Effects of cooperative e-learning teaching strategy on students’ achievement in secondary school Biology in Nakuru County, Kenya

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The major concern in secondary school Biology teaching is to improve student’s achievement and interest in the subject. Strategies used in the teaching of biology have been identified as some of the factors contributing to low achievement and a negative attitude towards learning Biology. This necessitates the development of a teaching /learning strategy that would enhance learning and development of positive attitudes. The world is fast embracing technology and most countries have introduced ICT in teaching and learning. This study investigated the effects of cooperative e-Learning (CEL) teaching strategy on students’ achievement. The study was quasi-experimental and the Solomon’s Four Non-Equivalent Control Group Design was used. Four secondary schools in Nakuru County in Kenya were used and the focus was on form two students (second grade students in the secondary school cycle). Convenience sampling was used to select the four schools that participated in the study. The study involved county schools to ensure that the students participating were of comparable academic abilities. Two hundred (200) students participated in the study. The CEL intervention focused on the topic transport in animals and lasted for five weeks. The instrument that was used in this study is Biology Achievement Test (BAT) with a reliability coefficient of 0.97. Data was analysed using Analysis of Variance (ANOVA) and t-test. Statistically significant values were accepted at α = 0.05. The findings indicate that CEL enhances achievement when compared with conventional methods. The findings further indicate that CEL overcomes the gender disparity in achievement. It is concluded that CEL is an effective strategy that should be incorporated in the teaching of Biology. CEL should also be incorporated in teacher education programmes.

Key words: Cooperative learning, e-learning, achievement.

INTRODUCTION

The government of Kenya in its economic blue print that is popularly referred to as vision 2030 has set out a long term development policy of transforming the country into an industrialized, middle income economy by the year 2030. One of the key pillars identified to drive this transformation is quality and accessible education to its citizens that is globally competitive (GOK, 2007). Biology is one of the key subjects that would make a contribution towards the realization of this objective because its knowledge is applied in many sectors of the economy including agriculture, industry and medicine. In agriculture for example, it has been applied in plant breeding to produce high yielding and disease resistant crops to ensure improved food production for the ever growing population. In medicine, it has made it possible for organ transplants and disease control to ensure a healthy and productive population. In industry, it has been applied in beer brewing, bread making and milk processing. Biological knowledge has also enabled humanity to appreciate the essence of biodiversity and environmental
conservation and sustainable utilization of natural resources (UNESCO, 1986; 2004). Performance of students in sciences in Kenya at Kenya certificate of secondary examinations (KCSE) has been recording low achievement (KNEC, 2013; 2012; 2011). In the year 2012, the percentage mean scores in biology, chemistry and physics were 26.21, 27.93 and 37.85 respectively (KNEC, 2013). Girls also have been recording lower achievement in science compared to boys. In the year 2012, the percentage mean scores for girls in biology, chemistry and physics were 24.36, 25.95 and 36.22 respectively while those of boys were 27.86, 29.54 and 38.48 respectively (KNEC, 2013).

According to FAWE (1998), approaches used in teaching science subjects such as Biology have been identified as some of the factors contributing to this poor performance. Most of the teaching approaches practised in Kenyan schools are mainly expository and fact oriented, assigning a passive role to learners (Kiboss, 1997). Teachers usually act as the dispensers of knowledge while learners listen and try to understand and remember. Expository approaches cannot stand up to the challenges of the new demands and objectives of Biology education because they do not actively engage learners in authentic and meaningful learning activities. UNESCO (1986; 1996) argues that a fresh look at new teaching and learning activities. UNESCO (1986; 1996) argues that a fresh look at new teaching approaches should be taken.

Small group instruction allows students to cognitively rehearse and relate course material into existing mental schema, producing a deeper level of understanding. When peers work together, there is a great deal of modelling, cognitive disequilibration, feedback and perspective taking that emerges as students explain and receive explanations from their colleagues (Cooper and Robinson, 2002). They further assert that cooperative learning is a teaching approach where students are encouraged to work together to help one another learn. Students are placed in small groups while considering their gender and academic ability. Each individual in a group is accountable to the group’s success. This encourages members to explain difficult concepts to one another so that the group gets a good grade at the end.

