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Effect of experiential concept mapping teaching strategy on students' motivation in learning chemistry in Tigania West Sub County, Kenya

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Abstract
Low achievement in chemistry can be attributed to lack of innovativeness in the method of instruction, low motivation towards instructional chemistry by both, instructors and learners besides other factors. The study sought to look into the effect of Experiential Concept Mapping teaching strategy on students' motivation in learning chemistry in Tigania West sub county, Kenya. A quasi -experimental research design and in particular, the Solomon Four non- corresponding regulator cluster design was utilized. It comprised a target population of 1765 Form two learners from Tigania West Sub County, Kenya. The sample size involved 182 students from four sub county coeducational secondary schools, selected through simple random sampling. This simple random sampling method was utilized to allot the schools to either investigational or regulator clusters. The study comprised four clusters; two investigational clusters (E1 and E2), and two regulator clusters (C1 and C2). A student Motivation Questionnaire (SMQ) was administered during the pre-test and post-test in order to look into learners' attainment in chemistry. Data obtained was input into Statistical Package for Social Science (SPSS) version 24. For descriptive statistics; percentages, frequency distributions, mean and standard deviation was used to present these analyzed data. U-test, and H-test were used for inferential statistics. The statistical significance was tested at $\alpha = 0.05$. The results established a statistically significant difference in achievement in learning chemistry among the control and experimental clusters of students. Adoption of ECM to improve the learners' motivation to learn chemistry. The results of this study will benefit chemistry teachers by providing information on how to implement experiential concept maps into everyday practice in their classrooms. In addition, policy makers and curriculum developers will find these results relevant since they will be able to obtain more insights and develop policies that can be incorporated into the application and implementation of Experiential Concept Mapping teaching strategy. The findings of study will benefit teacher education institutions and curriculum designers by integrating creative teaching strategies into curricula.

Keywords: Motivation, achievement, curriculum, chemistry, student, Tigania

1. Introduction
Biomass is the main source of fuel both in the rural and urban areas within countries like India, China, Nepal, and Bangladesh. Biomass is available in two forms Charcoal and fuel wood (Food and Agriculture Organisation, 2012, Moreno *et al.* 2019) [17]. In the past few decades, increase in the consumption of fuelwood have led to more pressure on natural resources worldwide (Tilman *et al.* 2001; Arrow *et al.* 2004, Liu *et al.* 2010 and Velho *et al.* 2018) [27, 1, 29]. The demand for energy is partly met by firewood which is the important source of domestic energy for the developing world (Heltberg *et al.* 2000) [11]. This is particularly important to the areas where limited energy sources lead to high pressure on scarce natural resources. For example, the dependency on forest biomass as primary source of energy was up to 87% in India, (Madhu 2009, and Bhatt *et al.* 2016) [15, 5], 77% in Nepal (Benato *et al.* 2016) [3], 78% in Bhutan (Rana *et al.* 2016) [23], 73% in Bangladesh (Huda *et al.* 2014) [12] and 38.82% in Myanmar (Wen *et al.*, 2017) [30].
In the study area, the high energy requirement is believed to be one of the main reasons for natural resource degradation. In this region, winter lasts for five months (October to February) during which local people heat their homes throughout the day because of very low temperature. The present study was undertaken to investigate the availability of fuelwood, pattern of fuel wood collection and its impact on forest ecosystem.

Effective process in a school environment relies on the desire that prompted learners to the course and thus, student motivation is an essential element that is necessary for quality education [7]. Motivated students pay attention, they begin working on tasks immediately, they ask questions and volunteer answers, they appear to be happy and eager [8]. Some learners seem naturally enthusiastic about learning, but many need or expect other factors to inspire, challenge and stimulate them. In a classroom, inspiration can be noticed as learners exhibit a desire and eagerness to acquisition of knowledge [6]. Learners ideally ought to be subjected to a variety of sources of inspiration in the course of their learning experiences.

Motivation is the expenditure of effort to accomplish results and therefore, it is heightened when learners are subjected to a variety of inspiring experiences and other encounters frequently [7]. noted that students' motivation depends on the extent to which the teacher is able to satisfy the students need for feeling competent, feeling connected to others and desire for feeling in the control of their process of learning. The improved understanding of chemistry can be considered as owing to the more time spent in studying and also the motivation of the students. Improved understanding due to more time spent in studying may apply where the curriculum content is spiraled in a number of topics. According to [10], human being's thoughts have the potential to shape information upon existing framework, which enhances learners' motivation to take in new ideas. Motivation arises out of the fact that career aspiration of the students and performance in examinations. If the two correlate positively it results into higher motivation hence less difficulties in learning.

