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Bomet County, Kenya

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IMPACT OF COOPERATIVE MASTERY LEARNING APPROACH ON STUDENTS' ACADEMIC ACHIEVEMENT IN CHEMISTRY BY GENDER IN BOMET COUNTY, KENYA

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Abstract

Purpose: The study investigated the Impact of Cooperative Mastery Learning Approach (CMLA) on Students' Achievement in Chemistry by Gender in Bomet County, Kenya.

Methodology: Non-equivalent control group design under quasi-experimental research was used in which samples of four co-educational sub-county 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 subjects. Students in all the four groups were taught the same chemistry content of the topic, Effect of Electric Current on Substances for a period of five weeks. In the experimental groups, CMLA teaching strategy was used while Conventional Teaching Methods were used in the control groups. Data was collected using a Chemistry Achievement Test (CAT) whose reliability coefficient was found to be 0.78, hence suitable for data collection since the value was greater than the threshold of 0.70. One null hypothesis was stated. The data collected were subjected to statistical analysis at 0.05 α -level of significance using Statistical Package for

Social Sciences (SPSS) computer package. t-test statistics was used.

Results: The findings from the study indicate that the achievement level was high for students taught using CMLA compared to those taught using Conventional Teaching Methods (CTM). The results also indicate that there was no gender difference in achievement when boys and girls were taught through CMLA implying that the teaching approach is suitable for teaching both male and female students. This in turn will help in bridging the persistent gender gap in chemistry achievement among secondary school students.

Unique contribution to theory, practice and policy: Since CMLA enhances students' achievement in chemistry, educators and teachers should be encouraged to use it in an attempt to improve performance in chemistry. In addition, teacher education institutions should make it part of their teacher training curriculum content.

Keywords: *Cooperative Mastery Learning Approach, Chemistry Achievement, Gender Parity*

1.0 INTRODUCTION

1.1 Background of the Study

The ultimate goal of teaching science 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). One of the prime aims of modern science education is to enhance creativity among learners (Okere, 1996). 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 & Mwangi, 2004). It is one of the core science subjects that students are required to pass in order to qualify for admission into tertiary institutions to pursue science-based courses such as engineering, medicine pharmacy among others (Barchok, 2006).

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). 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). The teaching approach that a teacher adopts is one factor that may affect students' achievement (Wambugu, 2006). For this reason science educators have been advocating for science instruction at all levels that focus on enhancing students' conceptual understanding, higher levels of performance in scientific thinking, reasoning and problem solving (Osborn & Wittrock, 2003).

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). 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 addressed the impact of CMLA on students' achievement by gender in chemistry. 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.

The CMLA divides subject matter into small units that have predetermined objectives. Students work together in groups, through each unit in an organized fashion. The students must demonstrate mastery on unit exams, typically 80%, before moving on to new material (Kullik et al, 1990). Those 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.

In this study formal cooperative learning groups were adopted. 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 effect of CMLA on students' achievement in chemistry.

1.2 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. students' overall results in chemistry at KCSE national examinations results between 2005 and 2009 reveals that performance has persistently continued to decline, with average scores of 26.99% in 2005 and 19.13% in 2009 (Ligon, 2006). The Teaching method is a crucial factor that may affect students' achievement. Gender disparity in chemistry achievement is compounded by use of traditional methods of teaching and the students' lack of motivation to learn chemistry. In an attempt to address this issue the present study explored the impact of CMLA on secondary school students' achievement in Chemistry by gender in Bomet County, Kenya.

1.3 Objective of the Study

The specific objective of this study was to determine the differences in achievement in chemistry between boys and girls exposed to CMLA.

1.4 Null Hypotheses

The following hypothesis was tested at 0.05 α -level.

H₀₁: There is no statistically significant difference in achievement in chemistry between boys and girls exposed to CMLA

The conceptual framework used in this study is based on the constructivist theory of learning. In this theory, the teacher serves as a facilitator who attempts to structure an environment to enable the learner to organise meaning at a personal level (Cooper, Jackson, Nye & Lindsay, 2002). The conceptual framework was also based on the Systems Approach (Joyce & Weil, 1980), which holds that the teaching and learning process has inputs and outputs. To achieve good results then, the inputs must have suitable materials. Further, the study was based on the assumption that the blame for a students' failure rests on the quality of instruction and not lack of student's ability to learn (Bloom, 1981; Levine, 1985). The framework is represented diagrammatically in Figure 1.

