recognized that students at single-sex schools register higher learner achievement based on evaluations than those at co-educational schools (Younger and Warrington, 2002)). The reason for this is much disputed. Pitching the two groups advocating for single sex or co-ed schools is the argument for social advantage and the holistic approach to education. The former claim that students in single sex schools are 'better' educationally while the latter group argue that the students to the single-sex schools represent a more academic or socially advantaged group. In 2001, a British study concluded that nearly every girl regardless of her ability or socioeconomic status performed better in single sex classrooms than co-educational ones (Smithers and Robinson, 2006).

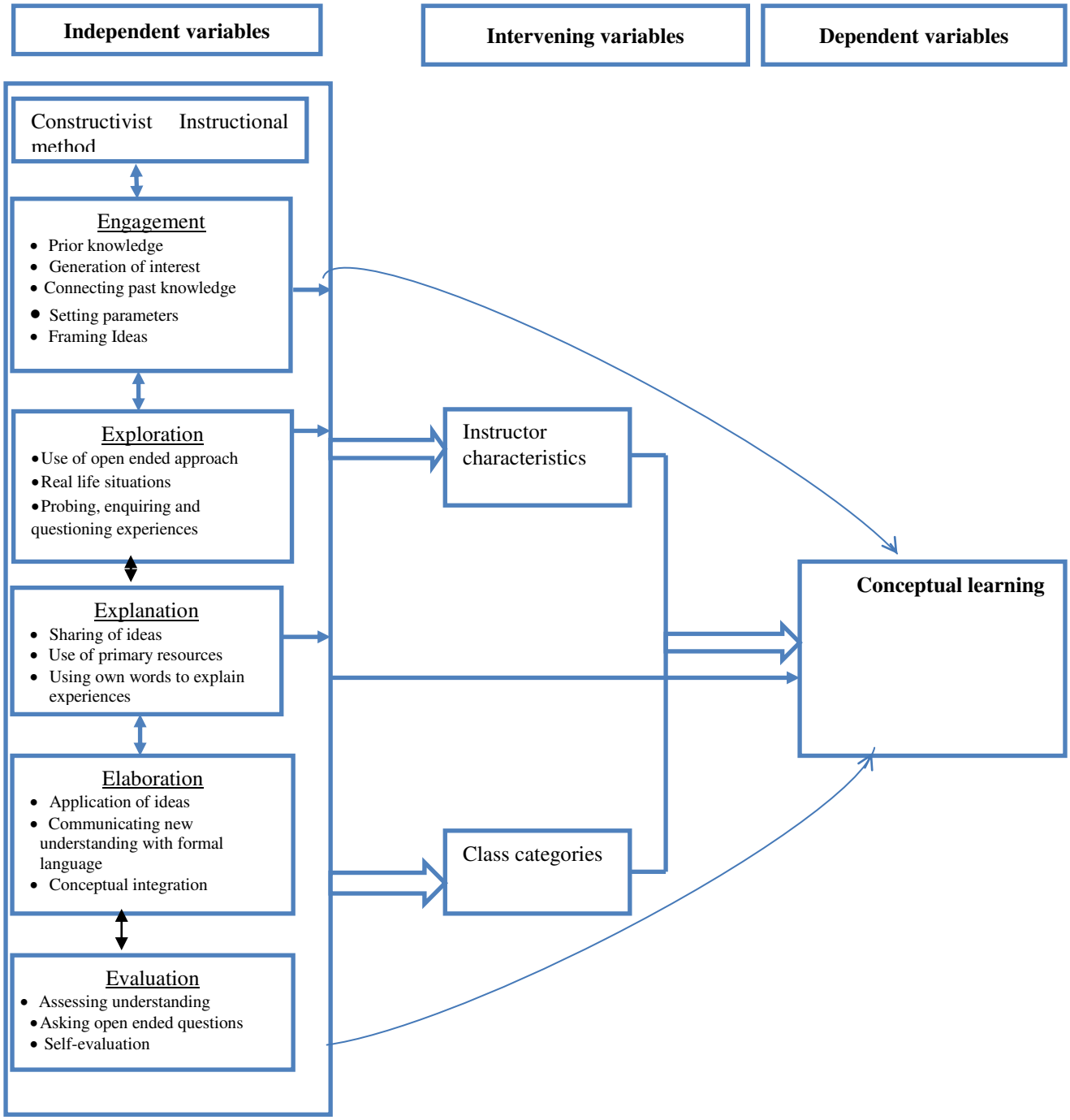
4. Theoretical Context

This study was guided by the social constructivist theory as proposed by Vygotsky. The theory view knowledge and truth as created during the instructional process (Fosnot, 2013). As such, concepts are constructed rather than discovered given that is a subjective experience of one's everyday life. It is therefore the learners who define the reality so constructed. The constructivist approach therefore

creates a context for learning in which students become engaged in activities that encourages and facilitates learning. The role of instructor in constructivist approach is to guide learners as they approach problems, encourage them to work in groups and think about issues and questions. The instructor thus facilitate cognitive growth and learning as do peers and other members of the learner's community. Four principles are applied in any Vygotskian classroom; that learning and development is a social, collaborative activity; that the Zone of Proximal Development can serve as a guide for curricular and lesson planning; that school learning should occur in a meaningful context and not be separated from learning and knowledge children develop in the "real world." And those out-of-school experiences should be related to the child's school experience (Daniels, 2016).

