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RESEARCH ARTICLE

EFFECTS OF CONSTRUCTIVIST TEACHING APPROACH ON STUDENTS' ACHIEVEMENT IN SECONDARY SCHOOL CHEMISTRY IN BARINGO NORTH SUB-COUNTY, KENYA

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Abstract

The purpose of this study was to determine the effects of Constructivist Teaching Approach (CTA) on students' achievement in Chemistry. The study was Quasi-experimental research and Solomon-Four Non-Equivalent Control Group Research Design. The target population comprised of secondary school students in Baringo North Sub-County .The accessible population was Form Two students in the Sub-County co-educational secondary schools. Purposive sampling was used to obtain a sample of four Co-educational Secondary Schools. Each school provided one Form Two class for the study hence a sample size of 160 students. The students were taught the same Chemistry topic of "Structure and Bonding". In the experimental group, constructivist teaching approach was used while the conventional teaching method was used in the control groups. The experimental groups were exposed to the Constructivist Teaching Approach (CTA) for a period of three weeks. The researcher trained the Chemistry teachers in the experimental groups on the technique of CTA before the treatment. The instrument used in the study was Chemistry Achievement Test (CAT) to measure students' achievement. Pilot test was done in a school in a different Division from the ones under study to ascertain the reliability of the instruments. Experts ascertained the validity of instruments before being used for data collection. The reliability coefficient α was 0.78. Data was analyzed using t-test, ANOVA and ANCOVA. Hypothesis was accepted or rejected at significance level of 0.05. The results of the study show that the CTA resulted in significantly higher students' achievement in Chemistry. The results of this study may be beneficial to Chemistry teachers, teacher trainers and curriculum developers in improving the teaching-learning process and achievement in Chemistry.

INTRODUCTION

Before the beginning of 19th Century, the pursuit of science was either a hobby of the few people or the solidarity of effort of those with scientific talent (Das, 1985; Wachanga, 2002). Since then, science has developed to today where people live in a scientific civilization in which science is no longer confined to a few devoted persons (Newton, 1988). Science is involved in the production, processing and preservation of the food eaten as well as purification and storage of drinking water. Scientific knowledge is also used in health care, transport systems and energy sector. In other words, science affects all aspects of human life hence every member in the society should acquire scientific

knowledge. The teaching of science therefore becomes part of the general education of the society (Mohapatra, 1989).

In the recent years, scientific and technological knowledge have grown very rapidly. It is now estimated that this knowledge is doubling every ten years. The changes that science and technology have brought to the environment have been great. This justifies why students should go through the Chemistry curriculum to help them to develop the attitudes, skills and confidence to deal with the present world. A research by the Department of Education and Science (DES) in the United Kingdom showed a gloomy picture concerning the few number of learners choosing science beyond the age of 14, many opting to go out of science. One outcome of the study was the need to address the types of approaches to be used to teach science to broaden its appeal. The teaching approach that a teacher adopts is one factor that may affect students' achievement (Mills, 1991). One of the disturbing trends in Africa is low academic achievement in science and mathematics. This concern was the agenda of a recent meeting of African ministers of Education in Johannesburg South Africa. The delegates warned that unless science education is improved, the continent's economies would fail to meet the Millennium Development Goals (Kigotho, 2007). The delegates further noted that while low achievement in science in Africa is historical, students' limited interest in studying science is rooted on how the subject is taught. Chemistry is one of the fundamental science subjects.
Research has shown that students have continued to consistently perform poorly in Chemistry Examinations conducted by external bodies such as West African Examination Council (WAEC) (Osokoya, 2003; Ibraheem, 2004). Prominent among the contributing factors to students' persistent poor performance or under achievement in Chemistry include ineffective teaching methods or approaches used by science teachers (Njoku, 2004). Other reasons include gender stereotyping, poor attitudes towards the subject and low numerical ability (Okeke, 2003; Ubom, 2003). Studies show that most Nigerian classrooms are dominated by ineffective and inappropriate teacher centered-teaching methods such as expository and teacher centered demonstration approaches (Njoku, 2004).

