Effect of Gender on Motivation in Chemistry Lessons when Students are Taught through Computer Based Cooperative Mastery Learning (CBCML) in Bomet County, Kenya

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Abstract
Chemistry occupies a central position among science subjects in the secondary school curriculum. However, the academic performance of Kenyan students in the subject in secondary schools has remained below average over the years. The fundamental challenge facing the teaching of chemistry is how to enhance students' motivation in the subject. Although Computer Based Cooperative Mastery Learning (CBCML) may help in enhancing students’ motivation to learn chemistry, its effects have not been determined in Bomet County. This was the focus of the study. Solomon Four Non-equivalent Control Group Design was used. The study sample comprised of 238 form three students from four schools purposively chosen from 21 County co-educational secondary schools in the county. The study involved two Experimental Groups taught through CBCML and two Control Groups taught through the Conventional Teaching Methods (CTM) for six weeks. A Student Motivation Questionnaire (SMQ) was administered during the pre-test and post-test. The reliability coefficient of the instrument was 0.88, estimated using Cronbach’s Alpha Coefficient. Data analysis was carried out using descriptive as well as inferential statistics. The differences between the group means were checked for statistical significance using t-test. The findings of the study showed that the students exposed to CBCML had relatively higher scores in the SMQ than those taught through CTM. Thus, CBCML enhances students’ motivation more than CTM irrespective of gender. Therefore chemistry teachers should incorporate the use of CBCML in their teaching.

Key Words: Computer Based Cooperative Mastery Learning, Chemistry, Students’ Motivation, Gender

Research Paper

Introduction
The Government of Kenya recognizes the importance of Science and Mathematics in the attainment of its vision 2030 which is to become a globally competitive and prosperous country by the year 2030 (Kerich, 2004). Apart from providing trained teachers to handle the subjects, the Government has institutionalized in-service training for science and mathematics teachers under strengthening of mathematics and science in secondary education (SMASSE). In spite of all these, one great challenge teachers are facing is how to improve
students’ performance nationally in Chemistry as its pass rates in KCSE examinations is the lowest compared to that of Biology and Physics (Barchok, 2006). Table 1 shows the overall performance nationally in KCSE for the three science subjects from 2010-2014.

**Table 1**: Students’ National KCSE Percentage Mean Scores in Chemistry, Biology and Physics from 2010-2014

<table>
<thead>
<tr>
<th>Subject</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry (%)</td>
<td>24.89</td>
<td>23.65</td>
<td>27.93</td>
<td>24.83</td>
<td>32.16</td>
<td>26.69</td>
</tr>
<tr>
<td>Biology (%)</td>
<td>29.20</td>
<td>32.44</td>
<td>27.21</td>
<td>31.63</td>
<td>29.84</td>
<td>30.06</td>
</tr>
<tr>
<td>Physics (%)</td>
<td>36.11</td>
<td>36.64</td>
<td>38.69</td>
<td>40.10</td>
<td>38.29</td>
<td>37.80</td>
</tr>
</tbody>
</table>

Source: KNEC (2014)

Table 1 shows that performance in chemistry has been generally low compared to that of the other science subjects in all the five years considered. The highest mean score is 32.16% recorded in the year 2014 and the least score being 23.65% recorded in the year 2011. However, an improvement in performance from a mean of 24.83% in 2013 to 32.16% in 2014 was noted. The results in national examinations have shown that boys perform better than girls in chemistry. Girls show poor self confidence in their ability as most of them believe that boys perform better (Vermeer, Boekaerts, & Seegers, 2000). As such their motivation to learn science has gone down over the years. Several initiatives have been undertaken to attract girls and women in science and technology education, including continuous sensitisation and lobbying of policymakers and legislators; promoting gender mainstreaming in policy and gender related programmes; incentives such as scholarship-award systems; special internships for female students; career guidance and mentoring in institutions of learning, adaptation of curricula, and interaction of teachers and parents (Ceci, Ginther, Kahn, & Williams, 2014). However, boys have continued to outperform their female counterparts in chemistry.