The National Science Teachers Association (NSTA) (2007) of America supports and encourages the use of e-learning experiences for science students as well as for science educators engaging in professional development in the traditional, informal or distance learning environment. NSTA does not confine e-learning solely to distance-based online courses and instruction where the learner and instructor are separated by place and time, but considers the following experiences to be within the scope of e-learning: Traditional classroom instruction that incorporates the planned and effective use of collaborative and/or interactive digital tools and resources; blended learning experiences that incorporate various combinations of technology-mediated and traditional classroom instruction and distance delivered courses or programmes.

Interactive learning by using animations and simulations for abstract topics, where students become active in their learning, provides opportunities for students to construct and understand difficult concepts more easily. Appropriate simulation and applications based on simulations generally increase learning speed by allowing students to express their real reactions easily. Better designed simulations provide students opportunities to express their cognitive style and to choose from the computer screen. Complex information given to students is simplified by technology and provides them opportunities of learning by doing (Tuysuz, 2010). According to Dede, Brown-L’Bahy, Ketelhut and Whitehouse (2004), e-learning is an increasingly prevalent, viable and fully recognised strategy of teaching and learning science. NSTA gives several reasons of supporting e-learning as a component of everyone’s experience in learning science in the 21st century. First, it is seen as an effective way to more effectively provide access to certain science concepts and pedagogy when appropriate tools are incorporated for scientific observation, measurements and investigations. Secondly, it gives science educators opportunities to experience firsthand the appropriate use of technology in teaching and learning, and increase their confidence in using these tools in their own practice. Third, it meets the needs of students who have learning styles conducive to and have preferences for learning and interacting in an online environment. Fourth, it reduces the isolation of science educators, especially those in rural areas or teaching specialised science subjects by providing an expanding access to colleagues and experts. Fifth, it provides diverse learners and educators with equitable access to high-quality courses, content, learning experiences and instructors by overcoming the barriers of place and time (Linn and His, 2000). Sixth, it engages a greater number of teachers in continuous and high quality professional development. Seventh, it provides remote access via computers and networks to scientific instruments that allow students and teachers to conduct scientific investigations that might otherwise be unavailable to them (NACOL, 2008). Lastly, it provides future workers with strong skills and fluency in the convergence of media, which are critical to for success in the 21st century workplace which is becoming increasingly digital.

In view of the perceived benefits of both cooperative and e-learning, this study investigated the effects of CEL (as a hybrid teaching/learning strategy) on achievement in biology. The study also investigated whether CEL can bridge the gender disparity in achievement in biology.

**Conceptual framework**

The conceptual framework that was used to guide this
study is based on the constructivist theory of learning. Within the constructivist perspective, learning is an active process where students are actively involved in meaningful construction of knowledge. Rather than having a teacher serve as a dispenser of facts and lower level cognitive information, constructivists believe that a teacher should serve as a facilitator who attempts to structure an environment in which the learner organises meaning on a personal level (Cooper and Robinson, 2002). The study was based on the assumption that a teaching strategy that involves students actively is more likely to lead to meaningful learning as opposed to conventional methods. Figure 1 diagrammatically represents the conceptual framework that guided the study.

Learning is influenced by various factors, ranging from teacher factors, learner characteristics and teaching strategies used as shown in Figure 1. Teacher training and experience determine the teaching strategy a teacher uses. It also determines how effective a teacher will use the strategy. The study used qualified Biology teachers with a minimum of four years teaching experience to control for teacher factors. The influence of the teaching strategy on the students’ achievement in Biology was investigated. Socio-economic status of students may influence how effective they adapted to the new teaching strategy. Those from lower socio-economic status may have lacked adequate exposure to computers. To mitigate this learners were trained on the E-Learning techniques for two weeks before the commencement of the study. Only schools whose learners were already using computers were selected for the study. It is thought that students’ gender may influence their learning and subsequent achievement in Biology and hence this study addressed the gender variable.