Chemistry is a major science subject which forms part of the Kenyan secondary school curriculum. Its study involves the pursuit of truth, and therefore it inculcates intellectual, honesty, diligence, perseverance and objective observation in the learners. Studying Chemistry leads to the development of a scientific attitude in the learners which includes critical observation, broad mindedness, non-belief in superstitions and the respect of other peoples' opinions. When these qualities are developed in the learners, they help in solving many problems either individual or societal (Das, 1985; Wachanga, 2002). In addition to being part of the general education of individuals, secondary school Chemistry prepares students for vocation and forms a basis for specialization at higher educational levels. Chemistry therefore, is a critical subject which should be taught in a way that learners understand and enjoy. Traditional instructional practices that centre on teacher dominated pedagogy predominate in most schools. Changeiywo (2000) observes that learning activities in most secondary school classrooms focus on text books and past examination papers. These two serve as major determinants of what is taught in schools. In an attempt to improve performance in Chemistry, various strategies of teaching have been researched in Kenya. Wachanga and Mwangi (2004) found out that Cooperative Class Experiment teaching method facilitated students' Chemistry learning. This method also increased students' motivation to learn. On the effect of Advanced Organizers on Chemistry Achievement, another study showed that the method has a significant positive effect on students' Chemistry achievement than the regular teaching methods (Wachanga,Arimba & Mbugua, 2013).

The Kenyan goal of achieving an industrialized status by the year 2020 and vision 2030 depends on how the youth are equipped with scientific skills. Chemistry therefore will play a very important role in the national development if it is properly taught. In spite of its contribution, the students' performance of Chemistry in National Examinations in Kenya, Baringo North Sub-County included has been deteriorating (MOEST, 2005; KNEC, 2013). This means few students are able to pursue Chemistry and Chemistry related courses at Colleges and Universities hence the country may not achieve industrialization expectations and vision 2030. Some of the factors which may affect students' performance in Chemistry include their motivation, attitude, teaching / learning resources, learning environment and teaching methods. The constructivist teaching approach may help improve students' performance in Chemistry, but its usefulness is not known in Kenya. Therefore, this study sought to determine the effects of Constructivist Teaching Approach (CTA) on students' achievement in the learning of Chemistry.

Constructivism is a theory of learning which was developed in the recent years and has become the significant and dominant perspective in science education (Taber, 2006). According to Bodner (1986), constructivist model focuses on construction of knowledge in the learners mind. Every student has different learning experiences; therefore,

teachers have to be aware that knowledge is constructed differently in the learners' mind. Students have their own pre-existing knowledge based on their experiences that is constructed in their mind (Taber, 2006). Most studies show the advantage of the constructivist theory of knowledge in the learning process, especially its ability to address students' alternative conceptions. According to Krishnan and Howe (1994), students' difficulties in understanding the concepts in science arise due to teachers' lack of knowledge on students' prior understanding in the classroom.

In the constructivist classroom, the teachers' role is to organize situations which will allow the learners to hypothesize, predict, manipulate objects, pose questions, research, investigate and invent meanings. A constructivist classroom is student centered placing more value on student learning rather than the teacher teaching. In other words, the learner is active. The active participation takes the form of relating prior knowledge to new situations (Driver, 1995); cited by (Kaya,Tufecki & Bilasa, 2010). This will enable learners to have control of their own learning (Brooks & Brooks, 1993; Akar & Yildirim, 2004). In the constructivist atmosphere, both the instructor and the learner work actively (Akar & Yildirim, 2004). The teacher watches, listens and asks questions in order to learn about students and how they learn so that students benefit more rather than teachers being dispensers of knowledge. In other words, the teacher behaves as a researcher (Calkin, 1986). Correct answers and single interpretations of phenomena are de-emphasized. Errors are common but necessary in the process of formulating more sophisticated hypotheses. Students should not be penalized or condemned fort taking risks that lead to "errors" during the learning process. Instead they should be assisted with patience and tolerance to eliminate what is perceived as error (Weaver, 1996). It is recommended that before undertaking students' error correction the teacher must consider the possible effect it might have on their understanding of the concept under discussion. Therefore, learning is most likely to be effective when students are actively involved in dialogue and construction of meanings that are significant to them (Wells & Mejia - Arauz, 2006).