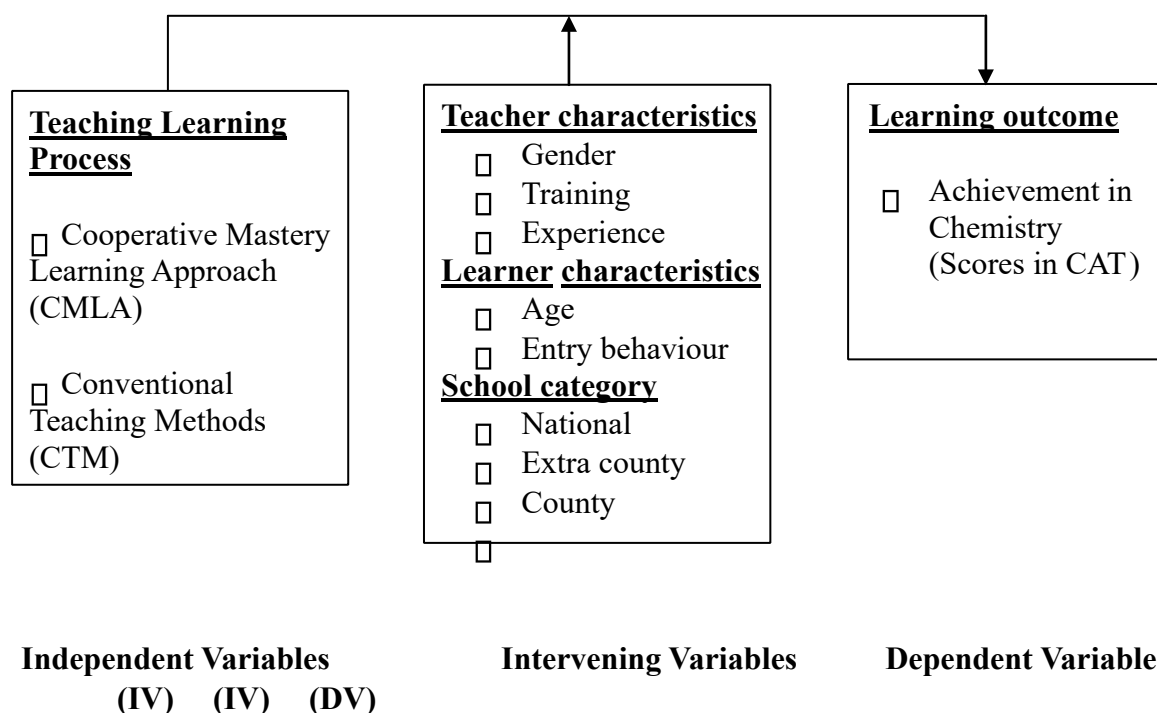


Figure 1: Conceptual Framework for determining the effect of using Cooperative Mastery Learning Approach (CMLA) on students' Achievement in Chemistry

Figure 1 shows the relationship of variables for determining the impact of using CMLA on secondary school Students' Achievement in Chemistry. Learning outcomes are influenced by various factors. These include: learner characteristics, classroom environment and teacher characteristics as shown in the figure. These are extraneous variables which had to be controlled.

Teacher training determines the teaching approach a teacher uses and how effective the teacher uses the approach. The learners' age, entry behaviour and hence their class determines what they are taught. The type of school as a teaching environment affects the learning outcomes. To control for teachers' characteristics as sources of internal invalidity, only male teachers of equivalent training and experience were chosen. The types of school selected for the study were sub-county co-educational schools to control the effect of the classroom environment. Form Two students who are approximately of the same age were involved in the study to avoid the threat of maturity to internal validity.

2.0 RESEARCH METHODOLOGY

Since the classes existed as intact groups and could not, for ethical reasons, be re-constituted for research purposes, the study used Solomon's four-group, non-equivalent control group design, shown in Figure 2, which was rigorous enough for experimental and quasiexperimental studies (Borg & Gall, 1989). This design controlled all major threats to internal validity except those associated with interactions of selection and history, selection and maturation, and selection and instrumentation (Cook & Campbell, 1979). To control for interaction between selection and interaction, the schools were randomly assigned to control and treatment groups, while that of interaction between selection and instrumentation were controlled by ensuring

that the conditions under which the instruments were administered were kept as similar as possible in all the schools (Borg & Gall, 1989; Zechmesh & Shanghnessy, 1994). The effect of Maturation was taken care of by the short time of five weeks that the study took.