The fact that the candidates underperformed in practical exams shows that they had little or no exposure to practical work (KNEC, 2014). Therefore candidates must be given enough practice in qualitative and quantitative analysis before they sit for KCSE examinations. The practical paper is mandatory for a student to be considered to have passed chemistry (KNEC 2014). This requirement shows the importance attached to practical work in chemistry and science in general. Practical work plays an important role in the teaching and learning of science and chemistry in particular. Apart from helping students to gain insight into scientific knowledge, it also helps them to acquire a number of scientific skills, both cognitive and psychomotor, not to mention the motivational factors it creates among students. The concepts that the students learn in practical work are tested across all the three papers.

The theoretical aspect of chemistry presents students with concepts and principles that are abstract thus making it difficult for them to concretize. The use of practical work in chemistry teaching makes the theoretical aspect of chemistry more concrete. Practical work covers all the three domains of learning as suggested by Blooms in his taxonomy of learning objectives.
Olaewe (2005), argues that the cognitive, psychomotor and affective domains of learning cannot be isolated from each other because almost all learning activities involve more than one domain. It is with this in mind that this study was set to investigate the effects of gender on motivation in chemistry when CBCML is used in teaching chemistry.

Motivation to learn has increasingly been viewed as an integral part of education, together with cognition, in the last decades. Motivation is defined by Glynn and Koballa (2006) as an internal state that arouses, directs, and sustains students’ behaviour. In particular, motivation to learn refers to the disposition of students to find academic activities relevant and worthwhile and to try and derive from them the intended benefits (Glynn, Taasoobshirazi, & Brickman, 2009). Motivated students achieve academically by strategically engaging in behaviours such as class attendance, class participation, question asking, advice seeking, studying, and participating in study groups (Pajares, 2001).

Motivation to learn chemistry benefits all young students by fostering their chemical literacy, which is the capability to recognize chemical concepts as such, definition of some key-concepts, identifying important scientific questions, use of their understanding of chemical concepts to explain phenomena, use of their knowledge in chemistry to read a short article, or analysis of information (Shwartz, Ben-Zvi & Hofstein, 2006).

Learning, according to Taber (2009), is a personal activity and each student has to construct his or her own knowledge from it. For meaningful and effective learning to be realized, students should reflect on what is taught; develop interest on subject matter and construct new knowledge based on their understanding of the concepts. Science teaching therefore, ought to be proactive and student-centred.

Conventional Teaching Methods (CTM) of instruction focus on the mastery of content, with little development of the skills and attitudes necessary for scientific inquiry. The teacher transmits information to students, who receives and memorizes it. Assessment of knowledge typically involves one right answer. Moreover, the curriculum is loaded with many facts and a large number of vocabulary words, which encourages a lecture format of teaching (Leonard & Chandler, 2003). This kind of teaching approach encourages rote learning.

The use of CBCML in teaching chemistry aims at finding a solution to the problem of gender disparity in performance in the subject. Computer Based Cooperative Mastery Learning (CBCML) is defined as group learning activities in which computer technology is used to supplement the teaching and learning resources. It is unique in the sense that learners work together in groups to accomplish given tasks. Technology appeals to many senses hence encouraging stimulus variation and consequently meaningful learning is realized. The approach is designed to stimulate and motivate students. Eventually mastery of content is achieved by the learners (Wachanga & Mwangi, 2004).

CBCML approach to the teaching and learning of chemistry enhances meaningful learning through active involvement of the learners in hands-on activities as well as their self-determination to attain mastery of scientific concepts and science process skills. Furthermore, the shared responsibility and interaction generates better inter-group relations, and result in better self-images for students with histories of poor achievement (Joyce & Weil, 1980). Science teachers should use different strategies as there is no single universal approach for a
specific class. Lack of good strategies in the teaching of science is affecting students’ performance and in the long run affect students’ enrolment (Oladejo, Olosunde, Ojebisi, & Isola, 2011). Therefore, the use of CBCML in the teaching and learning of chemistry could be a remedy to this persistent problem of poor performance in science originating from lack of motivation to learn among the students.

Since motivation to learn has an effect on student achievement, it is crucial to investigate how gender affects students’ motivation to learn chemistry. Therefore, the purpose of this study was to determine the effect of gender on students’ motivation to learn chemistry when CBCML is used in teaching.

Statement of the Problem
The poor performance and low level of motivation to learn chemistry by secondary school students in the subject 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. The poor performance could be as a result of lack of motivation caused by Conventional Teaching Methods used by most teachers. Such methods of teaching make the learners passive during the teaching/learning process. Chemistry as an experimental science relies on the harmony between theory and practical. It should therefore be taught as such. It follows therefore that, understanding of concepts in chemistry practical chemistry assist in enhancing students’ understanding of chemistry concepts. Although gender may affect students’ motivation to learn chemistry when CBCML is used, its effects have not been determined in Bomet County. In view of this gap the study sought to determine the effect gender on students’ motivation to learn Chemistry in Bomet County, Kenya.

