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EFFECTIVENESS OF EXPERIENTIAL CONCEPT MAPPING TEACHING AND LEARNING STRATEGY ON SECONDARY SCHOOL STUDENTS' ATTITUDE TOWARDS PHYSICS IN MAARA SUB-COUNTY, KENYA.

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ABSTRACT

The fundamental challenge facing the teaching and learning of physics as a science in Kenya secondary schools is how to enhance students' affective characteristics associated with teaching and learning process. The challenge is clearly depicted by low enrolment of students taking physics in schools. Thus, application of new teaching strategies that will not only improve students' achievement in physics but also positively change their attitude towards physics as a subject should be used. One of these teaching strategies is experiential concept mapping. The purpose of the study was to investigate the effectiveness of using experiential concept mapping teaching and learning strategy on students' attitude in physics in secondary school. The target population of the study was 8430 physics student in Maara Sub County. Accessible population was 3137 form one students, from purposively sampled co-educational secondary schools in Maara sub-county. Solomon's Four Group Non–Equivalent Control Group Design was used in the study. Based on the design, four co-educational schools forming the sample size of about 182 form one students, was randomly sampled. The researcher ascertained the validity of the instruments by seeking opinions from experts in the field of study as well as assistance from supervisors. The experimental groups were taught using experiential concept mapping teaching and learning strategy while the control groups were taught using other conventional methods of teaching. The instrument used to collect data was Student Attitude Towards Physics Learning Questionnaire (SATPQ). Piloting was conducted prior to data collection to improve reliability of the instruments. Reliability of the instrument was computed using Cronbach Alpha formula. Reliability coefficient of 0.705 was obtained. The raw data obtained was scored, coded and analysed using descriptive statistics (mean, standard deviation and percentages) as well as inferential statistics (ANOVA, and t-test). Hypothesis was tested at the alpha (α) value of 0.05 level of significance using Computer Statistical Package for Social Sciences (SPSS) version 20. The results from the current study showed that students attitude towards teaching and learning of physics was influenced by the method of instruction. The analysis of items in the SATPQ revealed that students in the experimental groups that were instructed using ECMTLS had positive attitude towards physics as compared to those in control group that were instructed using CTM. From the study there was evidence that experiential concept mapping influence students' attitude towards physics learning. The researcher therefore recommends the inclusion of ECMTLS as a strategy in teaching to improve attitude in physics.
Keywords: Experiential, concept mapping, attitude, co-educational schools, affective characteristics

INTRODUCTION

Trends of development in Kenya show that careers in Physics have contributed to socio-economic and technological transformation and especially in this era of information, communication and technology (Munishi, et al 2006). The world is increasingly dependent on physics, fueled by breakthroughs in physics research. Socio-economic and technological transformation requires the fundamental principles of Physics education taught in Secondary Schools. In addition, it prepares learners for scientific and technological vocations. However, in spite of this importance of physics, there is increased students' apathy to physics as a science subject. Students view science particularly physics as uninteresting and uninspiring (Smithers & Robinson, 2006). Less and less students are studying physics, which is causing the general public to mitigate their understanding about scientific concepts (Smithers & Robinson, 2006).

Students' attitude in Physics has been poor. Smithers & Robinson (2006) noted that the study of Physics in secondary schools and universities is spiraling into decline as teenagers believe it is too difficult. There is a perception among most students that physics concepts are difficult to grasp, conceptually (Changeiywo et al, 2011). Williams et al (2003), observed that major reasons for students finding Physics uninteresting are that it is seen as difficult and irrelevant. Another reason identified is that the teaching method used may not be interesting thereby resulting in more students dropping Physics in upper secondary schools (Gunasingham, 2009; Changeiywo 2011). According to (Broggy & Mc Clelland, 2008), teaching and learning method used are the ones that make learners to be uninterested with science especially physics since they are teacher centred and the learners are passive.