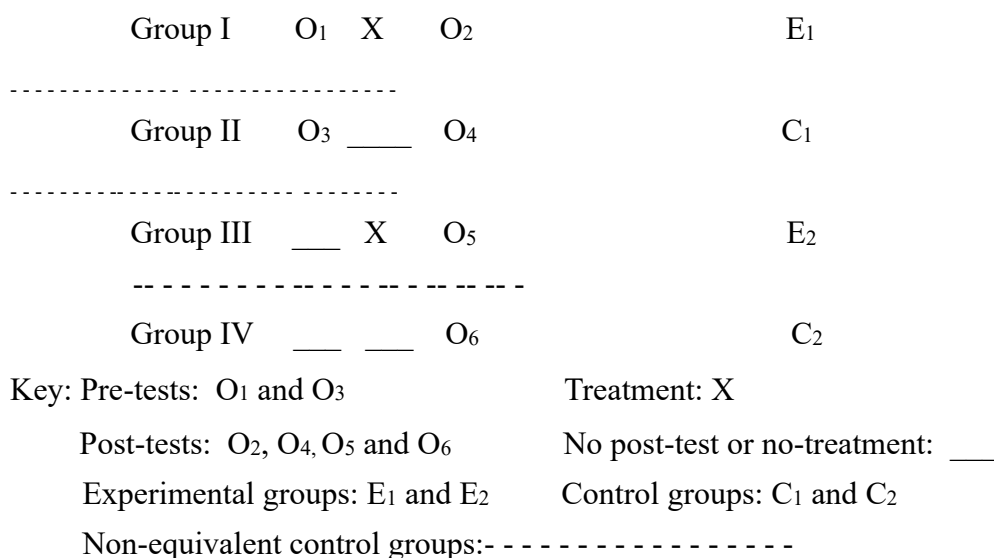


Figure 2: Solomon's Four Non-Equivalent Control Group Research Design.

Source: Fraenkel and Wallen (2000)

Group I received the pre-test, X and post-test; Group II received a pre-test and post-test; Group III was not given the pre-test but received X and post-test; and Group IV received the post-test only. Groups I and III were taught through CMLA while Groups II and IV were taught through the CTMs.

Four co-educational sub-county secondary schools were selected for the study. The four were randomly assigned to treatment and control conditions. The instructional materials used were those approved by Kenya Institute of Education (KIE) and contained descriptions of the syllabus, chemistry teachers' manual and worksheets for students. A chemistry achievement test (CAT) with 14 structured items was adapted from the Kenya National Examinations past examination papers and modified to make them suitable for the study. The test contained items to assess the students' general achievement (CAT 1) before the treatment and also the conceptual understanding of the topic; Effect of Electric Current on Substances after the treatment (CAT 2). The Kuder-Richardson K-R21 reliability coefficient obtained from a pilot test for the CAT was found to be 0.78. According to Fraenkel and Wallen (2000), a value of 0.70 or greater is considered suitable to make inferences that are accurate. Therefore, the instrument was suitable for collection of data. Before pre-tests, teachers in the experimental Groups 1 and 3 were trained for on CMLA, issued with manuals and their teaching supervised by the researcher. Students in the control Groups 2 and 4 were taught through Conventional Teaching Methods whose. A post-test was given soon after the treatment ended. For two means, a t-test was used because of its superior power in detecting differences in the treatment and control groups based on gender (Borg & Gall, 1989).

3.0 RESULTS AND DISCUSSION

Pre-Test Results

To establish whether the experimental (E) and the control groups(C) were similar at the beginning of the study; the pre-test scores of CATS were analyzed using independent sample ttest. The results are shown in Table 1.

Table 1: Independent Samples t-test of Pre-test Scores on CAT based on Gender

Variable	Gender	Mean	Std. Dev.	df	t-value	p-value
CAT	Male (N = 62)	9.69	4.36	102	1.55	0.13(ns)
	Female (N = 42)	8.38	4.06			

Table 1 shows that the pre-test mean scores in CAT for male students was ($M=9.69$, $SD=4.36$) while for female students was ($M=8.38$, $SD=4.06$), $t_{(102)}=1.55$, $p>0.05$. This shows that there was no significant difference in achievement in chemistry between male and female students. This implies that the groups used in this study exhibited similar characteristics before treatment and were therefore suitable for the study.

