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Effects of Mastery 5Es Constructivist Teaching Approach on Secondary School Students' Achievement in Chemistry in Rongai Sub-County, Nakuru County, Kenya

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Abstract
Analysis of chemistry performance in Kenya since 2013 indicates a trend of below average performance. This may be attributed to the conventional teaching methods that are mainly teacher centered. Mastery 5Es constructivist teaching approach (M5EsA) may help address the problem of poor performance in chemistry though its effects have not been determined. This study investigated the effects of using M5EsA on students' achievement in chemistry in Rongai sub-county. Solomon Four Non-Equivalent Control Group Design under Quasi experimental research was used. Sample size of 303 students. Chemistry Achievement Test (CAT) with reliability of 0.701 was used to collect data. Hypothesis was tested using t-Test, ANOVA and ANCOVA at critical alpha value of 0.05. The findings indicated that M5EsA led to increased students' achievement in Chemistry.

Keywords: Mastery 5Es Constructivist Learning Approach, Secondary School Students', Achievement in Chemistry

1. Introduction

Chemistry is one of the branches of science that is taught at secondary school level in Kenya. It plays a critical role in the production of human capital which is the most important resource for any nation (Aniodoh & Egbo, 2013). The quality of human resource in the field of science for instance doctors, engineers, scientists, science teacher educators and science teachers, is directly pegged on the quality of science education offered. Highly qualified personnel equipped with scientific, technical and intellectual capabilities have a great impact in propelling a nation to the desired levels of development. Chemistry education equips learners with scientific knowledge, skills and attitudes towards science and technology, therefore an essential tool for economic and technological development of any society (Abungu, 2014).

According to Wachanga (2002); Bakhshi and Rarh (2012), Chemistry occupies a central position among science subjects because its knowledge helps in the learning of other subjects. For instance, the knowledge of chemicals and chemical processes aids in the understanding of various physical and biological phenomena (Bakhshi & Rarh). Chemistry also plays an important role in industrial and technological development of a nation. According to Wachanga (2005) and Royal Society of Chemistry [RSC] (2015), Chemistry has played important role in the field of medicine especially in drug discovery and pharmaceutical productivity. They further noted that chemistry knowledge has led to reduced dependence on natural material, increased efficiency in industrial processes, created efficient electronics and has enabled zero emissions of energy production. Chemistry also inculcates scientific attitudes and thought in the learners and prepares them for further vocations and specialization at higher levels of learning (Wachanga, 2005)

Although Chemistry is important for scientific and technological development and also its importance in the learning of the Physics and Biology, the trend of the students' achievement in the subject at the Kenya Certificate of Secondary Education (KCSE) level is below average. Table 1 indicates the performance of Chemistry at national level in KCSE since 2013.

Table 1: K.C.S.E National Students' Achievement in Chemistry by Gender (2013-2020)

Year	2013	2014	2015	2016	2017	2018	2019	2020
Overall % Mean score	24.57	32.55	34.36	23.71	24.05	26.88	26.09	22.51

Source: Kenya National Examination Council (KNEC), 2018 report

Given that the expected maximum mean score is 100%, the results shown in Table 1 indicates below average percentage for the years 2013 to 2020. The trend of poor students' achievement in Chemistry at KCSE level is not only exhibited at the national level but also in Rongai Sub-County. Table 2 indicates the performance of students in chemistry in Rongai sub-county since 2013.

Table 2: Rongai Sub-County KCSE Mean Grades in Science Subjects (2013-2021)

Subject	2013	2014	2015	2016	2017	2018	2019	2020	2021
Chemistry	2.67	3.21	3.79	4.71	4.68	3.98	4.20	4.19	4.29

Source: Rongai Sub-County Education Office, 2021

The indicated performance in chemistry all sciences in Table 2 is below average since the maximum mean grade according to Kenya National Examination Council (KNEC) is 12 points. The below average achievement in Chemistry by students in KCSE both at the National and Rongai Sub- County levels as indicated in Tables 1 and 2 may be attributed to inappropriate and ineffective teaching approaches employed by teachers in teaching Chemistry. This among other factors may have led to poor achievement of learners in chemistry. Teaching approaches employed by teachers in classroom may affect students' academic achievement (Wambugu, 2006; Galaj, 2011).