Asikhia (2010) points out that the role of secondary education is to lay a foundation for further education and if a good foundation is laid at this level there are likely to be no problems in the subsequent levels. The secondary school students therefore need to be guided carefully as mistakes at this stage would seriously affect the life of the

individual forever (Asikhia 2010). Methods of teaching science can be defined as the process of delivering knowledge and transmitting skills to learners by the teacher with an aim of making the learner comprehend and be able to apply the content and processes of science (SMASSE, 2007,

Kenyan learners may be graduating with lack of practical skills and desired attitude and values due to over concentration on theoretical knowledge and skills. (Otieno, 2010). SMASSE (2007) asserted that attitude has been the major hindrance to proper teaching of science and mathematics. The amount of learning in science classroom relate positively to initial interest and attitude that the learner will bring into classroom. SMASSE (2007) points out that the teacher's role is to bring about a child's self-esteem so that the child feels good about themselves, to be able to set and achieve appropriate educational goals, discovery of new vocation or destiny and acquire knowledge of values among others. Asikhia (2010) points out that the role of secondary education is to lay a foundation for further education and if a good foundation is laid at this level there are likely to be no problems in the subsequent levels. The secondary school students therefore need to be guided carefully as mistakes at this stage would seriously affect the life of the individual forever (Asikhia 2010). Methods of teaching science can be defined as the process of delivering knowledge and transmitting skills to learners by the teacher with an aim of making the learner comprehend and be able to apply the content and processes of science (SMASSE, 2007). Scientists and science educators have come to a conclusive agreement that teaching of science needs to involve students in the learning process. Science educators have come up with concept maps as one of such teaching learning techniques (Okoye & Okechukwu, 2006; Kinchin, 2000; Markow & Lonning, 1998). According to Novak and Canas (2006), concept maps are graphical tools for organizing and representing knowledge.

According to Chacko (2000), the kind of attitude the student has will affect learning. If one has a positive attitude about teacher and likes the subject, these students will experience some success and through reinforcement will work more effectively and achieve more. The influence of attitude on perception leads to the student seeing tasks to be learned as pleasant and important or unpleasant and useless. According to Krogh and Thomsons (2005), personal teacher support is the key predictor of learners' attitude to physics. Novak and Canas (2006) stated that knowledge creation is a process involving both knowledge and emotion or the drive to create new meaning and new ways to represent things. Broggy and Mc Clelland (2008) stated that the main finding from year –long study showed that there was a strong inclination that students attitude toward physics improve after working with concept maps. Karakuyu (2010) after carrying a research concluded that student who used concept maps where observed to have a tendency of more positive attitude than the control group students. Generally positive attitude among students is an important goal of science education in many jurisdictions (Mayer et al (2000).

Statement of the Problem

Physics is an important subject in secondary school curriculum. Technological transformation requires fundamental principles of physics education. Physics prepares learners for scientific and technological vocations. Despite its importance, most students view physics as difficult and uninteresting. Students' attitude in physics has been poor. The teaching and learning strategy employed by teachers has been identified as one of the factors contributing to negative attitude in physics. The conventional teaching methods employed by physics teachers are teacher centred making the learners passive. Therefore, it is necessary for effective strategies that enhance learning to be adopted in teaching the subject. Experiential concept mapping teaching and learning strategy has been shown to improve attitude in learning, however there is limited information on its effectiveness on attitude in physics by secondary school students. The current study sought to investigate effectiveness of experiential concept mapping teaching and learning strategy on attitude in physics by secondary school students in Maara sub-county, Kenya.

Objectives of the Study

The study was guided by the following objectives: To determine the effectiveness of experiential concept mapping teaching and learning strategy on secondary school students' attitude towards physics.

Hypothesis

There is no statistically significance difference in attitude towards physics subject between students exposed to experiential concept mapping teaching and learning strategy and those taught using conventional teaching methods.

Significance of the Study

The finding of the study may provide useful information to policy makers and stakeholders in education sector to help put policies in place which may improve learners' performance as well as attitude, hence may increase the

number of student who choose physics. The teacher training colleges and universities may greatly benefit from the findings which may help them to train teachers with effective strategies to use when teaching physics concepts. The finding may also form a point of reference by quality assurance and standards officers in organizing in-service courses for physics teachers. The findings may also greatly help upcoming researchers as a source of references.

Scope of the Study

The study was carried out in secondary schools in Maara Sub-County in Tharaka Nithi County. The accessible population of the study comprised of form one students from co- educational secondary schools within the Sub-County. The physics concept covered was electrostatics 1 in form one syllabus. The subject of the study were form one physics students. The effectiveness of experiential concept mapping teaching and learning strategy on attitude in physics by form one students in Maara Sub-County was investigated.