Post-Test Results Effects of Gender on Achievement in Chemistry when CMLA is used

To find the gender difference on achievement when students were exposed to the CMLA, the CAT post-test mean scores for male and female students were computed and then compared. The results are shown in Table 2.

Table 2: Independent Sample t-test on Post-test CAT mean scores based on gender when students are exposed to CMLA

Variable	Gender	Mean	Std. Dev.	df	t-value	p-value
CAT	Male (N = 62)	28.03	8.19	103	0.27	0.18 (ns)
	Female (N = 42)	29.59	7.86			

Table 2 shows post-test CAT mean scores ($M=28.03$, $SD=8.19$) for male students and ($M=29.59$, $SD=7.86$) for female students. The table also shows the independent sample t-test for male and female students exposed to CMLA. A comparison of the two scores using t-test $t_{(103)}=0.27$, $P>0.05$ shows that the difference in the CAT mean scores between male and female students was not significant. Therefore, these means that there was no gender difference in achievement in Chemistry at the end of the CMLA intervention. The hypothesis which states that there is no statistically significant difference in achievement in chemistry between boys and girls exposed to CMLA was therefore accepted.

Table 3 shows the mean gain between students CAT pre-test scores and post-test scores for male and female as well as the overall mean gain. These results show that both boys and girls gained from the teaching approach. This implies that the use of CMLA approach resulted in higher achievement for both boys and girls.

Table 3: A Comparison of Students' Mean Scores with their Mean Gain in the CAT

	<u>Male (N=62)</u>	<u>Female (N=42)</u>	<u>Overall (N=104)</u>
Pre-test Scores	9.69	8.38	9.04
Post-test Scores	28.00	29.59	28.80

Mean Gain	18.31	21.21	19.76
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Effect of Gender on Achievement when CMLA is used

The non-significant difference between the male and female students' academic achievement in Chemistry in this study could be due to the free interaction between male and female students in the sub-county co-educational schools used in the study. It may also be because both male and female students have equal perception of what success in chemistry is all about. In other words, the female students did not feel inferior to their male counterparts and thus they were able to compete favourably with them. It appeared that the male students did not also feel superior to their female counterparts. Thus, it implies that both have a level playing ground hence, no gender differences occurred in their achievement.

Research on gender differences in achievement for males and females has resulted in inconsistent findings. Researchers such as Nagarathanamma & Rao (2007), Kaushik & Rani (2005) and Ligon (2006) found no significant difference between boys and girls with regard to achievement level. However, earlier research done by Vermeer, Boekaerts, & Seegers, (2000) found significant difference in achievement between boys and girls.

In the present study the results indicate that there was no significant difference in achievement between boys and girls exposed to CMLA Teaching Approach but both performed significantly better than those taught through CTM. The Forum for African Women Educationists (FAWE) (1999) indicates that science achievement for girls in Kenya was lower than for boys partly due to their poor attitudes towards science and discouragement by their teachers. The CMLA Teaching Strategy helped chemistry teachers to balance classroom interaction between boys and girls enabling them to give similar attention to both sexes, which led to improved achievement by both. This teaching approach could therefore be used to bridge gender gap in achievement at KCSE chemistry examination.

4.0 CONCLUSION

The CMLA facilitates students' chemistry achievement more than the CTMs do. While using this method, gender does not affect students' chemistry achievement. There was no significant difference in achievement between boys and girls taught using CMLA. This result implies that the use of CMLA in teaching chemistry will help in improving students' achievement in chemistry irrespective of their gender.

5.0 IMPLICATIONS OF THE STUDY

The findings of this study indicated that the use of CMLA teaching strategy results in higher students' achievement in chemistry. Thus, 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. Curriculum developers in their efforts to improve the effectiveness of chemistry teachers should encourage the use of CMLA. Teacher training institutions should also make the use of CMLA as part of their teacher education curriculum.

Students taught through the CMLA teaching strategy performed better than those taught through the CTM irrespective of gender, implying that the CMLA teaching strategy would be suitable for teaching both male and female students whether the school is single sex or coeducational. Therefore, education authorities should encourage chemistry teachers to use this

teaching strategy and teacher education institutions to make it part of their teacher training curriculum content.

The achievement of girls in national examinations has been quite low as compared to that of boys. The findings of the current study indicates that if the CMLA teaching strategy is used, it would minimize the gender disparities experienced in the performance in science subjects in secondary schools.

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