The Purpose of the Study

The purpose of the study was designed to determine the effects of using Constructivist Teaching Approach (CTA) on students' achievement in secondary school Chemistry.

Objective of the Study

This study was guided by the following objective:
The specific objective of the study was to determine whether there is any significant difference in students' achievement in Chemistry when taught by the Constructivist Teaching Approach (CTA) and when taught by the conventional teaching methods.

Hypothesis of the Study

The following null hypothesis was statistically tested at the 0.05 level.

H_o1 There is no statistically significant difference in students' Chemistry achievement between those exposed to Constructivist Teaching Approach (CTA) and those not exposed to it.

Conceptual Framework

The conceptual framework that guided the study is based on the Systems Approach (Joyce & Weil, 1980) which holds that the teaching and learning process is dynamic and has inputs and outputs. The best results are achieved when the most suitable materials are fed into the teaching - learning system in the best possible way. The study was based on the assumption that a teaching method that involves students' cooperation and activity was more likely to lead to worthwhile learning than a transmission teaching method (Haurahan, 1998). The failure of students to learn concepts rests on the quality of instructions and not due to their abilities (Bloom, 1981; Levine, 1985). The study therefore involved the guided discovery approach in which the teacher plays a role in planning and facilitation of learning.

The conceptual framework is represented diagrammatically in Figure 2. The figure shows the relationship of variables for determining the effect of using Constructivist Teaching Approach (CTA) on secondary school students' achievement in Chemistry. The extraneous variables which include teacher characteristics, learner characteristics and classroom environment were controlled. The teacher training determines the teaching approach a

teacher uses and how effective the teacher will use the approach. The learners' age and hence their class, determine what they are taught. The type of school as a teaching environment affects the learning outcomes. The study involved trained Chemistry teachers so as to control for the teacher experience. The type of school was co-educational to control the effect of the environment. Form two boys and girls who were approximately15 years of age were involved in the study. In this study therefore the teaching method used was expected to influence the learning outcomes.

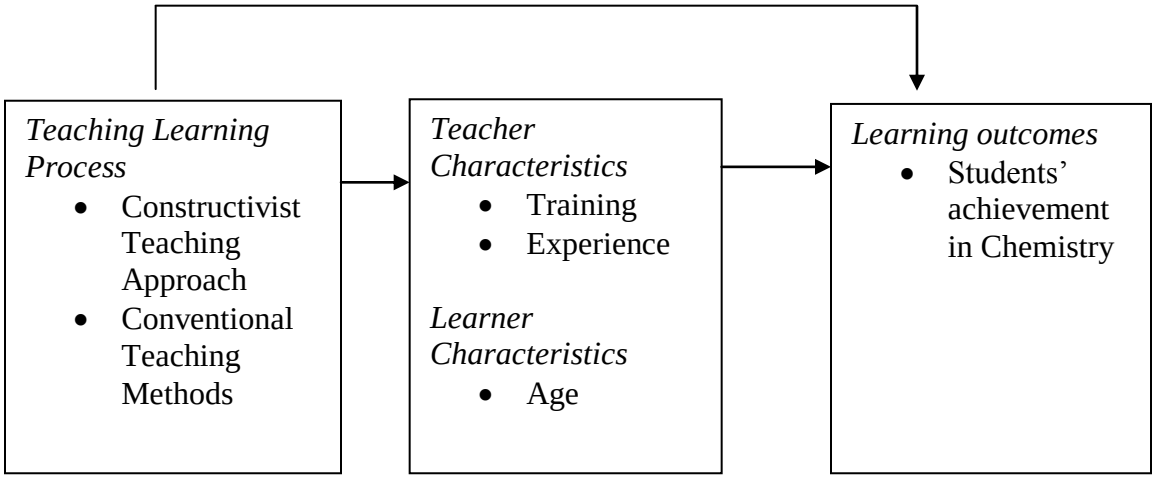

Figure 2: Conceptual Framework for Determining the Effects of Constructivist Teaching Approach.