The teaching of Chemistry in Kenya has continued to be teacher-centered thus has contributed to poor achievement in the subject by learners (Wachanga, 2002; Keter, 2017). This is because learners are not engaged in the teaching learning process thus leading to lack of understanding of chemistry concepts which is therefore reflected in the poor achievement. Therefore, there is need for the teachers to employ teaching approaches that are learner-centered and constructivist-based because such approaches would not only capture learner's interest, enhance learners' participation and understanding, but also would inculcate in them critical thinking skills that would enable them solve any problem encountered in chemistry thus leading to higher achievement in the subject.

Mastery Learning refers to a category of instructional methods which establishes a level of performance that all students must master before moving on to the next unit (Slavin, 1987). 5Es learning cycle model is a constructivist-based approach to learning in which students in small groups are given opportunity to learn through five phases

denoted as 5Es (By bee, 2014). These phases are: Engage. Explore, Explain, Elaborate and Evaluate. The first phase Engage helps students to make connections between past and present learning experiences and capture their interest in the lesson. This makes the learners to be thoughtfully involved in the concept, process, or skill to be learned (Mwanda, 2016). The second phase Exploration gives learners time and opportunities to work with materials provided in different ways. Hands-on experiences are provided for the students express their current ideas and demonstrate their abilities as they try to clarify puzzling elements of the engage phase (By bee, 2014). The third phase Explain, a phase in which the concepts, practices, and abilities with which students were originally engaged and subsequently explored are made clear and comprehensible (By bee, 2014). The teacher directs students' attention to key aspects of the prior phases and first asks students for their explanations then using students' explanations and experiences, the teacher introduces scientific or technological concepts briefly and explicitly (By bee, Taylor, Gardner, Scotter, Powell, Westbrook, and Land es, 2006). The fourth phase Elaborate is a phase in which students are involved in learning experiences that extend, expand, and enrich the concepts and abilities developed in the prior phases thereby transferring the concepts and abilities to related, but new situations (By bee, 2014). Finally, the fifth phase is Evaluation, addresses the issue of assessment. It goes on throughout the learning cycle and helps is determining the effectiveness of each phase throughout the learning process.

The current study is informed by the results obtained from mastery learning and the inquiry based 5Es learning cycle studies. M5EsA being a hybrid of the two teaching approaches, M5EsA may reap the benefits associated with each approach. M5EsA involved breaking down of subject matter into units with objectives to be mastered by the students. Students were given quizzes at the end of each unit where they must demonstrate mastery of a minimum score of 80%, before moving on to new material (Kulik, Kulik & Banger t-Drowns, 1990). Students who did not achieve mastery received remediation through tutoring, peer monitoring, small group discussions, or additional assignments (Aggarwal, 2004). Additional time for learning was given for those requiring remediation and the cycle of studying and testing continued until mastery was achieved. Learning of the units was guided through 5Es learning cycle whereby students in small groups in each lesson went through activities sequenced in the five phases. Therefore, students got opportunities to create their understanding together.

The study focused on the topic "Effect of electric current on substances" in chemistry. This is a topic taught in Form Two in Kenyan secondary schools. The topic forms the foundation of the Electrochemistry and has been identified to pose problems to students (Yilmaz, Erdem & Morgil, 2002; Garnett & Treagust, 1992) yet it plays important role in different types of curricula and in everyday life (Karamustafaoglu, 2015). It is also noted in KNEC council report (KNEC, 2018) that Electrochemistry question 3 in Chemistry paper 1 (233/1) was poorly performed since learners could not identify and state the uses of the different parts of a dry cell. Therefore, there is need to build a good understanding of the topic by the students. This study sort to find out the effects of using M5EsA on student's achievement in the topic. The results obtained would then be generalized to chemistry.

1.2 Objective of the Study

This study was guided by the following specific objective;
To determine the effects of using mastery 5Es constructivist teaching approach on students' academic achievement in Chemistry.

1.3 Hypothesis of the Study

This study was guided by the following hypothesis;
There is no statistically significant difference in students' achievement in Chemistry between students who are taught using M5EsA and those who are taught using CTM.

1.4 Conceptual Framework

This study has been conceptualized with constructivist-based M5EsA approach and Conventional Teaching Methods (CTM) as the main independent variables while students' chemistry achievement in Chemistry forms the dependent variable. In an ideal situation the independent variables have direct influences on the dependent

variables. However, in real situations factors such as; learners' characteristics (gender, entry behavior and age), type of school (resources), and teacher's training and experience may interfere with the relationship between independent and dependent variables if they are not controlled. These factors form the intervening variables. These intervening variables should be controlled so that there will be no interaction effect of these variables and the independent variables on the dependent variables.