Objective of the Study
The study sought to find out whether gender affects students’ motivation to learn Chemistry when boys and girls are taught through CBCML.

Hypothesis of the Study
H₀₁: There is no statistically significant gender difference in motivation to learn chemistry when students are taught through CBCML.

Conceptual Framework
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 in which the learner organises meaning at a personal level (Cooper, Jackson, Nye & Lindsay, 2002). The study was also 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. In view of this Computer Based Cooperative Mastery Learning (CBCML) is likely to enhance students’ motivation to learn chemistry more than the Conventional Teaching Methods (CTM) irrespective of their gender.
Figure 1. Conceptual Framework for determining the effect of using CBCML on Students’ Motivation in Chemistry

Teachers’ training and experience were controlled by involving those who were trained at diploma or degree level and had an experience of at least three years. Learners’ gender was controlled by involving both boys and girls in co-educational schools.

METHODOLOGY

Research Design

The study used Solomon’s Four Non-equivalent Control Group Design which is rigorous enough hence appropriate for quasi-experimental studies (Wachanga & Mwangi, 2004). The design controls for all major threats to internal validity except those associated with interaction of selection and history, selection and maturation, and selection and instrumentation (Cook & Campbell, 1979). The design involved a random assignment of intact classes to the four groups. The design is shown in Figure 2.

Group 1       O₁   X   O₂                E₁
-----------------------------
Group 2       O₃   ___   O₄                C₁
-----------------------------
Group 3       ___   X   O₅                E₂
-----------------------------
Group 4       ___   ___   O₆                C₂

Key: Pre-tests:  O₁ and O₃                Treatment: X
Post-tests: $O_2$, $O_4$, $O_5$ and $O_6$  No pre-test or no-treatment: ___
Experimental groups: $E_1$ and $E_2$  Control groups: $C_1$ and $C_2$
Non-equivalent control groups: -----------------------------

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

Group 1 received a pre-test, treatment (X) and then a post-test while Group 2 received a pre-test and post-test. On the other hand, Group 3 were not given a pre-test but received the treatment (X), followed by a post-test while Group 4 received the post-test only as shown in Figure 2. This implies that in this study, Groups 1 and 3 were taught through the CBCML and therefore were the Experimental Groups while Groups 2 and 4 were taught through the CTM and were therefore the Control Groups.

Sampling Procedures and Sample Size
The unit of sampling was secondary schools rather than individual learners because secondary schools operate as intact groups (Borg & Gall, 1996). Purposive sampling was used to select secondary schools that offer computer studies in the County. This ensured that the students have the pre-requisite skills on the use of computers for learning. Form Three classes were purposively selected for the study because the topic to be covered is usually done in Form Three. The Form Three classes in the four Co-educational County secondary schools were randomly assigned to experimental and control groups.

To ensure that the four schools are located far apart from each other and to eliminate diffusion of information regarding treatment from the Experimental Groups to the Control Groups, one school was picked from each of the four sub-counties. Table 2 shows the total number of students per group used in the study.

Table 2: Assignment of sampled schools and students to the Experimental and Control Groups and distribution among the four Sub-counties

<table>
<thead>
<tr>
<th>Group</th>
<th>Type of Group</th>
<th>No. of Students (N)</th>
<th>School</th>
<th>Sub-County</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>Experimental 1 (E1)</td>
<td>59</td>
<td>1</td>
<td>Bomet</td>
</tr>
<tr>
<td>Group 2</td>
<td>Control 1 (C1)</td>
<td>60</td>
<td>1</td>
<td>Chepalungu</td>
</tr>
<tr>
<td>Group 3</td>
<td>Experimental 2 (E2)</td>
<td>52</td>
<td>1</td>
<td>Konoin</td>
</tr>
<tr>
<td>Group 4</td>
<td>Control 2 (C2)</td>
<td>67</td>
<td>1</td>
<td>Sotik</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>238</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Table 2 shows that the total number of students selected from the four sub-counties for the study was 238. According to the Solomon’s Four Non-equivalent Control Group Design used, the schools selected for use in the study represents the county as a whole.