METHODOLOGY

Research Design

The study used the Solomon Four Non-Equivalent Control Group Research under Quasi experimental Research Design as shown in Figure 3. In Kenyan secondary schools, once classes are constituted they exist as intact groups and school authorities do not normally allow them to be broken up and reconstituted for research purposes (Borg & Gall, 1989; Fraenkel & Wallen, 2000). This design has advantages over others since it controls the major threats to internal validity except those associated with interaction of selection and history, selection and maturation and selection and instrumentation (Cook & Campbell, 1979). In this study no major event was expected in the sampled schools to introduce the threat of history and interaction. The condition under which the instruments were administered was kept as similar as possible across the schools in order to control for instrumentation and selection. The schools were randomly assigned to the control and treatment groups to control for selection, maturation and interaction (Aryl; Jacobs & Razavich, 1992).

Group I	(E_1)	O_1	X	O_2
Group II	(C_1)	O_3	_	O_4
Group III	(E_2)	_	X	O_5
Group IV	(C_2)	_	_	O_6

Figure 3: Solomon Four Non-Equivalent Control Group Research Design.
Source*:* Fraenkel and Wallen (2000, p.291)

Where O_1 and O_3 were pre-test; O_2, O_4, O_5, O_6 were the post -test; X was the treatment where students were taught using the Constructivist Teaching Approach (CTA).

The dotted line implies involvement of intact groups. Group I was the experimental group which received the pre-test, the treatment X and the post-test. Group II was the control group, which received a pre-test followed by the control condition and then the post-test. Group III received the treatment X and post-test but did not receive the pre-test. Group IV received the post-test only since it was a control group. Groups I and III were taught using Constructivist Teaching Approach (CTA) while Group II and IV were taught using the conventional teaching methods. The pre-test measured the students' initial concepts on the "Structure and Bonding" topic while the post-test measured the students' achievement in the topic after being taught by either the constructivist or the conventional teaching approaches.

Sampling Procedures

The study involved public co-educational secondary schools because they are the majority in the Sub-County and their performance has been low. The unit of sampling was the secondary school rather than the individual learners because secondary schools exist as intact groups (Borg & Gall, 1989). This therefore meant that, each school was considered as one group. The list of the co-educational schools in the Sub-County formed the sample frame. The researcher made a visit to the schools to ascertain their suitability for the research. During the visit the researcher established the training levels of the teachers and the number of students per class. Purposive sampling technique was used to select four secondary schools that formed the sample of the study. This sampling method was used in order to minimize experimental contamination (Fraenkel & Wallen, 2000). The four schools were randomly assigned to treatment and control groups. For schools having more than one Form Two streams, all the streams were taught using similar teaching method and then simple random sampling was used to select one stream for the study because of ethical reasons.

Sample size

A sample of four selected co-educational schools in the sub-county was obtained out of 12 co-educational secondary schools.

The subjects in each group are shown below:

Group I	(Experimental Group), N=	43	(26.9%)
Group II	(Control Group), N =	38	(23.8%)
Group III	(Experimental Group), N =	39	(24.4%)
Group IV	(Control Group), N =	40	(25%)

Therefore, the sample size in the research was 160 Form Two students. Fraenkel and Wallen (2000) recommend that at least 30 subjects per group. Hence this number was adequate for the study.

Instrumentation

The instrument used was a standardized Chemistry Achievement Test (CAT) on "Structure and Bonding" topic. The Test (CAT) was constructed by the researcher based on the Kenya Certificate of Secondary Education (KCSE) Chemistry examination questions of the previous years on "Structure and Bonding" topic and moderated by two Chemistry teachers who were Chemistry National Examination Markers and then validated by three social research experts in the Curriculum Instruction and Educational Management Department of Egerton University. It contained twenty multiple choice items with a maximum score of 20 to measure students' achievement in Chemistry. Each item contains only one single answer and three distracters. The test was pilot tested using a school in a Division that was not included in the study but had similar characteristics as the sample schools to ascertain the test reliability. The reliability coefficient was calculated using Kuder-Richardson formula 21 (KR-21) (Gronlund, 1981). This method is suitable when test items can be scored correct or incorrect. The reliability coefficient of instrument was 0.78 which was above the 0.7 threshold recommended by Fraenkel and Wallen (2000).

