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Effects of Cooperative Mastery Learning Approach on Students' Motivation to learn Chemistry by Gender

Authors: Keter K. John[1], Barchok H. K[2]. & Ng'eno J. K[1].
[1]Faculty of Education and Community Studies, Egerton University, P. O. Box 536-20115 Egerton, Njoro, Kenya
[2]Faculty of Education, Chuka University, P. O. Box 109-60400 Chuka, Kenya
*Corresponding author: jkngeno72@gmail.com

Abstract
This study investigated the effects of Cooperative Mastery Learning Approach (CMLA) on students' motivation by gender in chemistry in Kenya's Bomet County. Non-equivalent control group design under quasi-experimental research was used in which samples of four co-educational district secondary schools were drawn from the schools in the County. Each school provided one Form Two class for the study. This translated to a total of 205 Form Two chemistry students. Students in all the four groups were taught the same chemistry content of the topic, Effect of Electric Current on Substances. In the experimental groups, CMLA teaching strategy was used while Conventional Teaching Methods were used in the control groups. Data was collected using Students' Motivation Questionnaire (SMQ) whose reliability coefficient was 0.82, hence suitable since it was above the 0.70 threshold. A t-test and one-way ANOVA statistical techniques were used to analyse the data. The Statistical Package for Social Sciences (SPSS) was used in data analysis. All statistical tests were subjected to a test of significance at 0.05 α-level. The findings indicate that after treatment, the level of motivation for both male and female students went up. However, there was no significant gender difference in motivation to learn chemistry. Since the level of motivation was high for boys and girls taught using CMLA compared to those taught using conventional teaching methods, it implies that the teaching approach is suitable for teaching both male and female students. CMLA enhances students' motivation to learn chemistry, therefore educators and teachers should be encouraged to use it in an attempt to improve performance in chemistry as well as bridge the gender gap that exists between boys and girls in the learning of science. In addition, teacher education institutions should make it part of their teacher training curriculum content.
Keywords: Cooperative Mastery Learning, Chemistry Learning, Gender, Motivation,

Background Information
The ultimate goal of teaching science education in secondary school is to develop members of society that are sufficiently literate and that possess relevant skills needed for technological innovations as well as meet the manpower requirements for the development of a country. Science and Technology Education (STE) is regarded as a vehicle for economic and social development in a country (Shumba, 2003). Thus without a strong base in STE, the development of a country is in shambles (Barchok, 2006).
Currently, science is perceived as something having universal value, and perhaps more importantly, an essential component of the core curriculum for all (Osborn & Wittrock, 2003). One of the prime aims of modern science education is to enhance creativity among learners (Okere, 1996). Science education should therefore develop the ability of the students to reason, understand and bring out their ability to use inventively and originally the theoretical knowledge and skills acquired. Kenya needs to develop through STE, a human resource capacity for rapid industrialization which will ensure economic growth and sustainable development (Changeiywo, 2000).
Chemistry as a branch of science offered in Kenyan secondary school curriculum is introduced to the learners for the first time at secondary school level. Chemistry has contributed tremendously to mankind in a number of ways such as improvement of health, supply of foodstuff, increased comfort, convenience and pleasure, increasing efficiency of industrial processes and reduction of dependence on natural materials (Wachanga, 2004). Although chemistry is essential for mankind, there has been a general decline in academic performance of secondary school students at KCSE level. Students in Kenya perform poorly in mathematics and sciences (Changeiywo, 2000).This is particularly the case in KCSE chemistry examinations. Results show that students' performance in chemistry compared to that of the other two science subjects is relatively low. Although Chemistry candidature has continually increased nationally in Kenya over the years, results show that there has been a general decline in performance in the subject. It is evident that the overall performance has been quite low. The highest mean score is 26.99% that was recorded in the year 2005 and the least score being 19.13% recorded in the year 2009. Perhaps, the poor performance in chemistry stems from students' lack of motivation to learn the subject or the teacher centred teaching methods used by most teachers. This calls for more research to find out exactly where the problem is and possibly find ways of improving it.
In Kenya, secondary school chemistry examinations usually test students' understanding of facts, concepts and general principles in chemistry (KNEC, 2008). The subject is tested using three papers; two of which are theory while the third is a practical paper. It has been noted that many students in Kenya have a negative attitude towards sciences as compared to art subjects; this is a common feature especially among girls (Aduda, 2003). This implies that there motivation towards chemistry is low. This is a situation that requires drastic and deliberate

action in order to motivate students towards the learning of science at secondary school level.