**Purpose and objectives of the study**

This study was aimed at determining the effect of using co-operative e-learning teaching strategy on students’ level of academic achievement. The study also sought to find out if there was a gender difference in achievement when students are taught using CEL. Its specific objectives were:

i.) To determine whether there is a difference in students’ achievements in Biology between those taught using Cooperative E-Learning and those taught using conventional methods only.

ii.) To determine whether there is a gender difference in achievement in Biology when students are taught using cooperative e-learning strategy.

**Hypotheses of the study**

The following null hypotheses were tested.

\[ H_{01} \] There is no statistically significant difference in achievement scores between students exposed to cooperative e-learning and those exposed to conventional methods.

\[ H_{02} \] There is no statistically significant gender difference in achievements of students exposed to cooperative e-learning teaching strategy.

**METHODS AND MATERIALS**

This study involved quasi-experimental research. This is because there was non-random assignment of subjects to the groups since the school authorities do not normally allow the classes to be dismantled so that they can
randomly be re-constituted for the purpose of research (Wiersma and Jurs, 2005; Borg and Gall, 1996). The design that was adopted in this study is Solomon’s Four Non-Equivalent Control Group Design. The Solomon’s Four Non-Equivalent Control Group Design is as follows:

- Group I: O₁, X, O₂
- Group II: O₃, - , O₄
- Group III: - , X, O₅
- Group IV: - , - , O₆

Key: O₁ and O₃ are pre-tests; O₂, O₄, O₅ and O₆ are post-tests; X is the treatment.
- Group I (Experimental group) received pre-test, treatment X and post-test.
- Group II (control group) received pre-test and post-test only.
- Group III (Experimental group) received the treatment X and a post-test.
- Group IV (Control group) received post-test only.
Group II and IV will be taught using regular methods.

The design controls for all major threats to internal validity except those associated with interactions of selection and history, selection and maturation and selection and instrumentation (Cook and Campbell, 1979). To control for interaction between selection and maturation, the schools were assigned randomly to the control and treatment groups. The conditions under which the instruments were administered were kept as similar as possible in all the sample schools to control for interaction between selection and instrumentation (Gall et al., 1996).

Sample size and sampling procedures

Schools were used as sampling units and only county schools were used. This ensured that the students involved in the study were of comparable academic abilities. This is because the selection of students into secondary schools in Kenya is based on the Kenya Certificate of Primary Examination (KCPE) administered at end of the eighth grade (final grade in the primary school cycle). Secondary schools have been categorized as National, County and Sub County schools. Selection into secondary schools is meritorial based on overall achievement in KCPE. National schools admit the highest achievers followed by the County and Sub County schools respectively. Therefore, students admitted into each category of schools are of comparable academic abilities. A list of county secondary schools in Nakuru County was used as a sampling frame. Convenience sampling technique was used to select four schools that formed the study sample. Schools that participated in the study were those that had well equipped computer labs that gave at least a ratio of one computer to four students. This study used four groups that gave a total sample size of 200 students whose ages ranged between 15 and 16 years. Sampled schools were at least five kilometres a part to minimise experimental treatment diffusion. In schools that had more than one Form two stream, simple random sampling was used to select one stream for the study. The schools were randomly assigned to the four groups. The numbers in each group were as follows:

- Group I (Experimental group), N=42
- Group II (Control group), N=55
- Group III (Experimental group), N=45
- Group IV (Control group), N=58

The Biology achievement test was developed by the researchers and used as a pre-test. The test items were re-organised and then used as a post-test. There were 27 test items which were open ended with a total of 60 marks. The test items carried different scores ranging from 1-6. The test items tested knowledge, comprehension and application of knowledge. The test was based on the Form two topic; Transport in animals. The topic is considered one of the difficult topics in Biology (KNEC, 2013) and its abstract nature makes it amenable to computer based instruction teaching strategy. The test was validated by five experts in science education and three secondary school Biology teachers with at least five years teaching experience. The test was piloted in two secondary schools with similar characteristics as the sample schools in Nakuru County. Since the items were not scored dichotomously the reliability coefficient of the test was estimated using Cronbach’s alpha coefficient (α) (Thorndike and Thorndike, 1994). The BAT yielded a reliability coefficient of 0.97 and hence was suitable for the study (Fraenkel and Wallen, 2000).