The Figure 1 illustrates how the intervening variables affect the relationship between the independent variables and the dependent variables.

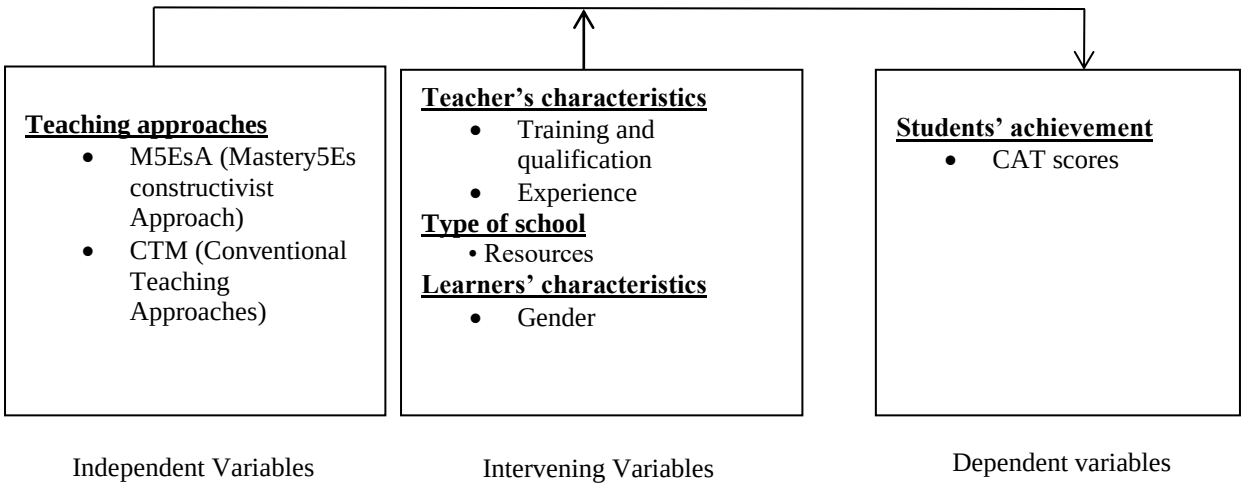

Figure 1: Conceptual Framework

This study was carried out in public secondary schools because teachers in public secondary schools are all trained and qualified. Only schools where teachers have a teaching experience of above three years were selected for the study. Therefore, teachers' characteristics were controlled. Chemistry teachers involved in the experimental groups were trained by the researcher on the M5EsA and they were also guided by a manual that was provided by the researcher; this minimized teacher variability effect on the study. Gender could be controlled by involving boys' and girls' schools, however in this study effect of gender was studied rather than being controlled. Therefore, co-educational schools were involved in this study. Sub-County co-educational schools with similar characteristics were selected so as to minimize the effect of school characteristics such as resources on the experimental results. Learners' entry behavior was controlled since learners enrolled into Sub-County schools have approximately similar academic achievement.

2. Methodology

2.1 Research Design

Quasi-experimental research was used in this study in which Solomon's Four Non-Equivalent Control Group Design was used. The sampling unit used in this research was classes since there was no random assignment of students to the experimental and control groups due to the fact that secondary school classes once constituted exists as intact groups and authorities do not normally allow such classes to be broken up and reconstituted for research purposes (Gall, Gall & Borg, 2007, Fraenkel &Wallen, 2000). To avoid interaction of students from different groups that may contaminate the results of the study, one class from a school constituted one group hence four schools which are far apart were selected purposively in this study. The schools were randomly assigned to the control and treatment groups to control for selection and interaction (Ary, Jacobs & Razavien, 1979). The conditions under which the instruments were administered were kept as similar as possible across the schools in order to control instrumentation. This was done by ensuring that the topic was covered and administration of the instruments across the four schools at the same time. The groups were organized as follows; E1 which received a pre-test, treatment (X), and then post-test, C1 which received a pre-test and post-test. On the other, E2 were not

given a pre-test, but treatment(X) and post-test were given while C2 was not given a pre-test, no treatment but a post-test was given. E1 and E2 were the experimental thus were taught using M5EsA while C1 and C2 were taught using CTM since they were the control groups. This design is represented in Figure 2.