The Development and use of Instructional Materials

The content of the study used in this research was based on the revised Chemistry syllabus (KIE, 2005). A guiding manual based on the above syllabus was constructed for the teachers involved in administering the Constructivist Teaching Approach (CTA) and was used throughout the treatment period. The teachers of the experimental groups were each trained by the researcher for one day on how to use the manual. Each of these teachers taught using the Constructivist Teaching Approach (CTA) on a different topic other than "Structure and Bonding" for one week to enable them to master the skills. After that period the pre-test was administered to Group I and Group II by the researcher assisted by the Chemistry teachers in the respective schools. Treatment period took three weeks as recommended in the syllabus. At the end of the treatment period a post-test was administered to all the groups by the same teachers assisted by the researcher.

Data Collection

For this study, Chemistry Achievement Test (CAT) was used to collect data. The researcher scored the pre-tests and post-tests and generated quantitative data which were analyzed.

Data Analysis

The collected data were analyzed using t-test, ANOVA and ANCOVA. A t-test was used when dealing with two means because of its superior power to detect differences between two means. ANOVA was used to analyze the differences in post-test mean scores of the four groups. It was used to determine whether the differences were significant or not. On the other hand, ANCOVA was used to establish whether there were initial differences in the treatment and control groups. It reduces experimental errors by statistical rather than experimental procedure (Borg & Gall, 1989; Coolican, 1994).

RESULTS

Pre-test for Examining the Entry Behavior

The Solomon Four Group Design used in the study enabled the researcher to have two groups sit for pre-test as recommended by Borg and Gall (1989). This enabled the researcher to assess the effects of the pre-test relative to no pre-test and assess if there was an interaction between the pre-test and the treatment, Table 1.

Table1. Pre-test Analysis by Teaching Approach

Scale	Group	N	Mean $\overline{X}$	SD	df	t- value	p-value
CAT	C_1	43	5.40	1.62	79	2.30	0.02*
	E_1	38	4.55	1.67			

*($p<0.05$, df=79, tcal = 2.30, tcrit=1.66), * Denotes significant at $P< 0.05$, otherwise not significant

From the pre-test analysis on CAT Table 1, the mean score of group E_1 (4.55) was less than of C_1 (5.40) out of a maximum of 20. It was found out that both groups' achievement levels in this unit were low before the experiment. Also the results in the table revealed that E_1 and C_1 are not similar on entry level since their mean scores are significantly different at (t (79) = 2.301, $P<0.05$), Table 1. Ideally, at the start of a program, groups should be similar. However, when dealing with intact classes, the ideal situation is not usually realized. This implies that these differences have to be taken care of with appropriate statistical tools which are ANCOVA and covariates during post-test analysis. The differences in CAT achievement at entry point could be due to the variations in the availability of teaching and learning resources.

Post-test Analysis for Examining the Effects of CTA on Students' Chemistry Achievement.

Students' achievement was determined by conducting a mean gain analysis on students' CAT post-test. The purpose of gain analysis was to check which of the groups E_1 and C_1 gained more after undergoing the course. Hypothesis H_O1 of the study sought to find out whether there was any statistically significant difference in achievement scores between students exposed to Constructivist Teaching Approach (CTA) and those not exposed to it. The mean gain of the experimental and control groups is shown in Table 2.