The construction of instructional materials and their use

The researchers in collaboration with computer programmers developed an instructional module which teachers used during the treatment period. The researchers provided specific guidelines on how the module should be developed in order to achieve the stated objectives based on Kenya Institute of Education (KIE) (2003) Biology syllabus. The module was installed in computers that were used by treatment groups. Teachers and students involved were trained on how to use the module before the start of the treatment. The teachers of the experimental groups were inducted by the researchers on the skills of co-operation in learning and
TABLE 1. Independent samples t-test of the pre-test scores of BAT.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>t-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAT</td>
<td>1</td>
<td>6.53</td>
<td>2.68</td>
<td>2.87</td>
<td>0.068(ns)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5.35</td>
<td>2.43</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TABLE 2. Analysis of variance (ANOVA) results of the post–test scores of the BAT.

<table>
<thead>
<tr>
<th>Sum of squares</th>
<th>df</th>
<th>Mean square</th>
<th>F</th>
<th>P – value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>11127.92</td>
<td>3</td>
<td>3709.31</td>
<td>61.82</td>
</tr>
<tr>
<td>Within groups</td>
<td>13200.64</td>
<td>220</td>
<td>60.00</td>
<td>0.00 (s)</td>
</tr>
<tr>
<td>Total</td>
<td>24328.56</td>
<td>223</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

s = significant at p < 0.05.

Data collection

Before the commencement of the CEL Groups I and II were pre-tested. This was followed by a five week CEL intervention for the experimental groups. After the intervention, BAT was administered to all the four groups by the researchers with the assistance of Biology teachers in respective schools. The students’ pre-test and post-tests responses were scored to generate data for analysis.

Data analysis

The methods used for data analysis were one-way ANOVA and t-test which was undertaken using Statistical Package for Social Sciences (SPSS) Version 17.5. Analysis of variance (ANOVA) was used to determine whether the four groups differed significantly among themselves on variables of the study. In analysing differences between two means, a t-test was used because of its superior quality in detecting differences (Gall et al., 1996). Hypotheses were tested at a significance level of α = 0.05.

Results

Table 1 shows the pre-test BAT mean scores and the independent sample t-test results for group I and II. The results of the t-test of pre-test scores show that there was no statistically significant difference between groups I and II t (85) = 2.87, p > 0.05. This indicates that the two groups were comparable at the start of the experiment. Thus the two groups were suitable for this study.

Effects of CEL on students’ achievement in Biology

To determine the relative effects of CEL teaching strategy on students’ achievement in Biology, an analysis of students’ post – test scores in BAT was carried out. The means for groups I, II, III and IV were 30.73, 16.78, 31.26 and 18.57 respectively. One way ANOVA was used to find out whether the groups’ mean score differences were statistically significant. The results are presented in Table 2. Results in Table 2 show that there was a significant difference between the means F (3,223) = 61.82, p < 0.05. It was then necessary to carry out further tests on the group means to find out where the differences occurred (Post-Hoc tests). There are several Post-Hoc tests in use depending on the comparison of interest. Use of Bonferroni procedure with α = 0.05 for example, guarantees that the probability of any false rejection among all comparisons made is no greater than 0.05. This is a much stronger protection than controlling the probability of a false rejection at 0.05 for each separate comparison. In this study, Bonferroni Post-Hoc test was used. Table 3 presents the results of Bonferroni Post-Hoc test.

The results in Table 3 show that the pairs of BAT mean scores of groups 1 and 2, groups 1 and 4, groups 2 and 3, groups 2 and 4, groups 3 and 4 were significantly different at the 0.05 level. However, the mean scores of experimental and control groups (groups 1 and 3 and 2 and 4) were not significantly different. Therefore, the results of the experimental groups had a statistically significant difference when compared with the control groups. The results indicate that:

i.) The BAT pre-test did not interact significantly with the treatment conditions. If it was not so, the groups that took
Table 3. Post-Hoc comparisons results of the BAT post – test Mean Scores.