5. Conceptual Framework

This study has been conceptualized with the 5Es constructivist instructional approach as the main independent variables while learner attitude forms the dependent variables. Figure 1 illustrates the conceptual framework.



6. Methodology

The study adopted quasi-experimental non-equivalent group design with a pre-test and a post-test (Fraenkel and 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 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 researchers 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 (Wilson, Taylor, Kowalski, & Carlson, 2010). Each lesson or double lessons progressed through five stages of activities. The stages are: Engagement, Exploration, Explanation, Elaboration and Evaluation. Here follows brief explanation of activities that took place in the various stages during the lesson(s).

The Control group 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, a pre-test and a post-test achievement exam. The study used descriptive statistics and statistical tests of significance to analyse and compare data from different treatment groups.

7. Data Analysis and Discussion

7.1 Demographic characteristics of the respondents

The study was conducted among form three students in Homabay County. All the students in the sampled schools participated in the study. Table 1 below represents the demographic characteristics of the participants.

Table 1. Demographic characteristics

		Frequency	Percentage
Gender	Boys	117	50.65
	Girls	114	49.35
Class category	Girls	71	30.74
	Boys	78	33.77
	Mixed	82	35.50
Total		231	100.00

Of the sampled learners, 117(50.65%) were boys while 114 (49.35%) were girls. In the class categories, girls class had 71(30.74) learners while boys class had 78(33.77%). The mixed class category had the highest percentage of 35.5%. The demographic information demonstrates fair representation of gender and class categories in the study.

7.2 Effectiveness of Constructivist Instructional Method on Learner Achievement in Biology

In order to compare the effect of constructivist instructional method amongst learners in different class categories, pre-test and post-test results of the groups participating in constructivist instruction was analysed and presented by use of descriptive statistics (mean and standard deviation). T-test was also used to find out significance in mean difference in performance between different class categories. The analysed pre-test and post-test results for the three classroom categories in the constructivist group as well as the post-test--pre-test mean difference are presented in table 1.

Table 2 : Pretest and Posttest Results of the Constructivist Group

Class category	Pre-test M_1 SD	Post-test M_2 SD	Posttest-pretest $M_2 - M_1$
Boys(n = 71)	29.15 13.53	38.45 11.96	9.3
Girls(n = 78)	14.14 11.32	54.27 14.69	40.13
Mixed(n = 82)	20.93 11.90	44.23 14.60	23.30

As shown in table 1, the analysed pre-test results of participants in the constructivist group indicate that boys classroom category with a mean and standard deviation of (M = 29.15; SD = 13.53) performed better than participants in the mixed sex classes with (M = 20.93; SD = 11.90) and girls classroom category with (M = 14.14; SD11.32). The pre-test was taken before the participants received the instructional information and testing was based on the 5Es cognitive levels as per Blooms classification of cognitive Knowledge (Bloom *et al*., 1956). The pre-test results indicate that before instruction, participants in boys' classes were more knowledgeable of facts and concepts of the topic ecology than participants in mixed sex and girls' class categories.

This finding may lead to a conclusion that boys' classes were somehow motivated to 'read a head' for an impending test since all participating students were informed of the pre-test examination in advance. Further, all participating students had not received any instruction on the topic at the time pre-test was taken. The better achievement of learners in boys category classrooms in the pre-test examination could therefore only be explained by a more organized revision boys on their part.

Data in table 1 indicate that in post-test, participants in girls' class categories attained the highest mean score and standard deviation (M = 54.27; SD = 14.69) followed by participants in the mixed sex class categories who scored (M = 44.23; SD = 14.60) and lastly participants in boys' class categories with scores of (M = 38.45; SD = 11.96). All the Participants took the post-test after receiving instructional information for a period of five weeks. The instruction followed similar instructional methodologies for all class categories. However, the results suggest that different levels of learning registered by participants in the three categories of classes was not the same. Post-test ANOVA results revealed a significant difference in the mean score values between learners in the three class categories i.e. F (2,228) = 25.0393, p = 0.001 at p=0.05 level of significance. The null hypothesis was thus rejected and conclusion made was that constructivist method of instruction produce different learning effects in different class categories. Students in girls single sex class categories learn significantly better than boys or students in mixed sex class categories when teachers use constructivist methods of instruction. The pre-test to post-test mean gains (M_2-M_1) indicate that learners in girls single sex class categories had the largest mean gain of (40.13%) followed by those in mixed sex class categories with a mean gain of (23.30%) and lastly boys' class categories with a mean gain of (9.3%). Girls class categories 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 customised the constructivist method of instruction and therefore gained from it more than participants in mixed sex class or boys. This finding concurs with those of Miheso-O'Connor (2002) who found out that girls are more positive and readily customize interactive methods of instruction. According to Newby *et al.* (2010), a pre-test focuses learners on important aspects of instruction. It is possible therefore to argue that learners in girls class categories took advantage of the pre-test and used it better than learners in boys and mixed class categories . 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 Dev (2016) who found out that girls have higher self-expectation and work harder to compensate for what they believe are personal inadequacies and this explains their improvements given a second chance.