Table2. CAT Post-test Mean Gain by Teaching Approach

Scale	C1	E1
Pre-test N	43	38
$\overline{X}$	5.40	4.55
SD	1.62	1.67
Post-test N	43	38
$\overline{X}$	9.35	11.37
SD	2.35	1.87
Mean Gain	3.95	6.82

Post-test mean gain analysis tested the differences between the groups, thus revealing which one performed better. The gain analysis involved finding out the gain of each group by determining the differences between post-test and pre-test out of a maximum of 20. It tests the differences in gain between the two groups, Table 2. Pre-test CAT score of C_1 was found to be 5.40 while that of E_1 was found to be 4.55. This showed that C_1 mean score was higher than that of E_1. On the other hand, the post-test CAT mean score of C_1 was found to be 9.35 while that of E_1 was 11.37. The mean gain of E_1 was greater than that of C_1 which means the experimental group E_1 improved more than the control group C_1. However, the results in the Table 2 do not show whether this difference in improvement is significant or not. Consequently, it was necessary to carry out t-test to check whether the difference was statistically significant at 0.05 alpha, Table 3.

Table 3. Comparison of Mean Gain of E_1 and C_1 Groups on CAT

Group	N	Mean Gain	df	t-value	P-Value
C_1	43	3.95	79	5.37	0.00*
E_1	38	6.82			

*($p<0.05$, df=79 tcal.=5.37, tcrit.=1.66)

From Table 3, the mean gain by using t-test is significant at 0.05 alpha level of significance ($t(79) = 0.00$, $p< 0.05$). This significance in mean gain of Experimental group E_1 over the control group C_1 is attributable to the treatment. This means that, despite the fact that E_1 had lower mean score on the pre-test than the C_1, they managed to score higher in the post- test on CAT. This implies exposure to treatment enhanced learning. This can be explained by the fact that the constructivist teaching approach allows students to actively interact in small groups, solve problems and construct their own knowledge. Under the Constructivist Teaching Approach (CTA), the teacher acts as a facilitator. The gain analysis in table 3 involved C_1 and E_1 only. The results suggested that the use of CTA was moderately effective in enhancing learning in the experimental group E_1. After being taught the "Structure and Bonding" topic, all the four groups E_1, C_1, E_2 and C_2 however were all post-tested. The CAT post-test mean scores of each group is given in Table, 4.

Table4. CAT Post-test Mean Score for the Four Groups

Group	N	Mean $\overline{X}$	SD
C_1	43	9.35	2.45
E_1	38	11.37	1.87
C_2	39	8.77	1.98
E_2	40	10.30	2.00

The results show that the Experimental groups did better than their control counterparts. This findings show that the Constructivist Teaching Approach (CTA) enables students to understand better scientific concepts related to "Structure and Bonding" topic. However the results in Table 4 do not show whether these differences are significant or not. There was need to carry out ANOVA analysis to check if the difference were significant, Table 5.

Table5. One-way ANOVA of Students' post-test CAT Mean Scores

Scale	SS	df	Mean Square	F- values	P-values
Between groups	151.17	3	50.39	11.80	0.00*
Within groups	665.93	156	4.27		
Total	**817.10**	**159**			

*($p<0.05$, df = 3, F = 11.80)

The results in Table 5 showed that the differences in achievement among the four groups were significant (F (3,156) = 11.80, P<0.05). However, the results do not reveal where the differences are. It was therefore necessary to carry out the post hoc analysis (multiple comparison test), Table 6.

Table6. Multiple Comparison Test (Sceffe's Post hoc) Analysis using ANOVA

(I)Learning Approach	(J) Learning Approach	Mean differences	p- value
E_1 V/S	C_1	2.02*	0.00*
E_1 V/S	E_2	1.07	0.16
E_1 V/S	C_2	2.60*	0.00*
C_1 V/S	C_2	0.58	0.66
E_2 V/S	C_2	1.53	0.02*
C_1 V/S	E_2	.0.95	0.23

* ($p<0.05$ represents a statistical significant difference)

From Table 6, the E_2 mean score is greater than that of C_1 but not significant contrary to expectations. The reason is that the mean score of C_1 at entry point was found to be higher as compared to the mean score of E_1, Table 2. This may be attributed to difference in availability of teaching-learning resources. Ideally, at the point of entry, all the four groups are supposed to be similar. However, according to the design (Solomon Four), only C_1 and E_1 are pre-tested. It is thus not possible to know the entry behavior of E_2 and C_2. In the Post test analysis, using ANOVA, the entry behavior of the groups was not taken into consideration. In order to take care of entry behavior differences of the four groups, the ANCOVA test was done using Kenya Certificate of Primary Education (KCPE) examination mean scores as covariate. The groups mean score after being adjusted by the covariate is given in Table 7.