<table>
<thead>
<tr>
<th>(I) Group</th>
<th>(J) Group</th>
<th>Mean difference (I-J)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonferroni</td>
<td>1</td>
<td>13.95*</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>-.53</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>12.16*</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>-13.95*</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>-14.48*</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>-1.79</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>12.69*</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>.53</td>
<td>1.00</td>
</tr>
</tbody>
</table>

* = the mean difference is significant at p<0.05.

Table 4. Independent Sample t-test results of the pre–test BAT scores of Boys and Girls.

<table>
<thead>
<tr>
<th>Gender</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>t</th>
<th>df</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>50</td>
<td>7.72</td>
<td>2.61</td>
<td>3.50</td>
<td>40</td>
<td>0.00</td>
</tr>
<tr>
<td>Girls</td>
<td>37</td>
<td>4.75</td>
<td>1.66</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5. Independent sample t-test results of the post –test BAT scores of Boys and Girls Exposed to CEL.

<table>
<thead>
<tr>
<th>Gender</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>t</th>
<th>df</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>50</td>
<td>31.94</td>
<td>9.23</td>
<td>1.25</td>
<td>85</td>
<td>0.22</td>
</tr>
<tr>
<td>Girls</td>
<td>37</td>
<td>29.09</td>
<td>8.44</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

the pre-test would have obtained significantly different results from those that did not.

ii.) The pre–test did not interfere with the learning of students. This is because groups that had a pre-test and those who did not had the results that were not statistically different.

iii.) The use of CEL teaching strategy resulted in higher students’ achievement than the conventional teaching methods since groups 1 and 3 obtained scores that were significantly higher than those of groups 2 and 4. Hypothesis \( H_0 \) was therefore rejected.

Effects of CEL and gender on students’ achievement

To find out whether there was a gender difference in achievement when students were exposed to CEL teaching strategy, the BAT mean scores were analysed on the basis of gender and compared to determine whether there was a significant difference. Table 4 presents the mean scores and the independent sample t-test results of the pre-test BAT of boys and girls.

Results in Table 4 show that the difference between the pre-test BAT mean scores for boys and girls was statistically significant; \( t (85) = 3.50, \ p < 0.05 \). This, therefore, indicates that boys and girls were not at the same level of achievement in Biology at the start of the treatment. Boys had significantly higher mean achievement scores compared to that of girls. The post-test BAT means and independent sample t-test results are presented in Table 5.

The result in Table 5 show that there was no statistically significant difference between the mean scores of boys and girls after the treatment; \( t (85) = 1.25; \ P > 0.05 \). Hypothesis \( H_0 \) is, therefore, upheld. This, therefore, indicates that the use of CEL bridges the gender gap in achievement.

Discussion

The effects of CEL on students’ achievement in biology

The results indicate that students who were exposed to CEL strategy achieved significantly higher scores in the BAT compared to those taught using conventional methods. This implies that the CEL teaching strategy was more effective in enhancing student’s achievement than
the conventional methods. An earlier study conducted by Wachanga (2002) compared the effects of traditional and co-operative class experiment learning strategies on students' achievement and motivation in secondary school chemistry also found a significant difference in achievement. Students who were taught using cooperative class experiment methods were found to have higher achievement in Chemistry than those taught using traditional methods. His study is related to the current one since students were also working in small groups. In Wachanga's study, group rewards were based on the individual learning of the group members. This made students to make sure that every member of the group mastered the content in order to boost their group grade. In the present study, positive interdependence was also emphasised which made students to take more time explaining various concepts to one another. This made the CEL teaching strategy to have a positive influence in their achievement.