E1	O_1	X	O_2
C1	O_3	_	O_4
E2	_	X	O_5
C2	_	_	O_6

Figure 2: Solomon Four Non- Equivalent Control Group Research Design.
Source: Fraenkel and Wallen (2000 p.291)

2.2 Population of the Study

The target population involved all the students in public secondary schools in Rongai Sub-County. The Sub-County was selected by the researcher because there is limited evidence of studies carried out to investigate on the effects of M5EsA on students' academic achievement in chemistry in the Sub-County. The accessible population was the form two students in public Sub-County co-educational schools in Rongai Sub-County. This accessible population constituted the sample frame from which the samples for the research were drawn. Co-educational schools were selected so as allow the researcher investigate the effect of the treatment on boys and girls learning under similar conditions. Form two students were involved because the selected topic (Effect of electric current on substances) is taught at this level in Kenyan secondary schools.

2.3 Sampling Procedures and Sample size

The unit of sampling in this study was secondary school rather than individual learners because secondary schools operate as intact groups (Gall et al, 2007). The list of the Sub-County co-educational schools constituted the sampling frame. The researcher after obtaining permission from NACOSTI, Nakuru county and Rongai Sub-County educational offices visited co-educational schools to ascertain that they were suitable for research, that is, researcher established that the schools selected had functional laboratories in which learners carried out the suggested experiments and that there were trained teachers with a teaching experience of a minimum of three years. To minimize experimental contamination (Fraenkel & Wallen, 2000), purposive and stratified sampling techniques were used to select four public Sub-County co-educational secondary schools with trained teachers with a teaching experience of three years and above. Also, schools with almost similar characteristics and resources but not close to each other were considered. The four schools formed the sample size and were randomly assigned to the treatment and control groups. Schools that had more than one form two streams, all the streams were taught using similar method of teaching because of ethical reasons (Wambugu & Changeiywo, 2006). Random sampling technique was then be used to pick one stream whose data was used for analysis. Sample size for the study was 303 students. This was constituted by the total number of students in the selected classes in the four schools.

2.4 Instrumentation

Chemistry Achievement Test (CAT)was done in one hour. It measured the learner's acquired and mastered content. This CAT was constructed by the researcher using Secondary Chemistry students' Book 2 (2009), Secondary Chemistry Book Two teachers' guide (2009) published by the Kenya Literature Bureau (KLB), Secondary Chemistry Book 2 by Longhorn publishers and items from KCSE past papers. The test was administered as CAT 1 before the treatment. The items in the CAT1 were rearranged and administered as CAT 2 after the treatment. The CAT contained 12 items which measured concepts and principles in the sub-topics of conductors and non-conductors, electrolytes and non-electrolytes, electrolysis, and applications of electrolysis with scores allocated as indicated in Table 3.

Table 3: CAT scores allocation per sub-topic

Sub-topic	Number of items	Scores per sub-topic	Maximum scores	Minimum Scores
Conductors and Non-conductors	4	10	10	0
Electrolytes and Non-electrolytes	4	14	14	0
Electrolysis	3	24	24	0
Application of electrolysis	1	2	2	0
TOTAL	12	50	50	0

The minimum and maximum score of the CAT were 0 and 50 marks respectively. The items in CAT measured the different levels of learning in the cognitive domain such as knowledge, comprehension, analysis, synthesis and evaluation. The items were scored dichotomously as either correct or wrong. Validity of the CAT was ascertained by three experts in the Department of Curriculum, Instruction and Educational Management of Egerton University. Comments from these experts were used to improve the instruments.

Reliability of CAT was estimated after a pilot study was conducted in a co-educational school in Njoro sub-county with similar characteristics to those in which the study was conducted. Reliability coefficient of CAT was calculated using Kuder-Richardson formula 20 (KR-20). This method is suitable when test items can be scored as correct or incorrect and are of different difficulty level (Gronlund, 1993). Reliability coefficients of 0.701 was obtained. Thus, the its' reliability coefficient was accepted because according to Fraenkel and Wallen (2000) a reliability coefficient of alpha value 0.7 and above is considered suitable to make possible group predictions that are sufficiently accurate.