It has been argued that one way of addressing the difficulties students experience in Kenyan science classrooms is through appropriate teaching interventions that can be realized through professional development of science teachers (Karega, 2008). Kenya in collaboration with JICA, Japan through SMASSE has made mathematics and science subjects to become more relevant to learners, more practical and therefore more interesting, less expensive and more accessible (Kibe, Odiambo & Ogwel, 2008). Although the government has done its part, the role of the teacher in the classroom is important. The teaching approach that a teacher adopts is one factor that may affect students' motivation (Wambugu, 2006).

In an attempt to improve the teaching and learning process in science, research on teaching methods and approaches have been carried out in Kenya. Wachanga & Mwangi (2004) found out that Cooperative Class Experiment (CCE) Teaching Method facilitated students' chemistry learning. This method also increased students' motivation to learn. The Cooperative Concept Mapping (CCM) approach teaching method enhanced the teaching of secondary school biology in Gucha district (Orora, Wachanga & Keraro, 2005). A research done in teaching of physics by Wambugu (2006) using Mastery Learning Approach (MLA) revealed that students taught using the approach outshined their counterparts taught using CTM. This study will address the effects of CMLA on motivation to learn chemistry by gender. The CMLA brings together cooperative learning and mastery learning approaches to teaching. It is therefore a hybrid of the two approaches and therefore, motivated the students by not only appealing to their cognitive domain but also their affective domain irrespective of their gender.

The CMLA divides subject matter into units that have predetermined objectives. Students, in groups, work through each unit in an organized fashion. Students must demonstrate mastery on unit exams, typically 80%, before moving on to new material (Kullik et al, 1990). Students who do not achieve mastery receive remediation through tutoring, peer monitoring, small group discussions, or additional assignments (Aggarwal, 2004). Additional time for learning is prescribed for those requiring remediation. Students continue with the cycle of studying and testing until mastery is met. Block (1981) states that students with minimal prior knowledge of material have higher achievement through mastery learning than with traditional methods of instruction due to their desire to learn chemistry.

In this study the researcher adopted formal cooperative learning groups. These are groups which last for one period to several weeks to complete any course requirement and therefore appropriate for this study. Specifically, the study employed CMLA in the selected experimental groups. This CMLA is based on the fact that when students work independently they attribute their success or failure to personal effort while on the other hand cooperative goal structures require students to work together to accomplish shared goals (Ames & Ames, 1984; D'Amico & Schmid, 1997) and therefore do not simply copy the science world; rather, they construct their own meaning of it. They must therefore be provided with opportunities to construct scientific knowledge through the interaction of their observations, prior knowledge, and mental processes as well as interaction with others. The present study explored the effects CMLA on students' motivation to learn chemistry by gender.

Statement of the Problem

The poor performance of candidates in Chemistry as reflected by the KCSE Examinations results has continued to trigger a lot of concern among educationists and other stakeholders nationally and also in Bomet County over the years. This poor performance in chemistry among other factors is likely to undermine the attainment of the projected goals as envisaged in the Vision 2030 development strategic plan. A critical look at students overall performance in chemistry at KCSE national examinations results between 2005 and 2009 reveals that it has persistently continued to decline, with average scores of 26.99% in 2005 and 19.13% in 2009. The Teaching method is a crucial factor that may affect students' motivation and consequently achievement. Gender disparity in chemistry achievement is compounded by use of traditional methods of teaching and the students' lack of motivation to learn chemistry. However, what is not known is how CMLA affects motivation to learn chemistry by Gender. In an attempt to address this issue the present study explored effects of CMLA on motivation to learn chemistry by gender in selected schools in Kenya's Bomet County.

Purpose of the Study

This study was designed to investigate the effect of CMLA on Students' Motivation to learn Chemistry by gender.

Objectives of the Study

Its specific objective of the study was:

(i) To determine whether there is a difference in motivation to learn chemistry between boys and girls exposed to CMLA.

(ii) Hypothesis of the Study

(iii) The following null hypothesis was tested in this study at significance alpha level of 0.05.

(iv) H_o1 There is no statistically significant difference in students' motivation to learn Chemistry between

boys and girls exposed to CMLA

Methodology

The study involved quasi-experimental research in which the researchers used Solomon's Four Non-Equivalent Control Group Design. In this research design schools were randomly assigned to both the experimental and control groups. The design has an advantage over others since it controls the major threats to internal validity except those associated with interaction and history, maturity and instrumentation (Cook & Campbell, 1979).

The groups were organised as follows; group I received a pre-test, treatment (X) and then a post-test while group II received a pre-test and post-test. On the other hand, group III were not given a pre-test but received the treatment(X), followed by a post-test while group IV received the post-test only. This implies that the experimental groups were taught using the CMLA while the control groups were taught using the Conventional Teaching Methods.