Conceptual Framework

The researcher sought to investigate the effectiveness of experiential concept mapping teaching and learning strategy on attitude in physics by secondary school students. Figure 1 gives a model showing relationship among study variables which include the independent, variables, extraneous variables and dependent variables.

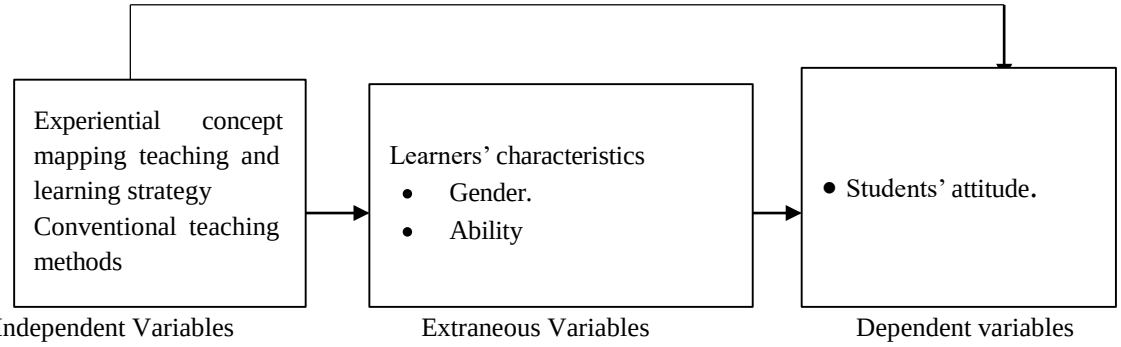

Figure 1: Conceptual Representation of Variables

Mugenda and Mugenda (1999) defines independent variable as variables that a researcher manipulates in order to determine its effect or influence on the other variables. Independent variable also called predictor variable, predicts the amount of variation that occurs in another variable. In this research the independent variable was conventional methods and experiential teaching and learning strategy. Mugenda and Mugenda (1999) defines dependent variables as a variable that attempt to indicate the total influence arising from the effect of independent variable. They vary as a function of independent variable. In this study the dependent variable was students' attitude towards physics. Extraneous variables include; Learners' characteristics; girls usually tend to feel that sciences are for boys. This could affect both attitude towards physics subject**.** Also, due to difference in psychological development, different learners of particular age may comprehend the technique of concept mapping at different rates.in a classroom, learners are usually of mixed ability. The study intended to minimize this by selecting form one students who were assumed to be of same age and almost similar entry behaviour.

METHODOLOGY

Research Design

The study is a quasi-experimental research, because the unit of sampling was a class in secondary school level. Solomon's Four Non- Equivalent Control Group Design was used since the subject were already constituted and classes once constituted exist intact and the researcher works with existing streams (Nachmias & Nachmias, 2004). The SFNECG Design was used since it enables the researcher to control and measure the main effects of testing. Solomon's Four Non- Equivalent Control Group Design is also considered rigorous for quantitative studies since it involves two control groups as compared to other experimental designs (Ogunniyi, 1992; Borg & Gall, 1989). Solomon's Four Non-Equivalent Control Group Design makes it possible to evaluate the main effect as well as the reactive effects of testing, history and maturation (Fraenkel & Wallen, 2000). It also allows the researcher to exert complete control over the variables and to check that the pre-test will not influence results (Shuttleworth, 2009).

The Solomon's four non-equivalent group design is as presented as shown.

Group		Pre-test	Treatment	Post-test
Experimental group	E1	O1	X	O2
Control group	C1	O3	-	O4
Experimental group	E2	-	X	O5
Control group	C2	-	-	O6

Source: Shuttle Worth (2009)

O1 and O3 was the pretest while O2, O4, O5 and O6 was posttests. X was the treatment where students was taught using ECMTLS in the topic of electrostatics in physics. E1 was the experimental group which received pretest, treatment and post-test. C1 was the true control group that received the pretest followed by the control conditions and finally post-test. E2 is the experimental group two that received treatment followed by post-test. C2 received posttest only. C1 and C2 was taught using CTM.