According to [8], the technique for ensuring motivation that leads to higher achievement include; providing simple and clear explanations, providing hands –on-activities as often as possible and creating an environment where students ask and answer questions freely. Various factors affect a particular learner motivation to engage in learning activities, desire in a content area, overall desire to excel, surrounding, resources besides patience and determination. Nevertheless. Psychologists affirm that reasonable school acquisition of knowledge by learners may fail to occur if there is lack of motivation towards learning [3]. Further, [3] maintains that it is of great significance to motivate learners to develop and endure their desire towards learning in a school set up.

Factors that lead to less motivated learners are; truancy, faking responsiveness in class, negative perceptions, lack of learner commitment, resulting into poor scores or failures thereof, and at times, most of them will drop out of school [12]. Thus, an instructor ought to thoroughly comprehend the changing aspects that enhances leaner motivation in order to improve on their thoughtfulness on internalizing conceptions [9]. When students are academically motivated, they tend to capture the rationale of working freely, and show the ability to realize the inherent tenet and tacit didactic bonds boosts their possibility of accomplishment [5]. Learners should be inspired to develop actual desire in the acquisition of knowledge and skills; the know-how learnt posteriorly should be embraced to their preference.

[10] carried out a study on the effect of learner motivation on academic achievement in secondary schools in Dagoreti sub county, Nairobi. The research used a survey research design and involved a sample of 40 teachers. The major findings were that individual inspiration between learners is a primary aspect towards desirable academic achievement. Consequently, the study concluded that learner motivation has a positive effect on academic achievement. Thus, the researcher recommended that subsequent investigations should concentrate on how motivational approaches can be utilized to create longer influence, the actual association amongst self-motivation and academic attainment. Additionally, researchers need to concentrate on how to make content delivery more stimulating in order to motivate learning. It is in the light of this that the investigator sought to determine the effect of Experiential Concept Mapping (ECM) instructional method on motivation of students in learning chemistry in relation to gender.

2. Materials and Methods

2.1 Location and Description of the Study Area

The research study was conducted in Tigania West sub county, Meru County. The Sub County has students with different academic abilities and different social economic backgrounds. In addition, Tigania West sub-county has recorded dismal achievement in KCSE science subjects, especially in chemistry, yet there is no empirical research carried out in the sub county to help education stakeholders understand the reasons that lead to low achievement in chemistry thus the need for the study.

2.2 Target Population

The study targeted all public secondary schools in Tigania West Sub County. There was an approximate student population of 1765 Form two students in Tigania West Sub County as shown in Table 1. Form two learners were targeted to participate in this study because the main topic; the structure of the atom and the periodic table are covered in this level.

Table 1: Target Population

School type	Number of schools	Total number of students
Girls only	4	365
Boys only	3	400
Co-educational schools	20	1000
Total	27	1765

Source: Tigania West Sub County Education Office (2021)

Information on Table 1 indicates that there were 4 girls' boarding schools in Tigania West sub- county with 365 form two students, 3 boys' boarding schools with 400 form two students and 20 co-educational schools with 1000 Form two learners. The study targeted 1765 Form two learners in Tigania West sub-county.

2.3 Sample Size and Sampling Procedures

Simple random sampling method was employed in the selection 4 sub county co-educational secondary schools in Tigania West Sub County. The sampled schools were further assigned as either control group or experimental group using simple random sampling (Table 2).

Table 2: Sample Size

School type	Sample school	Total population	Number of Students		
			Experiment Group	Control Group	Total
Sub county coeducational school	4	40	50	40	90
		48			
		50	44	48	92
		44			
Total		182	94	88	182

Table 2 shows that learners in sampled coeducational schools were 40, 48, 50 and 44, giving a total of 182 form two students. The schools assigned as experimental groups had 50 and 44 students, while those assigned as the control groups had 40 and 48 students. In cases where a school had more than one stream, all of them took part in this investigation.

2.4 Research Instrument

Student motivation questionnaire (SMQ) was used to assess student motivation towards chemistry when instructed by utilization of experiential concept mapping instructional approach and conservative approaches before and after the course. The questionnaire consisted of 25 items developed using five point Likert scale extending from strongly agree with 5 points to strongly disagree with a score of 1 point. Learners were expected to point out whether they strongly Agree (SA), agree (A), Not Sure (NS), Disagree (D), or Strongly Disagree (SD). In the current study, a perception of the student was considered to be a magnitude alongside the range from the strongly negative to a strongly positive effect based on Likert scale notations.

2.5 Data Collection

The researcher visited the sampled schools to establish a conducive working environment with the school management besides getting introduced to the chemistry instructors. The investigator then trained teachers of the investigational cluster on how to use ECM for four days. The researcher administered the Student Motivation Questionnaire (SMQ) to experiential cluster (E1) and regulator group (C1) followed by three weeks' integration of ECM approach to the investigational clusters E1 and E2. The conventional teaching strategy was subjected to regulator clusters (C1 & C2). SMQ was then administered to all the regulator and investigational clusters.