Arman (2013) carried out a study on the effectiveness of ICT approach on students' 8th grade achievement in mathematics in Palestine schools. He examined an experimental group of 48 students after studying a course that integrated the use of ICT in instruction. The students' achievement was examined before and after the experiment. The results indicated that there was an increase in the mean scores by a gain value of 8.94 after the ICT intervention. There was a significant difference in achievement at p = 0.05 level between the mean scores of the pre-test and post-test. Opara (2011) carried out a study in Granada, Spain titled "Inquiry methods and student academic achievement in Biology: Lessons and policy implications". The students in the control groups were taught using conventional methods (lecture) while the experimental group students were taught using the inquiry method. He found that the mean score of the students taught using inquiry was 54.3 with a standard deviation of 10.54 while the control group that was taught using conventional methods had a mean achievement score of 24.3 with a standard deviation of 4.95. The Z calculated for these means was greater than the Z critical, therefore, the null hypothesis was rejected implying that inquiry teaching method was considered to be superior to conventional methods. The researcher further asserts that students who learned in small cooperative groups in the laboratory scored higher in achievement and on several inquiry skills than did students who learned in a large classroom setting.

Khan and Inamullah (2011) investigated the effects of Student's Team Achievement Division (STAD) on academic achievement. Students studying chemistry at higher secondary level in Khyber Pukhtunkhwa (Pakistan) participated. The post-test mean scores indicated that the experimental group taught using the STAD performed better in the test than the control group taught using the traditional lecture method. In this study, the calculated t-test value (0.72) was lower than the table Value (2.07) indicating that the difference in achievement between the two groups was not statistically significant. They argued that the statistically insignificant difference might have been due to the fact that the researcher was the instructor of the course. According to FAWE (1998), one of the key factors influencing the quality of education is the quality of a teacher and the teaching carried out in the classroom. This depends on the pre-service or in-service teacher education curriculum. If a teacher education programme is flawed, the quality of teachers and teaching will also be flawed.

In the present study, teachers were carefully inducted on the skills of co-operative learning and computer aided learning. They taught their students using the new strategy on a different topic other than transport in animals for three weeks to enable them master the skills. The teachers who participated in the study had good teaching experience with the least having teaching experience of four years. Students worked in mixed ability teams and ensured that all team members learned. So, the team member's activities focused on explaining concepts to one another, helping one another practice and encouraging one another to achieve (Slavin, 1992). This, therefore, demonstrates that introduction of cooperative learning in schools with the integration of ICT may address the challenges of students' poor performance in Biology. Teacher education programmes, therefore, need to incorporate the use of ICT and cooperative learning.

The effect of CEL on the achievement of Boys and Girls

The results in this study have shown that there is no statistically significant difference between the achievement of boys and girls who are exposed to CEL teaching strategy. Evidence available indicates that boys' performance in science subjects is better than that of girls (KNEC, 2013; 2012; 2011; 2010). The CEL teaching strategy therefore appears to help overcome the gender disparity in achievement. In a study aimed at improving the participation and performance of girls in science and mathematics in primary and secondary schools in Kenya, it was reported that girls' achievement was much lower than that of boys partly due to their poor attitude towards science. It also indicated that teachers in normal competitive classes use discouraging remarks on girls' participation in learning science (FAWE, 1998).

Some teachers knowingly or unknowingly make remarks in class that discourages girls' participation in the learning of science. Some assume that girls could not answer specific types of questions that are of higher taxonomy (Wachanga, 2002). UNESCO (2004) also argues that teachers often consider girls as less intelligent and destined to less well-paid jobs than boys. Girls are also given little praise compared to boys. According to FAWE (1993), low self-esteem, poor self...
image, non-assertive behaviour among girls and poorly trained teachers contribute to their shying away from science and mathematics. FAWE further asserts that girls believe boys are more superior and intelligent and more capable of handling difficult subjects. Boys in turn perpetuate this myth by dominating in most of what they consider to be "masculine zones" such as computer rooms, science laboratories and technical equipment or engineering laboratories.

FAWE (1998) identifies insensitive teaching methods and attitudes of teachers and girls as factors contributing to poor performance of girls in science and mathematics. Many teachers, including female teachers do not believe that girls have the ability of performing as well as boys in these subjects. FAWE further argues that teachers discourage girls during science and mathematics lessons by directing only simple recall type questions to them, while posing more difficult reasoning out type of tasks to boys.