Instrumentation
A Student Motivation Questionnaire (SMQ) was used to measure the learners’ level of motivation in chemistry before and after treatment. The researcher adopted and modified the SMQ developed and used by Barchok (2006) to suit the study. The instrument contained items on the students’ socio-background factors and psychological concept of motivation. The items were on a 5-point Likert scale ranging from Strongly Agree (SA) to Strongly Disagree (SD).
Validity
Validity refers to the extent to which an instrument measures what it is intended to measure. The SMQ was validated by the university supervisors and chemistry teachers. It was then moderated by three education specialists from the Department of Curriculum, Instruction and Educational Management of Egerton University and markers of Chemistry registered with Kenya National Examinations Council (KNEC). Comments from these specialists were used to improve the instruments and make them suitable for use in the study.

Reliability
The SMQ was pilot-tested in the neighbouring Narok West Sub-County in two selected secondary schools whose subjects were assumed to have similar characteristics with that of the sampled schools. The Cronbach’s alpha coefficient for the SMQ was found to be 0.88. According to Fraenkel and Wallen (2000), an alpha (α) value ≥ 0.7 is considered suitable to make possible inferences that are accurate.

Data Collection Procedures
The researchers sought a permit to conduct research in the sampled schools in Bomet County from the National Commission of Science, Technology and Innovation (NACOSTI), through the Board of Postgraduate Studies of Egerton University. Chemistry teachers of the experimental groups were trained on CBCML as a teaching strategy for two days and then issued with copies of Chemistry Practical Teachers’ Manual (CPTM) containing worksheets for practical work.

Data were collected in two stages during the main study. At the beginning of the study, the SMQ was administered to the Experimental Group 1 (E1) and Control Group 2 (C1) as a pre-test. This was followed by exposure of the Experimental Groups 1 and 3 to treatment which lasted six weeks. Students in the Control Groups 2 and 4 were taught through the Conventional Teaching Methods (CTM). At the end of the six-week period, the items in the instruments were re-organised and administered by the researcher as a post-test with the assistance of the chemistry teachers in the respective schools involved in the study. The researcher then scored the tests to get quantitative data to use for data analysis.

Data Analysis
The data obtained from the instruments during the pre-test and post-test assessment were coded and analysed using means and followed by a t-test. This enabled the researcher to find out whether there was any statistically significant difference between the performance of the two groups, before and after the treatment. This way, it was possible to determine the impact of CBCML on motivation to learn chemistry hence examine whether gender affects students motivation.

Results
SMQ Pre-test Results based on Gender
Group 1 and Group 2 were exposed to pre-test before the start of the intervention. To find out whether there were any significant gender differences in the SMQ means of the two groups before intervention, an independent t-test based on gender was carried out. The results of this pre-test t-test are shown in Table 3.
Table 3: Independent Sample t-test of Pre-test Scores on SMQ based on Gender

<table>
<thead>
<tr>
<th>Scale</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>df</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMQ</td>
<td>Male</td>
<td>57</td>
<td>3.86</td>
<td>0.59</td>
<td>117</td>
<td>0.410</td>
<td>0.694(ns)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>62</td>
<td>3.82</td>
<td>0.57</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ns: non-significant mean difference at p>0.05 alpha level; SMQ Maximum Score = 5

The results in Table 3 shows that the pre-test mean scores on SMQ for male students was (M =3.86, SD = 0.59) while that of female students was (M = 3.82, SD = 0.57). T-test analysis results shows that there was no significant gender difference in Motivation to Learn Chemistry between male and female students before intervention (t (117) = 0.410, p>0.05). The two groups were not significantly different at 0.05 alpha level implying that the group had comparable characteristics and therefore were suitable for use in the study.

SMQ Post-test Results based on gender
Groups 1 and 3 taught through CBCML had 57 boys and 62 girls. A t-test was conducted to investigate whether the two groups were statistically different on SMQ pre-test mean scores based on gender. Table 4 shows the independent sample t-test analysis results for the post-test scores on SMQ.