2.6 Data Analysis

The information gathered was counted, coded and prepared for analysis. Descriptive statistics (mean and standard Deviation) and inferential statistics (Kruskal-Wallis H test and Mann-Whitney U -test) were employed in the analysis the gathered data. This was achieved by the use of the Statistical Package for Social Sciences (SPSS) version 24. The information was then presented in tables, and bar graphs.

3. Results

3.1 Respondents' Demographic Information

Analysis of respondents' demographic information was done. This included gender of the students (Table 3).

Table 3: Gender of the Respondents.

	Control groups		Experimental groups		Total	
Gender	f	%	F	%	F	%
Male	39	44.32	50	53.19	89	48.90
Female	49	55.68	44	46.81	93	51.10
Total	88	100	94	100	182	100

Results on Table 3 indicates that 55.68% of the respondents under control group were female, and 44.32% of the respondents were of the male gender while, 53.19% of the respondents on experimental group were of the male gender while 46.81% of the respondents comprised of the females. This implies that more girls than boys were in the control groups. .Experimental groups had 50 boys and 44 girls and that the overall percentage of girls involved in the study was 51.10% and that of boys was 48.9%. Information in Table 4 shows the groups involved in the study and number of students in each groups.

Table 4: Sample Size Stratification

Group	Experimental and control	Number of students
C1	Control	40
C2	Control	48
E1	Experiment	50
E2	Experiment	44
Total		182

Information on Table 8 indicates that control group (C1) had 40 students, control group (C2) had 48. Experimental Group (E1) had 50 students and experimental group (E2) had 44 students.

3.2 Outcome of Post-test Mean Rank Analysis on SMQ

The SMQ post-test average ranks were scrutinized to evaluate the associated effects of
ECM on learners' motivation in learning chemistry.

Table 5: SMQ Post-test Group Mean ranks Analysis

Groups	N	Mean rank	Std. Deviation	Std. Error
C1	45	2.7590	1.44165	.21491
C2	48	3.2197	1.41590	.20437
E1	46	3.9507	1.00494	.14817
E2	41	3.4781	1.42016	.22179
Total	180	3.3502	1.38950	.10357

Findings in Table 5 demonstrates that the average ranks of experimental clusters E1 (M= 3.95, SD=1.00) and E2 (M= 3.47, SD= 1.42) were greater when compared with those of regulator clusters C1 (M= 2.75, SD=1.44) and C2 (M=3.22, SD=1.41). It can be deduced from table 14 that the experimental clusters had a greater motivation to learn

chemistry when instructed by use of Experiential Mapping Teaching approach than the control cluster that were instructed by use of conservative instructional techniques. To determine whether variations that occurred among the average ranks of the clusters were significant, Kruskal-Wallis H test was carried out and findings illustrated in Table 6.

Table 6: Kruskal-Wallis H test Results for Motivation Scores on SMQ

Groups	N	Mean Rank	Chi-Square	Df	Asymp. Sig.
C1	45	69.90	14.394	3	0.002
C2	48	85.24			
E1	46	109.22			
E2	41	98.27			
Total	180				

Significance level = 0.05

A Kruskal-Wallis H test showed that there was a statistically significant difference in motivation scores between the different groups of students, $\chi^2(3) = 14.394$, $p = 0.002$, with a mean rank motivation score of 109.22 for Group E1, 98.27 for Group E2, 85.24 Group C2 and 69.90 for Group C1. These results demonstrate that there is a statistically significant difference in learners' motivation in learning chemistry among learners instructed using ECM teaching strategy and those taught using conventional methods. Since the Kruskal-Wallis H test results revealed that there were statistically significant differences between the means of motivation ranks for the four groups. This implies that when learners were instructed using Experiential Concept Mapping instructional approach, they get more motivated to learn on their own and practice drawing concept maps regularly, which leads to a deeper understanding of the concepts. To find out the specific groups that accounted for this significant difference, a follow up test was done using Pairwise Multiple Comparison Test. Table 7 provides information on post hoc pairwise comparisons test of post-test means scores on SMQ.