The study was donein Maara in Tharaka Nithi County. The sub county has a variety of schools; National, Extra County and County level secondary schools. Co-educational Secondary Schools were selected for the study. The target population of this study include 8430 physics students in Maara Sub County. Accessible population was 3137 Form one students from purposively sampled co-educational school in the sub county. About 182 form one students in Maara Sub County was randomly sampled for the study. Form one students are chosen because in most secondary schools, at this level physics is compulsory and the topic electrostatic 1 is taught in form one. Reports from Kenya National Examination, KNEC (2017), also reveals that questions on electrostatic 1 were dismally performed.

The researcher listed all 52 secondary schools in Maara sub-county. The researcher then purposively sampled the co-education schools. Four schools were then be selected by simple random sampling. Sampling was done to minimize experimental contamination by making sure that the selected schools are far apart and to ensure homogeneity in characteristics of selected schools. The form one student from each of the four selected school formed the four groups of the study. The assignment of the four groups to either experimental or control groups was done through simple random sampling. The sample size for the study was about 182 students. This is in agreement with Mugenda and Mugenda (2006) who suggests that for experimental study, at least 30 subjects are recommended. This implies that the researcher had to choose only those schools that have 30 students per class or more. A summary of sample size stratification is shown in Table 1

Table 1: Summary of Sample Size Stratification

Group	Experimental/Control	Number of Students
I	Experimental(E1)	48
II	Control (C1)	45
III	Experimental(E2)	43
IV	Control (C2)	46
Total		182

Research Instruments

One research instruments was developed and used to collect data; student attitude towards physics learning questionnaire (SATPQ). Involved in concept map construction, psychomotor domain was also utilized. Student Attitude towards Physics Learning Questionnaire (SATPQ) dealt with affective domain.

Kless and Bloomquist (1985) observed that questionnaires offer considerable advantage in the administration. It presents an even stimulus potentially to a large number of people simultaneously. It also provides the investigation with an easy accumulation of data. Questionnaire gives respondent freedom to express their views and opinion and also make suggestions (Gay, 1992).

Student attitude towards physics learning questionnaire (SATPQ) consisted of 30 items. The thirty (30) items were on five-Likert scale indicating students' attitude. The scale ranged from strongly agree to strongly disagree with 5 = strongly agree, 4= agree, 3= undecided, 2= disagree, 1 = strongly disagree. The responses given by students on their views on questionnaire were used by researcher to obtain information on whether ECMTLS has any impact on students' attitude.

Piloting was done prior to data collection in a school with almost similar characteristics to those in the study, in the neighboring Meru South Sub-County to establish reliability. The school was selected by simple random sampling. The pilot study was used to determine validity and test reliability of research instruments (Kombo & Tromp, 2006). Reliability coefficient of the instrument was computed using Cronbach alpha formula. The reliability coefficient of 0.705 was obtained for SATPQ .Thus the instrument were reliable since according to Fraenkel and Wallen, (2009), reliability of 0.70 and above could be considered suitable to show the reliability of the instrument

Data Analysis

SATPQ was scored and data generated. Data was then analyzed using both descriptive and inferential statistics. Descriptive statistics enabled the researcher to meaningfully describe a distribution of measurements (Mugenda & Mugenda, 1999). Descriptive statistics which include mean, percentage standard deviation and variance were used to analyze the raw data. Inferential statistics deals with analysis, interpretation and decision on the basis of results (Nassiuma & Mwangi, 2004). Inferential statistics were used to analyse quantitative data.

The inferential statistics employed included one-way analysis of variance (ANOVA) and t-test, with an aid of a computer statistical package for social sciences (SPSS) version 20. ANOVA was used to test the statistical significance difference between and among the means in the post-test scores for the groups exposed to experiential concept mapping teaching and learning strategy (ECMTLS) and those exposed to conventional teaching methods (CTM). A t-test was used to test whether there is any significant difference between boys and girl scores when exposed to ECMTLS, this is because of its superior quality in detecting the differences between the two means (Coolican, 2018, Borg & Gall, 1996). The hypothesis was tested at the alpha (α) value of 0.05 level of significance. Summary of data analysis is as shown in the Table 2.