The target population of the study was Form Two Chemistry students from co-educational schools in Bomet East and Bomet Central Sub-Counties, Kenya. The accessible population was that of form 2 chemistry students since the topic selected for study is that of Effect of Electric Current on Substances which is usually covered in form 2 as per the KIE Syllabus. Moreover, it was assumed that by the beginning of the second year in secondary school, the students have developed stable attitude towards chemistry after their exposure to the subject for one year as they prepare to select subjects based on their area of specialisation. At this level also, the students were assumed to have developed a stable internal motivation towards chemistry learning. These conditions were necessary to allow for manipulation of intervention and determine the effect of the treatment on students' gender motivation in chemistry.

A stratified random sample of four co-educational district schools was drawn from the two sub-counties out of the 52 secondary schools. The unit of sampling was secondary schools rather than individual learners because secondary schools operate as intact groups (Borg & Gall, 1989). Only co-educational district schools were sampled for the study. This was done to avoid excessive stratification that results in complexities that stem from logistics involved in handling many schools in quasi-experimental designs. To ensure the schools selected are far apart from each other, two co-educational schools were selected randomly from each of the sub-counties. This helped to minimize experimental treatment diffusion and gave rise to a total of four schools. These schools were randomly assigned into treatment and control conditions to form four groups. In the case of schools with more that one stream per class, all streams were selected for the study.

Samples of four selected co-educational district schools in the selected sub-counties were obtained. The schools in each group are shown below.

- **Table 1**
- Composition of the selected Sample

Group	Category	Label	Class Size
Group 1	Experimental group	E1	51
Group 2	Control group	C1	53
Group 3	Experimental group	E2	51
Group 4	Control group	C2	50
Total			**205**

Therefore, the sample size in the research was 205 Form Two students from 4 co-educational district secondary schools. Nkapa (1997) argues that there is no strict rule for obtaining a sample size but Fraenkel & Wallen (2000), recommended at least 30 subjects per group, hence this number was adequate for the study.

The Students' Motivation Questionnaire (SMQ) was used to collect data. The questionnaire had a total of twenty three items constructed on a five point Likert scale. MTC was measured along four dimensions: Perceived confidence, Perceived choice, Perceived interest/enjoyment and perceived pressure/tension. The items were based on the topic Effect of Electric Current on Substances which was the focus of this study. It contained 23 five-point Likert scale items which aimed at assessing the students' level of motivation to learn Chemistry using the CMLA teaching approach and the Conventional Teaching Methods. The maximum score for the SMQ was 115 and the minimum 23. The instrument was validated five science education specialists. The SMQ instrument was pilot tested in one secondary school in Narok South sub-county, which neighbors Bomet County. Cronbach's coefficient alpha was used to determine the reliability of SMQ. A reliability coefficient of 0.82 was obtained.

The SMQ administered as a pre-test to the first two groups (E1 and C1) were also scored by the researcher based on the four domains of motivation to enable the researcher understand the level of motivation of the participants before treatment. Also the SMQ administered as a post-test to all the four groups were scored to determine their level of motivation after treatment and hence the effect of the treatment on the participants level of motivation.

Consequently, the results obtained from all the questionnaires administered were coded and analysed by the researcher. Inferential statistics were used in data analysis. The hypothesis was tested using t-test and one-way ANOVA. This analysis was done with the help of Statistical Package for Social Sciences (SPSS) version 19.0. To make reliable inferences from the data, all statistical tests were tested for significance at alpha (α) level at 0.05.

Results and discussion

Determination of the effects of CMLA on students' motivation to learn chemistry by gender was carried out using a t-test on the SMQ scores based on gender. To find out whether there was any significant gender differences in the means of the two groups before treatment, an independent t-test based on gender was necessary.

Table 2: t-Test Results of the Pre-test Scores on SMQ by Gender

Gender	N	Mean	SD	St. Error	df	t-value	p-value
Male	62	20.4274	2.49113	.31637	102	.602	.549
Female	42	20.1190	2.67169	.41225			

$t_{(102)} = 0.602$, $p>0.05$

The results in Table 2 show that the mean for male students before treatment was 20.43 while that of their female counterparts was 20.12. The t-test results indicates that there was no significant difference in the means of the two groups ($t_{(102)} = 0.602$, $p>0.05$) before treatment. This, therefore, means that the groups used in this study exhibited similar characteristics before treatment and were therefore found to be suitable for the study.

To establish the effect of CMLA on gender motivation in chemistry, the post-test mean scores of the SMQ were analyzed. Table 3 shows the t-test results.