2.5 Data Collection

The researcher obtained an ethical clearance the Egerton University Research Ethics Committee secretariat. This enabled the researcher obtain an introductory letter from Egerton University Graduate School through which a research permit from the National Commission for Science, Technology and Innovation (NACOSTI) was obtained. The researcher sort permission also from the Rongai Sub-County Director of Education. The principals and chemistry teachers of the participating schools were requested by the researcher to allow their schools to be involved in the study and their co-operation was appreciated. The researcher trained chemistry teachers in the experimental schools on the expectations and procedures of M5EsA and gave them an instructional manual specifically designed for the topic "Effects of electric current on substances". To ensure that the content was covered uniformly by all the groups, teachers in the four groups adopted a common scheme of work developed by the researcher. Before the treatment, data was collected using CAT1 as pre-test that was administered to the experimental group I and the Control group I. The students in the experimental group I and Experimental Group II were taught using M5EsA while those in the control group I and Control group II were taught using CTM. After six weeks the post-test was administered to all the groups as CAT2. Post-test provided data for all groups after the administration of the treatment.

2.6 Data Analysis

CAT generated quantitative data which was analyzed with the help of Statistical Packages for Social Science (SPSS) computer program. Pre-test analysis was done using t-Tests to determine if there are differences in the students' achievement between the two groups before administration of the treatment. t-Test was used to test differences between two means because of its superior quality in detecting differences between two means (Gall et al, 2007). ANOVA was used to analyze whether there were significant differences in the mean scores of the Groups' post-test results. ANCOVA was also used so as to take care of any initial differences in the treatment and control groups. It reduces experimental error by statistical rather than by experimental procedure (Gall et al, 2007). KCPE scores of the participants were used as a co-variate. To make reliable inferences from the data, all statistical tests were tested at threshold alpha values of 0.05.

3. Results and Discussion

3.1 Pre-test Results

Analysis of the pre-test enabled the researcher to assess the homogeneity of the groups before the administration of the treatment to the experimental groups as recommended by Borg and Gall (2006) and Wiersman and Jurs (2005). To find out whether there was significant difference in achievement of the two groups, descriptive statistics and an independent sample t-Test were carried out on CAT1. The results obtained on CAT1 analysis are as recorded in Table 4.

Table 4: t-Test results of Students' Mean Scores on CAT 1

Teaching approach	**n**	**Mean**	**SD**	df	**t-value**	**p-value**
E_1	67	1.40	1.326	148	.123	.902
C_1	83	1.37	1.552			

The results in Table 4 reveal that the mean score of the experimental group E_1 was higher than that of the control group C_1, though the difference between the means of the two groups was not statistically significant at the 0.05 level, t (148) = .123, p =.902. Therefore, the level of achievement of the learners in chemistry before the administration of the treatment was similar, the groups had similar entry behavior thus were suitable for the study.

3.2 Effects of M5EsA on Students' Achievement

The objective of this study was to determine whether there was a significant difference in students' achievement in chemistry when taught using M5EsA and CTM. To achieve this objective analysis of post-test scores on CAT2 was carried out using descriptive and one-way ANOVA statistical techniques. Table 5 shows the results obtained on the mean scores and the standard deviations of the four groups.

Table 5: Summary of CAT2 Mean Scores and Standard Deviations

Teaching approach	**N**	**Mean**	**SD**
E_1	67	22.9403	10.4923
C_1	83	12.4337	10.2888
E_2	79	19.9367	9.6521
C_2	74	11.9865	8.8045

The results indicate that the highest mean score was attained by E_1 (22.94) followed by E_2 (19.94) then C_1 (12.43) and finally C_2(11.98). This implies that students in the experimental groups had higher scores on CAT2 compared to those students in the control groups who had lower scores. In order to the determine whether the noted difference in achievement in Table 4 was statistically significant one-way ANOVA statistical technique was used to analyze the post-test scores on CAT2. The results obtained were as shown in Table 6.

Table 6: One-way ANOVA Post- Test Scores Results of CAT2 Students' Scores

	Sum of squares	df	Mean square	F	Sig
Between Groups	6588.658	3	2196.219	22.744	.000
Within groups	28871.817	299	96.561		
Total	35460.475	302			

The results in Table 6 show that the difference in the mean scores among the four groups was significant at the .05 level, *F (3,299)* = 22.744 p = .000. To find out where the differences existed, *Tukey post-hoc* analysis was carried out. Tukey post-hoc analysis was preferred because of the unequal number of students in the groups. The results of this analysis are presented in Table 7.