Table 2: Summary of Data Analysis

Hypothesis	Independent Variable	Dependent Variable	Statistical Test
H_{01}: There is no statistically significance difference in attitude towards physics as a subject between students exposed to ECMTLS and those taught using CTM	Experiential Concept mapping teaching and learning. Strategy CTM	Students Attitude	One way ANOVA

RESULTS ANALYSIS AND DISCUSSION

Students were asked to state their gender. The distribution of students by gender is presented in Table 3.

Table 3: Distribution of Students by Gender

Gender	Frequency	Percentage (%)
Boys	98	54
Girls	84	46
Total	182	100

Results in Table 3 illustrates the gender composition of the students' sample was 98 boys and 84 girls representing 54% and 46% respectively. This shows that more boys (54%) than girls (46%) were involved in the study. Thus the more boys than girls were enrolled in the sampled schools. A total of 182 students participated in the study.

Effectiveness of Experiential Concept Mapping Teaching and Learning Strategy on Students' Attitude towards Physics Learning

The objective of the study was to determine the effectiveness of experiential concept mapping teaching and learning strategy on secondary school students' attitude towards physics. The questionnaires (SATPQ) were administered to the students to find out their attitude towards teaching and learning of physics subject. The thirty (30) items were on 5 point Likert scale ranging from strongly agree to strongly disagree with 5 = strongly agree, 4= agree, 3= undecided, 2= disagree, 1 = strongly disagree. The responses given by students on their views on questionnaire items were used by researcher to obtain information on students' attitude.

SATPQ Pretest Mean Scores for E1 and C1

To assess students' attitude in physics prior to treatment analysis of student pretest scores in SATPQ was carried out. The mean and standard deviation for experimental group E1 and control group CI are presented in Table 4.

Table 4: Pretest Means Scores on SATPQ

Group	N	Mean	SD
E1	48	2.12	.46
C1	45	2.21	.40

Key
E1-Experimental group with pretest and posttest
C1-control group with pretest and posttest

The results in Table 4 indicates the values of sum, mean and standard deviation for experimental group (E1) and control group (C1) values. Results in table 7 show the mean and standard deviation for Experimental group (E1) was 2.12, and 0.46 respectively. On the other hand, control group (C1) had 2.21, and 0.40 as values of, mean and standard deviation. From the results of analysis, it was evident that the control group (C1) pretest data had a slightly higher mean values as compared to the experimental group (E1) pretest data (2.21 and 2.12 respectively). A t-test was performed to determine whether there was any significant difference in the mean scores for the groups E1 and C1. Results are presented in Table 5

Table5: The t- test of Pretest Scores on SATPQ based on Groups E1 and C1

Group	N	Mean	S.D	df	t- value	Sig(2-tailed)
E1	48	2.12	0.46	91.00	1.02	.312
C1	45	2.21	0.40			

Key
E1-Experimental group with pretest and posttest
C1-control group with pretest and posttest

The results on Table 5 shows that the t-(91) = 1.02, P=0.313, P> 0.05) and so the two SATPQ pretest mean sores for E1 and C1 were not statistically different. This implies that the level of student's attitude towards teaching and learning of physics prior to administration of teaching strategy, for both experimental group and control group were similar. This implies that the experimental group and control groups were equivalent and suitable for the study.

SATPQ Posttest Scores for E1 and C1
Posttest SATPQ scores were also generated. Table 6 shows SATPQ scores for students in E1 and C1.

Table 6: Posttest Values for E1 and C1

	N	Mean	SD
E1	48	3.53	.57
C1	45	2.33	.47

Key:
E1-Experimental group with pretest and posttes.
C1-control group with pretest and posttest

The Table 6 indicate the values of sum, mean and standard deviation for experimental group (E1) and control group (C1) posttest values. Experimental group (E1) posttest data had 48, 3.53, and 0.57 as values of sum, mean and standard deviation respectively. On the other hand, control group (C1) posttest data had 45, 2.33, and 0.47 as values sum, mean and standard deviation. From the results of analysis, it was evident that the experimental posttest data had a higher mean as opposed to the control posttest data. This implies that the group that was taught using ECMTLS had higher mean than the control group that was taught using CM implying that ECMTLS when used can improves learner attitude towards physics learning.