Table 7: Pairwise Multiple Comparisons Test of Post-Test Mean Scores on SMQ

Sample 1- Sample 2	Test Statistic	Std error	Std test statistic	Sig.	Adj. Sig.
C1-C2	-15.340	10.803	-1.420	0.156	0.934
C1-E2	-28.368	11.240	-2.524	0.012*	0.070
C1-E1	-39.317	10.916	-3.602	0.000*	0.002
C2-E2	-13.029	11.071	--1.177	0.239	1.000
C2-E1	-23.978	10.742	-2.232	0.026*	0.154
E2-E1	-10.949	11.182	-0.979	0.327	1.000

Significance level= 0.05

Table 7 reveals significant differences among the cluster C1-E1 (p= 0.000), C1-E2 (0.012), and C2-E1 (p=0.026). No significant differences were obtained among clusters C1-C2 (0.156), C2-E2 (0.239), and E2-E1 (0.327). There is no statistically significant difference when one experimental group is compared to another experimental cluster as well as when one regulator cluster is compared to another regulator cluster, an observation that is linked to positive influence ECM has on learners' motivation. Figure 1 gives a graphical comparison of the four groups on motivation mean ranks.

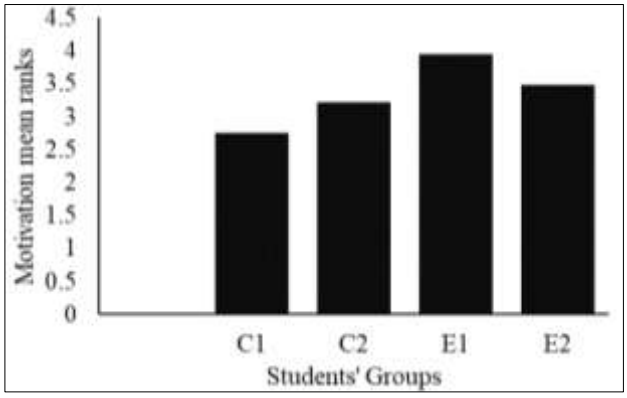

Fig 1: Motivation Mean Ranks

Information on Figure 4 indicates that students in experimental groups E1 and E2 had a higher motivation mean ranks (3.95 and 3.48) respectively compared to control groups C1 and C2 which had motivation mean ranks (2.76 and 3.22) respectively. Information in figure 4 clearly shows that experimental groups were more motivated to learn chemistry after exposure to ECM teaching strategy, compared to the control groups which were instructed using conservative instructional methods. This implies that ECM instructional strategy increases students' motivation in learning chemistry. This is an indication that when students are involved in constructing experiential concept maps as a learning activity they are able to master science concepts easily.

4. Discussion

These findings are in line with results of previous studies done by [1] on the influence of Experiential Learning Approach on learners attainment in secondary school mathematics in Kericho East sub county Kenya. The findings of the study pointed out a positive impact on learners' motivation in learning mathematics subject as compared to regular instructional techniques (RIT). Experiential learning strategy as used in learning and teaching, provide a link on how individuals acquire skills and meaningful learning through providing learners with adequate basis besides analytical thinking concerning various concepts. Students are able to approach learning in a balanced scenario and thus ECM acts as a motivating factor. This is an indication that ECM results in higher students' motivation than the conventional teaching methods.

These study results are also concurrent with those obtained by [11], on a study on the effect of concept mapping strategy on secondary school physics learners' achievement and motivation in Jos Metropolis Plateau State, Nigeria. The study showed that there is statistical difference between the post-test average scores of learners at various inspirational level in learning physics. This implies that concept mapping teaching strategy improves students' motivation.

[3] researched on the effect of Collaborative Concept Mapping Teaching Approach (CCMTA) on secondary school learners' achievement and motivation to learn biology in Nakuru North Sub-County, Kenya and found concurring findings with this study. The study compared the motivation and achievement of secondary school student when taught using CCMTA and conventional teaching methods and found out that CCMTA recorded greater learner motivation when compared with the conservative instructional approaches. This could be an indication of underlined active involvement of learners in the instructional process within CCMTA approach leading to extensive understanding of concepts in biology.

Another study with similar findings is [4] which examined the effect of Cooperative Concept Mapping Teaching Approach (CCM) on motivation of learners in biology and reported significant greater motivation between learners subjected to CCM unlike those instructed through conservative teaching techniques. Conversely, a previous study by [5] indicated that leaners taught using Concept and Vee Mapping Strategy (CVMS) exhibited a significantly higher motivation when compared with those taught instructed by use of conservative methods.

5. Conclusion

Students taught using ECM had a higher motivation to learn chemistry than those instructed by use of conservative teaching methods. Therefore, Students who are taught using ECM teaching strategy get higher motivation to learn, and their achievement in the subject increases.

6. Recommendations

Experiential Concept Mapping has generated significant advantages in relation to learners' motivation to learn chemistry, thus the teaching strategy should be incorporated and adopted to supplement other teaching strategies that have shown positive impacts on students' motivation to further improve perfomance in KCSE.

Chemistry teachers should embrace the use of ECM teaching strategy as a way of motivating students of both gender in order to cultivate interest in the subject and also in chemistry related careers.

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