Table 4: Independent Samples t-test of Post-test Scores on SMQ based on Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>Gender</th>
<th>N</th>
<th>Mean</th>
<th>Max. Score</th>
<th>SD</th>
<th>df</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMQ</td>
<td>Male</td>
<td>57</td>
<td>4.2374</td>
<td>5</td>
<td>0.4259</td>
<td>117</td>
<td>1.302</td>
<td>0.194(ns)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>62</td>
<td>4.1640</td>
<td>5</td>
<td>0.4407</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ns: non-significant mean difference at p > 0.05 level

The results in Table 4 show that the male students had a higher mean score (4.2374) than the female students (4.1640) on the SMQ out of a maximum score of 5. The t-test results show that there was no statistically significant gender difference in Motivation to learn chemistry at the end of CBCML intervention (t(111)= 1.302, p>0.05). Thus, H_01 was accepted.

Discussion of Results
The determination of the effect of gender on motivation when CBCML Teaching Strategy is used to teach chemistry was guided by the hypothesis (H_01) of the study. Data analysis indicates that the difference in SMQ mean scores between the male and the female students before treatment were not statistically significant (t (117) = 0.410, p>0.05). The pre-test mean scores on SMQ for male students was (M =3.86, SD = 0.59) while for female students was (M = 3.82, SD = 0.57). This shows that there was no significant difference in motivation to learn chemistry between boys and girls before intervention.

Post-test analysis results show that a slight mean gain in the students' level of motivation of 0.38 for boys and 0.34 for girls was recorded. This implies that CBCML boosted the level of motivation to learn chemistry for both boys and girls. A comparison of the two scores using t-test yielded the statistic, t(111)= 1.302, p>0.05. Therefore, that there was no gender difference in Motivation to learn chemistry at the end of CBCML intervention. The hypothesis of the study was therefore accepted.
Research focused on gender studies indicate that motivation towards science differ between males and females. A declining interest in chemistry and under-representation of females in the chemical science was found (Banya, 2005). Self-confidence in chemistry, the influence of role models, and knowledge about the usefulness of chemistry affect the decision of young female students on 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 to learn chemistry (Banya, 2005). Despite the studies done, and the recommendations made, the motivation of young female students to learn science and chemistry is still a challenge (Banya, 2005). The present study therefore sought to find out whether there was any significant gender difference in motivation when CBCML is used in teaching.

Meece, Glienke, and Burg (2006) argues that in the context of academic achievement, gender role stereotypes are confirmed when motivation is studied domain-specifically. Boys are found to be 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. Other Researchers have investigated whether these sex differences in motivation can predict sex differences in academic achievement. They found out that personality and motivation play important roles in explaining sex differences in school attainment (Steinmayr & Spinath, 2008).

The major finding in this study indicates that there was no significant gender difference in motivation to learn chemistry. Wachanga (2002) argued that teachers treat boys and girls differently and in ways that often are not beneficial to girls motivation and achievement. Puhan and Hu (2006) in their study also found that motivation is an important predictor of science achievement than gender. Prokop, Tuncer and Chuda (2007) also posit that teacher characteristics have a significant role on students’ motivation to learn chemistry. This suggests that more research needs to be carried out on the role of teacher characteristics on students’ motivation to learn science.

**Conclusion**

Based on the findings of the study, gender does not affect students’ motivation to learn chemistry when they are taught through CBCML approach. Both boys and girls taught chemistry through CBCML attained similar motivation scores. This implies that CBCML would be suitable for enhancing students’ motivation to learn Chemistry irrespective of gender. It is therefore appropriate for use as a remedy for minimizing gender disparities in performance in the subject.

**Recommendations**

The results of this study show that the use of CBCML in the teaching of chemistry improved the students’ motivation to learn chemistry irrespective of gender. Based on the findings and conclusions made in this study, it is recommended that:

(i) Chemistry teachers could use CBCML in their teaching in order to enhance students’ motivation in the subject and minimise existing gender gap in achievement.

(ii) Teacher training colleges and universities could make CBCML part of their training curriculum in the teacher education programmes they offer.
(iii) Curriculum developers should include as one of the innovative teaching methods in the chemistry curriculum.
(iv) Regular in-service training in workshops, seminars and SMASSE Programme could include CBCML in the training of mathematics and science teachers.
(v) Teachers should also ensure that they create opportunities for students to share ideas through interaction with others in group tasks using computer technology or manipulation of apparatus. Such activities will engage them effectively in the lesson.

Declaration of Conflicting Interests
The Author(s) Declared No Potential Conflicts of Interest with Respect to the Research, Authorship, and/or Publication of this Article.

References


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