Table 7: Tukey post-hoc Pair-Wise CAT2 Groups' Comparisons

(I)Teaching approach	(J)Teaching approach	Mean Difference(I-J)	Std. Error	Sig.
E_1	C_1	10.50656*	1.61388	.000
	E_2	3.00359	1.63203	.257
	C_2	10.95381*	1.65713	.000
C_1	E_1	-10.50656*	1.61388	.000
	E_2	-7.50297*	1.54457	.000
	C_2	.44725	1.57107	.992
E_2	E_1	-3.00359	1.63203	.257
	C_1	7.50297*	1.54457	.000
	C_2	7.95022*	1.58971	.000
C_2	E_1	-10.95381*	1.65713	.000
	C_1	-.44725	1.57107	.992
	E_2	-7.95022*	1.58971	.000

Table 7 reveals that there was statistically significant difference in the means of post-test CAT2 scores between the pairs of groups E_1 and C_1, E_1 and C_2, E_2 and C_1 and E_2 and C_2 at 0.05 level of significance. The significant difference noted was in favor of the experimental groups. However, there was no statistically significant difference between $E_1$and E_2 as well as C_1 and C_2. This result suggest that M5EsA led to improved students' achievement in the experimental groups.

The entry behavior of students into secondary school is a factor that may influence the students' achievement in this level. Though this intervening variable was controlled through purposive sampling of sub-county schools, its effects may still exist among the learners in the same group since they were admitted to the schools with different marks in their Kenya Certificate of Primary Education (KCPE). Therefore, ANCOVA test analysis was carried out in order to minimize such effects. KCPE marks were used as a co variate during the analysis of CAT 2 post-test scores. The adjusted means obtained are as shown in Table 8.

Table 8: Actual and Adjusted CAT2 Mean using KCPE as a Co variate

Teaching approach	N	Mean	Adjusted Mean
E_1	67	22.9403	22.561[a]
C_1	83	11.7108	11.007[a]
E_2	79	19.9367	20.325[a]
C_2	74	11.9865	12.706[a]

Table 8 indicates that the adjusted means scores of CAT2 for the four groups were different from each other. The students in the experimental groups had their adjusted CAT2 means higher than those of the students in the control groups. In order to determine whether or not the noted differences in the adjusted means were statistically significant, ANCOVA analysis was carried out and the results were as recorded in Table 9

Table 9: ANCOVA of the CAT2 post-test Scores with KCPE mark as a Co variate

Source	Sum of Squares	df	Mean Squares	F	Sig	Partial Eta Squared
Contrast	7179.696	3	2393.232	28.985	.000	.226
Error	24605.443	299	82.569			

The results in Table 9 shows that the differences in the adjusted mean scores of the groups were statistically significant at the 0.05 level, F (3,299) = 28.985, P= 0.000. This confirms that students' achievement in the four groups differed significantly. Partial eta squared= .226 indicates that the relationship between KCPE marks of the students and their achievement after the treatment was weak, that is, the effect of co variate on the students' CAT 2 marks was not significant. This implies that the noted significant difference noted in Table 10 was confirmed. In order to determine where the differences were, a *Tukey* post-hoc test was carried out. *Tukey post-hoc* was preferred because of the unequal number of students in the groups (Schlegel, 2018 & Zach, 2020). The results of the analysis are recorded in the Table 10.

Table 10: Tukey Post-hoc Pair-Wise Comparisons of the Adjusted CAT2 Scores

(I)Teaching approach	**(J)Teaching approach**	**Mean Difference(I-J)**	**Std. Error**	**Sig.**
E_1	C_1	10.820*	1.579	.000
	E_2	2.263	1.606	.160
	C_2	9.893*	1.641	.000
C_1	E_1	-10.820*	1.579	.000
	E_2	-8.557*	1.533	.000
	C_2	-.927	1.574	.846
E_2	E_1	-2.263	1.606	.160
	C_1	8.557*	1.533	.000
	C_2	7.630*	1.555	.000
C_2	E_1	-9.893*	1.641	.000
	C_1	.927	1.574	.557
	E_2	-7.630*	1.555	.000

Table 10 reveals that there are significant differences between the experimental and control groups in all the pairs are in favor of the experimental groups. There are no significant differences between; the experimental groups; E_1 and E_2, p=.160 and also between the control groups; C_1 and C_2, p= .557. This means that M5EsA led to increase in students' achievement in the topic. Therefore, the null hypothesis ($H_0$1) was rejected. This is because the students in the experimental groups attained higher scores as opposed to those students who were in the control groups who attained lower scores.