Table7. The Adjusted Post-test CAT Mean Scores Using KCPE Marks as Covariate

Group	Mean $\overline{X}$	SD error
C_1	9.35	0.32
E_1	11.35	0.36
C_2	8.78	0.34
E_2	10.32	0.34

The mean scores of the Experimental groups are higher than those of the Control groups as expected. These mean scores alone cannot show whether they are significant or not. To determine whether the differences among the four groups were statistically significant, the ANCOVA test was conducted using the KCPE mean scores as covariates. ANCOVA analysis is able to neutralize any initial differences that may have existed before the treatment. The results of the tests are shown in Table 8.

Table8. Test of Differences Using Analysis of Covariance (ANCOVA)

Scale	SS	df	Mean Square	F-value	P- value
Contrast	141.11	3	47.04	10.95	0.00*
Error	665.82	155	4.30		

*($p<0.05$, df=3, F=10.95)

The results in Table 8 showed that the differences between the Experimental and the Control groups are significant ($F(3,155) = 10.950$, $P< 0.05$). The ANCOVA results show that the students taught by the constructivist approach achieved significantly higher than their control counter parts. In the Constructivist Teaching Approach (CTA), the students constructed their own knowledge as they interacted with each other, with their teachers and with material presented. The students were active, their roles being to organize knowledge and the learning environment. They also carried out learning activities and monitored their own learning. However, in the conventional teaching method, information cannot be permanent because it is only memorized for exams and it is easily forgotten, hence, information is understood either imperfectly or wrongly hence cannot be applied to real life situation (Deryakulu, 2000; Gagnon & Gollay, 2001). These results in Table 8 do not reveal where the differences are. It was therefore necessary to carry out the multiple comparison analysis, Table 9.

Table9. Table of CAT Post- test Mean Scores Multiple Comparison Test (Scheffe's Post hoc) Analysis Using ANCOVA

(I) Learning Approach		(J) Mean learning Approach	mean Differences	p- value
E_1	v/s	C_1	2.00	0.00*
		E_2	1.03	0.05*
	"	C_2	2.57	0.00*
C_1	"	C_2	0.57	0.22
C_1	"	E_2	-0.97	0.04*

*($p< 0.05$ represents a statistical significance difference).

The results in Table 9 show that the use of Constructivist Teaching Approach (CTA) resulted in higher students' achievement compared to the conventional teaching methods since E_1 and E_2 mean score obtained were significantly higher compared with the control groups. The difference in achievement between Experimental groups E_1 and E_2 could be due to the difference in abilities. Therefore, the null hypothesis (Ho1) was rejected.

DISCUSSIONS

The findings of the study showed that there was statistically significant difference in pre-test mean scores between the E_1 and C_1 groups with respect to the topic "Structure and Bonding" implying that the students were not similar before the treatment. This meant that the two groups were not equal in terms of their prior knowledge. Consequently measures were put in place in the post-test so as to adjust for those differences. Similarly at the post-test level, there was statistical significance difference in the mean scores and standard deviations between the students in the Experimental group, E_1 and Control group, C_1, suggesting that students in the Experimental group gained significantly higher after treatment compared with their counter parts in the control groups.

From the mean gain analysis it was found out that the Experimental group E_1 gained more than the control group, C_1. This implies that the Constructivist Teaching Approach (CTA) is more effective than the convectional teaching method in enhancing students' achievement in Chemistry. It can be said that the students learnt more meaningfully in an active learning environment and become more successful. These findings are in line with several earlier studies (Marshall, 1992; Ormrod, 2004; Caprio, 1994; Kersch, 1998 & Omwirhiren, 2002) to the effect that the constructivist teaching approach involves the learners more in the instructional process both individually and in groups. The students would remember better what they participated in doing because they involve more sense organs than just their prior knowledge in knowledge construction (Wells & Mejia-Arauz, 2006). The findings of this study are also in agreement with those of (Saigo, 1999; White, 1996; Brandt, 2001 & Yager, 1991) which reported that the Constructivist Teaching Approach (CTA) led to a higher student's academic achievement than the traditional lecture methods. The results indicated that students taught by the constructivist instructional approach had

a significantly better acquisition of scientific conceptions related to "Structure and Bonding" topic and less misconceptions than the students taught by the traditionally designed Chemistry instruction.