SATPQ Posttest Scores for Experimental and Control Groups
Information in table 7 shows the posttest mean scores obtained in the study groups when students were exposed to experiential concept mapping teaching and learning strategy in experimental groups and to conventional methods in control groups.

Table7: Mean Scores in SATPQ Posttests for Experimental Groups and Control Groups

Variable	N	Mean	SD
C2	46	2.13	0.43
C1	45	2.33	0.47
E2	43	3.55	0.66
E1	48	3.53	0.57

Key
E1- experimental group with pretest and posttest after treatment
C1- control group with pretest and posttest
E2- experimental group with posttest after treatment
C2- control group with posttest

The information on Table 7 reveals that the control group (C2) had a sum, mean and standard deviation values of 46, 2.13 and 0.43 respectively. Control group (C1) on the other hand had 45, 2.33 and 0.47 as values of sum, mean and standard deviation respectively. The experimental group (E2) data had 43, 3.55, and 0.66 as values of sum, mean and standard deviation respectively while experimental group (E1) had sum, mean and standard deviation values of 48, 3.53 and 0.57 respectively. Comparing the attitude between experimental groups and control groups, the experimental groups that were instructed using ECMTLS had higher mean scores as compared to control groups that were instructed using CTM.

One Way ANOVA for Posttest Mean Scores on SATPQ
To determine whether there was any significant difference in attitude towards physics ANOVA test was run. The result are shown in Table 8.

Table8: ANOVA Table for SATPQ

group	Sum of Squares	df	Mean Square	F	Sig.
Between group	67.70	3	22.23	77.23	.000
Within group	52.01	178	0.29		
Total	119.71	181			

From the Table 8, F (3,178) =77.23, P=0.00, P<0.05. Therefore, the null hypothesis that there is no statistically significant difference in student's physics attitude scores between those who are taught through Experiential Concept Mapping Teaching and Learning Strategy and those taught using Conventional Teaching Methods was rejected.
This is in agreement with the Studies by Crawley and Black, (1990); Lyons, (2005); Nahashon, (2003); Cleaves, (2005); Munro and Elsom, (2000); Woolnough and Cameron ,(1991) that shows schools and science teachers have been identified to exert important influences on students' decisions about taking physics by providing students with enabling learning environment, interesting teaching methods and career information. The results of the study is also in agreement with findings by Changeiywo et al., (2011), who found out that if the teaching method used is not interesting leads to more students disliking physics and dropping Physics in upper secondary schools. Thus, experiential concept mapping teaching and learning strategy has proved to have positive effect on students' attitude towards physics learning and so it is an effective teaching strategy .It was therefore evident that those students exposed to ECMTLS had a more positive attitude as compared to those students under CTM.

CONCLUSIONS
The study determined effectiveness of experiential concept mapping teaching and learning strategy on attitude in physics by secondary school students in Maara, Kenya. Based on the results of ANOVA, significant differences were found between the means of groups taught using experiential Concept Mapping Teaching and learning strategy (ECMTLS) and those taught using conventional methods of teaching (CTM).The study indicated that ECMTLS was effective on students' attitude towards physics learning. Students in experimental groups that were instructed using ECMTLS have attitude improved significantly towards learning of physics as compared to their counter parts in control group that were instructed using CTM. Thus the attitude of students who were exposed to ECMTLS is statistically significance as compared to the attitude of students instructed using CTM. There was statistically significant difference in attitude when students were instructed using ECMTLS and those instructed using CTM.

RECOMMENDATIONS

Learning should be made as natural as possible with learners being allowed to be actively involved in the learning experiences so as to make learning enjoyable. Based on the finding and conclusions made in the current study, it is recommended that the use of ECMTLS be adopted for physics instruction and evaluation of education goals of physics. Due to positive influence exerted on students' attitude in physics when ECMTLS is used, massive restructuring of curriculum should be done to incorporate the use of ECMTLS on various topics in physics. Teacher training institutions should provide pre-service and in-service programs that use ECMTLS. Training sessions and professional development for ECMTLS that require concerted response from all stakeholders including school principals, school authorities and teachers should be done.

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