3.3 Students' Achievement Mean Gain analysis

The analysis of post-test scores on CAT2 indicated that there was significant difference in students' achievement between those using M5EsA and those taught using CTM in favor of those who were facilitated using M5EsA. However, to determine whether all the students benefited from the two approaches, achievement gain analysis was carried out after the study. This was done by comparing students' achievement scores in CAT1 before the study and their respective achievement scores in CAT2 after the study. The results obtained were as indicated in Table 11.

Table 11: Comparison of Students' Achievement Mean Scores with their Mean Gain

	Group 1(Experimental)	**Group 2(control)**
Pre-test Scores	1.40	1.37
Post-test Scores	22.9403	12.4337
Mean Gain	21.5403	11.063

The results in Table 11 indicates that both groups gained from the two learning approaches. However, the experimental group had a higher mean gain (21.5403 than the control group (11.063). To determine whether there was a significant difference in students' achievement gain, groups' achievement gain means were compared using t-Test. The results obtained from the analysis are as recorded in Table 12.

Table 12: Achievement gain t-Test results

Teaching approach	**N**	**Mean**	**SD**	**df**	**p-value**	**t-value**
E_1	67	21.5403	10.18663	148	7.368	.000
C_1	83	11.0637	7.95303			

Table 12 indicates that there was significant difference in mean achievement gains for the two groups in favor of the experimental group. This implies that M5EsA is a more effective approach to learning because it led to increased achievement in the topic "Effect of electric current on substances" compared to CTM.

The results obtained above leads to the rejection of the null hypothesis($H_0$1) upon which objective number one was based. This may be attributed to learners taught using M5EsA being engaged in discussion groups while constructing knowledge through the five stages; engagement, exploration, explanation, extrapolation and evaluation of the constructivist approach learning cycle. This ensures that learner understands the concepts deeply and is able to create his/ her own knowledge. In addition to ensuring clear understanding, M5EsA also ensures good mastery of the concepts. This is because subject matter is divided into smaller units which must be mastered by the learner. This is done by learners being given exams after every unit and those who do not attained the minimum set score must be given remediation until they achieve target then will be allowed to proceed and learn the next unit.

These results are in agreement to the results obtained by Adeniji, Ameen, Dambatta and Orilonse (2018), Kainua, Mayanchi &Anya (2021), Sunday, Adeyemo & Babajide (2014); Njoroge et.al (2014), Olaoluwa & Olufenke (2015), Uzezi (2017), and Umahaba (2018). In their studies on Mastery learning and inquiry-based 5Es learning cycle noted that the students in the experimental groups achieved higher scores than those in the control groups. M5EsA being a hybrid of mastery learning and construcivist-based5Es learning cycle reaps the benefits of both approaches to learning. This is because learners went through concepts in detail through 5Es learning cycle and receives remediation on the areas of the topic where they did not master. Therefore, there is combined positive effect of the approaches in M5EsA which is realized in the higher achievement of learners in the experimental groups signified by their higher scores than of those in the control groups.

4. Conclusions

A major conclusion drawn from this study based on the findings obtained is that both CTM and M5EsA approaches led to increase in students' achievement in chemistry but those who are taught using M5EsA had higher achievement compared to those who were taught using CTM. This indicates that M5EsA has a higher positive significant effect on learners' understanding of chemistry concepts compared to CTM.

5. Implications of the study

The findings of this study indicates that M5EsA led to enhanced achievement in chemistry. Therefore, if this teaching approach is incorporated into the teaching of chemistry in secondary schools it may lead to higher students' achievement in chemistry in secondary schools.

6. Recommendations

- M5EsA leads to improved motivation and higher achievement in chemistry. Therefore teachers, Ministry of Education (MOE) and Kenya Institute of Curriculum Development (KICD) may encourage the use of this

approach so as to enhance achievement in chemistry. This can be done through regular teacher-induction seminars and workshops that may be organized by the ministry.

- In order to have more information on the effect of M5EsA on students' achievement in and also to enrich the present findings, further research is recommended to find out effect of M5EsA on other topics in chemistry other than the topic used in this study. There is need also to carry out more research to find out effect of M5EsA learners' achievement in other subjects.

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