In a study by Eriba and Sesugh (2006) on gender differences in achievement in Markurdi metropolis, Nigeria, it was found that boys outperformed girls in science and mathematics achievement. Other studies have reported that males are becoming the disadvantaged gender in schools, and fewer males are interested in science (Weaver-Hightower, 2003; Omoniyi, 2006). A study by Olukemi (1998) on participation of girls in science and technology education in Nigeria shows that the cognitive power necessary for science endeavours is not foreign to girls. He further asserted that the science ability correlates highly with general intelligence in which no consistent gender differences were found. This implies that no gender has advantage over the other in science achievement. Ewumi (2011) carried out a study on gender and socio-economic status as correlates of students’ academic achievement in senior secondary schools in Ogun state, Nigeria. He found a significant relationship between gender and students’ academic achievement(r = -0.21; p < 0.05). The significant relationship indicated that the male participants achieved higher than the females. Differences in scholastic achievements of male and female are generally attributed to biological causes and cultural stereotypes (Klein, 2004). When students have opportunities to interact among themselves, a teacher and the materials, knowledge and skills are acquired and learning is real for both sexes.

A study by Afuwape (2011) investigated the relationship between students’ gender and academic performance in Basic science in Nigeria. Three hundred (300) students from public schools participated. Findings indicate no significant gender difference in achievement. However, female students were found to be slightly better with a mean score of 16.13 in basic science than their male counterparts whose mean score was 16.07. He further asserts that there are no longer distinguishing differences in cognitive, affective and psychomotor skills achievement of students in respect to gender.

Opara (2011) carried out a study on inquiry method and student academic achievement in Biology in Rivers state, Nigeria. The mean score of the male students taught using inquiry teaching method was 82.67 with a standard deviation of 6.93 while the female group taught using inquiry teaching method had a mean achievement score of 57.00 with a standard deviation of 11.00. From the analysis done on these scores, the Z calculated was 15.28 while the Z critical was 1.96. Since the calculated value was greater than the critical one, the null hypothesis was rejected. This implied that the inquiry method favoured the males more than females in Biology achievement. The researcher went further to suggest some of the reasons causing this difference including some illustrative diagrams and pictures in science books using male characters more than females as well as male role models than females which make females to take science to be a preserve of the males. Additionally, most authors of Biology text books use masculine form of pronouns as sex neutral. In this study boys and girls of mixed abilities were in equal proportions in each group. Teachers of the experimental groups were inducted on what they were to do while in class to ensure gender sensitivity and balance in participation in learning activities. Teachers were able to give similar attention and equal treatment to both boys and girls and the communication barrier between them was broken. Boys received explanations from girls while girls also received the explanations from boys. This made the performance of girls to be at par with that of boys in the study. Therefore, the gender disparity in performance in biology in the Kenya Certificate of Secondary Education (K.C.S.E.) would be addressed using CEL teaching strategy.

**Conclusion**

The following conclusions have been made from this study:

i.) The CEL teaching strategy enhances students’ learning in Biology leading to improved achievement compared to conventional methods

ii.) Gender does not affect students’ achievement in Biology when they are taught using CEL strategy. Therefore, CEL overcomes the gender disparity in achievement.

**Implications of the study**

The cooperative e-learning teaching strategy results in higher students’ achievement and overcomes the gender disparity. The strategy should therefore be used in Biology teaching at secondary school level. ICT should also be integrated in the teaching of biology because it
enhances students’ achievement and creates interest in learning. Teacher education programmes should also to the use of ICT to facilitate e-learning. Evidence available has indicated that there is a gender disparity in achievement in science subjects in national examinations. The findings in this study have indicated that CEL has the capacity to bridge this gender disparity. Teachers should, therefore, integrate ICT and use of small groups in their teaching. Teacher education also needs to incorporate CEL concepts in the teacher education curriculum to empower teachers to use this strategy. Educational administrators and curriculum developers should emphasize the use of CEL in biology lessons and, indeed, other science subjects.

REFERENCES