7.3 Constructivist instructional method and learner achievement in different class categories

In order to find out if constructivist method of instruction can discriminate learning of biology at different cognitive levels between girls and boys, performance of girls and boys was measured and compared on each of the items of the post-test and results presented in table 4.4. The results in table 4.4 are in terms of mean score and standard deviation values at each cognitive level. T-tests and p-values at each cognitive level are also presented in the table.

Table 3: Learner achievement in different class categories at Cognitive Levels

Cognitive level	Class category	No	M	SD	T-value	P-value
Knowledge	Girls	71	70.94	30.05	7.94	0.001
	Boys	78	41.49	26.11		
	Mixed	82	51.86	22.72		
Comprehension	Girls	71	44.19	26.33	3.57	0.001
	Boys	78	32.81	21.92		
	Mixed	82	41.01	19.07		

Application	Girls	71	46.58	29.19	5.3	0.001
	Boys	78	28.07	23.49		
	Mixed	82	35.09	20.44		
Analysis	Girls	71	62.65	25.94	1.64	0.102
	Boys	78	57.54	20.93		
	Mixed	82	61.93	18.21		
Synthesis	Girls	71	50.94	27.20	2.45	0.151
	Boys	78	60.09	29.55		
	Mixed	82	75.11	25.71		
Evaluation	Girls	71	24.77	28.79	1.23	0.21
	Boys	78	29.39	27.98		
	Mixed	82	36.74	24.34		

The results in table 2 indicate that learners in girls class categories had higher mean scores in items measuring at the knowledge (M = 70.94), comprehension (M=44.19), application (M = 46.58), and analysis (M = 62.65) compared to learners in boys class categories whose mean scores were; knowledge (M = 41.49), comprehension (M = 32.81), application (M = 28.07) and analysis (M = 57.54). This was also true with learners in mixed class categories (M=51.86, 41.01, 35.09 and 61.93) respectively for the four cognitive levels. These results imply that learners in girls class category performed better than those in boys and mixed class categories in the four items of post-test. T-test runs on mean differences in performance between learners in girls, boys and mixed class categories on the four items discussed above produced the following results; knowledge, $t(299) = 7.94$, $p < 0.001$; comprehension, $t(299) = 3.56$, $p < 0.001$; application, $t(299) = 5.30$, $p < 0.001$ and analysis, $t(299) = 1.64$, $p = 0.102$. These results are at $p=0.05$ level of significance. The results revealed a significant difference in performance between learners in girls class category and those in boys and mixed class categories at knowledge, comprehension and application levels. At synthesis and evaluation levels, although learners in boys class categories attained better mean score than those in girls class category, the t-test runs on mean difference revealed insignificant difference. From these results it is concluded that constructivist method of instruction enable learners in girls class category to learn better than those in boys class category at lower cognitive levels. But at higher cognitive levels, constructivist method of instruction did not discriminate learning between class categories. Since constructivist instruction is interactive, it can be reasoned that learners in girls class category learn better in interactive class.

Conclusion and Recommendations

The findings of this study revealed that constructivist instructional approach has positive influence on learner achievement in biology. In the same vein, learners in girls class category achieved the highest gain in mean , followed by those in mixed class category with the least gain registered by learners in boys class category and thus indicating that constructivist instructional methods leads to higher achievement in girls class category. The study also found that learners in girls class category had better achievement at lower cognitive levels as compared to their counterparts in boys and mixed class categories. The study recommends that instructors adopt the constructivist approach in learning so as to boost learner achievements in biology and other science based disciplines. Further investigations should be conducted to find out reasons for persistent of conventional lecture models of instructions in secondary schools. Further, It would investigations should be conducted in other fields of science to find out if the constructivist approach would also boost learner achievements in different class categories and the variations in the achievements. Finally, policy makers in the field of education in Kenya should come up with policies to ensure appropriate learning approaches for different class categories and especially girls class categories where learners have registered poor achievements in science based disciplines.

Acknowledgements

We appreciate all assistance received from the supervisors, Prof. Patrick Digolo and Dr. Japheth Origa both from the Department of Educational Communication and Technology, University of Nairobi for providing guidance, genuine interest in the study and inspiration to remain focused during the study. We also thank all the teachers and students

of the schools in Homabay County, Kenya for their participation in the study.

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