Akar (2005) found that the constructivist approach enabled students to perform better in Chemistry Achievement Test than the traditional lecture method. This is because, the students in the constructivist group benefited from discussion and interaction with peers. In this way, the teacher also provided a learning environment where students could use their prior knowledge and become aware of their already existing conceptions. During discussions with the peers, the students tried to make connections between their existing knowledge and the new concepts. They analyzed, interpreted and predicted information. In this way, they actively constructed knowledge instead of being passive recipients. Teaching and learning was an interactive process that engaged the learners in knowledge construction. Information does not become knowledge automatically until learners have been actively involved in its processing (Akinleye, 2010). However, in the control group, the teachers' thoughts and meanings were expected to be transferred to the passive learners. The teacher provided information without considering the students' prior knowledge. Another reason why the students were not successful in the control group was that they may have lacked the opportunity to develop their thinking, reasoning and communication skills. The students did not become confident in the understanding of Chemistry hence meaningful learning did not occur.

Wachanga and Mwangi (2004) found that students taught through the Cooperative Class Experiment (CCE) method performed significantly better in Chemistry than those taught by the regular teaching methods. The researchers concluded that learning in co-operation with others is an important source of motivation, support, modeling and coaching (Feden, 1995). In the Constructivist Teaching Approach (CTA), the teacher initially raised questions (invitation stage), to activate students prior conceptions that were subsequently discussed within groups of students (exploration). Thus the teacher created a learning environment where students could use their prior knowledge and became aware of their existing conceptions. During discussion with their peers, the students tried to make connection between their existing knowledge and the new concept. For example students' knowledge of the structure of the atom helped them to understand why atoms bond to each other. Wachanga and Mwangi (2004) in their study noted that the students' performance was enhanced because students in the experimental group were encouraged to apply their experiences to the new situations and through group discussion and appropriate teacher guidance they tried to find relevant answers to their questions. Similarly in this study, the students engaged each other in discussion, co-operation and application of concepts learned. They also took responsibility for their own learning rather than passively accepting the teacher's explanations as it may have occurred in the control groups. In the experimental group, social interaction was also emphasized and the teachers encouraged students to work together, to explain what they were doing and reflect during the learning process, hence meaningful learning occurred (Alesandrini & Larson, 2002).

CONCLUSION, IMPLICATION AND RECOMMENDATIONS

Based on the findings of the study, it can be concluded that instructions based on the Constructivist Teaching Approach (CTA) caused a significantly better students' achievement in Chemistry than the Conventional Teaching methods.

Implications of the findings

The study provides evidence to the effect that Constructivist Teaching Approach (CTA) enhances secondary school students' achievement in Chemistry. Since achievement is important in student learning process, Chemistry teachers should be encouraged to use the method so as to improve performance in Chemistry in National Examinations. Moreover, since the method improves Form Two students' Chemistry achievement, it is likely that it can also improve performance in Chemistry in National examinations if it is implemented early enough as in primary education. This may enable them to pursue Chemistry related courses in institutions of higher learning.

RECOMMENDATIONS

From the findings of this study, it is evident that the Constructivist Teaching Approach (CTA) is an effective method for teaching Chemistry. This means that the use of the approach at secondary school level can address the poor performance in Chemistry. Therefore, it will supplement the government efforts to improve the Chemistry

Education in Kenya's secondary schools. Curriculum developers will find the study helpful in designing appropriate instructional strategies which enhance Chemistry teaching and learning process. Teacher educators will also find the study useful in developing programs aimed at producing teachers capable of creating a learning environment that enables learners to actively construct knowledge and understanding for themselves, hence improve their achievement in Chemistry.

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