Table 3: t-Test Results of the Post-test Scores on SMQ by Gender

	Gender of respondent	N	Mean	Std. Deviation	Std. Error Mean	df	t-value	p-value
MTC	Male	64	22.2439	3.2148	.2911	100	.310	.757
	Female	38	22.0873	3.9840	.4373			

$t_{(100)} = 0.310$, $p> 0.05$

The data in Table 3 indicates that the difference in SMQ mean scores between the male and the female students were not statistically significant $t_{(100)} = 0.310$, $p> 0.05$. Male students who had a mean of 22.24 were slightly more motivated by CMLA teaching strategy by the female students who had a mean of 22.09. After treatment, the level of motivation for both male and female students went up. However, there was no significant gender difference in motivation. Therefore, both boys and girls were motivated to the same level by the teaching approach. Consequently, the null hypothesis, $H_0$1 which states that there is no statistically significant difference in motivation to learn Chemistry between boys and girls exposed to CMLA was therefore accepted.

Researches focused on gender studies have indicated that the motivation towards science education differ between males and females. A declining interest in chemistry and the under- representation of females in the chemical science was found (Banya, 2005). Self-confidence towards chemistry, the influence of role models, and knowledge about the usefulness of chemistry affect the decision of young female students about the study of chemistry (Banya, 2005). In the event of young female students finding difficulty in constructing knowledge of chemistry, self-confidence is lowered with subsequent alternation of motivation towards chemistry (Banya, 2005). Despite the studies done, and the recommendations made, the attitudes of young female students toward science and chemistry are still than positive (Banya, 2005). The present study therefore sought to find out whether there was any significant gender difference in motivation when CMLA is used in teaching.

Sex differences in motivation have been studied widely (Meece, Glienke, & Burg, 2006). In the context of academic achievement, gender role stereotypes are confirmed when motivation is studied domain-specifically, with boys being more confident and interested in mathematics and science compared to girls, while girls prefer, and feel more confident about language-related domains compared to boys. Researchers have studied whether these sex differences in motivation can predict sex differences in academic achievement. Personality and motivation play important roles in explaining sex differences in school attainment (Steinmayr and Spinath, 2008).

Many different motivational models have emerged to explain gender differences in motivation (Eccles-Parsons et al., 1983; Wigfield & Eccles, 2002). Theoretical models of achievement motivation relate this topic to future student success, learning outcomes, student choices, and student desire to engage in behaviour (Deci, Vallerand, Pelletier, & Ryan, 1991). Student's choice of academic major has its relation with their level of achievement motivation (Upadhyay and Tiwari, 2009). There are several reports that show students select their academic major based on some factors such as personality type, self-esteem and expectation (Pike, 2006; Pullmann & Allik, 2008). Ahmadi, Fathi-Ashtiani, Ghaffari and Hossein-Abadi (2009) reported that in terms of educational adjustment there was a meaningful difference between medical students and other academic majors. There are many other influencing factors that affect the selection of majors by students. These factors include interest in the major, peer pressure, family pressure, academic ability, the major's reputation, job availability, achievement motivation and others.

In addition to difference in science performance, motivation factors might underlie gender differences in educational and vocational choices. Eccles et al. Expectancy Value Model suggests that people's choices are strongly determined by their values and self-concepts of ability (Eccles et al., 1983; Jacobs & Eccles, 2002). Previous research indicates that even the males and females score equally well on standardized tests of math ability, the males hold higher self-concept of science ability and science value than females do, and males select more difficult math course than the female do (Simpkins, Davis-Kean, & Eccles, 2006). Thus, gender differences in attitudes toward science need to be closely examined.

Implications of the Study

The findings of this study indicated that the use of CMLA teaching strategy results in higher students' motivation in chemistry irrespective of gender. Based on these findings the following implications were arrived at.

i) The strategy should be incorporated into the teaching of chemistry at secondary school level. This in turn would improve students' motivation to learn chemistry and consequently achievement will be higher.
ii) Curriculum developers in their efforts to improve the effectiveness of chemistry teachers should encourage the use of CMLA.
iii) Teacher training institutions should also make the use of CMLA as part of their teacher education curriculum.
iv) The CMLA teaching strategy would be suitable for teaching both male and female students whether the school was single sex or co-educational.
v) Education authorities in Kenya should encourage chemistry teachers to use this teaching strategy and teacher education institutions to make it part of their teacher training curriculum content.
vi) If the CMLA teaching strategy is used, it would minimize the gender disparities experienced in the performance in science subjects in school.
vii) That, teachers should motivate and encourage students to work hard in order to achieve their goals. For example, teachers can motivate students to learn chemistry by showing them the value or importance of chemistry, teaching them how to set high academic goals and cultivating in them the importance of achieving these goals by working together with others in cooperative learning groups or using other motivational strategies.

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