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Effects of Collaborative Concept Mapping Teaching Approach on Secondary School Students' Motivation to Learn Biology in Nakuru North County, Kenya

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Abstract
This study sought to address the problem of ineffective instruction by teachers by investigating effects of Collaborative Concept Mapping Teaching Approach (CCMTA) on secondary school students' motivation to learn Biology. The study used the Solomon Four Non-Equivalent Control Group Design. The sample comprised 202 Form two Biology students in four secondary schools. The topic taught was "Gaseous exchange in plants and animals". Purposive sampling technique was used to select the four schools from which a single stream per school was selected by simple random sampling. The streams were composed of 47, 54, 55 and 46 students. The four schools were randomly assigned into two experimental and two control groups and coded as E1 & E2, C1 & C2 respectively. A Students' Motivation Questionnaire (SMQ) was used for data collection. Five educational research experts validated the research instrument. Three experienced biology teachers who are examiners with Kenya National Examination Council (KNEC) were also involved in validation of research instrument. The instrument was piloted and Cronbach's Alpha Coefficient used to estimate its reliability which was found to be 0.84. Groups E1 and C1 were pre-tested prior to the treatment. The treatment lasted three weeks after which all groups were post-tested. One-way ANOVA, t-test and ANCOVA were used to analyze the data generated. Kenya Certificate of Primary Education (KCPE) science scores for the sampled groups were used as covariates in the analysis. The results indicated that there was a statistically significant difference in motivation to learn biology between the experimental and control groups in favor of experimental groups. Students' gender had no significant effect on motivation when they were taught through CCMTA. The researchers recommend adoption of CCMTA in teaching and learning of Biology. Furthermore, the findings may help in improvement of in-service and pre-service Biology teacher education programmes.

Keywords: Collaborative Concept Mapping, Secondary School Students; Motivation to Learn Biology**.**

Introduction

Biology is one of the science subjects offered at the secondary school education cycle in Kenya. The Kenya Institute of Curriculum Development [KICD], the national curriculum development centre in Kenya has identified objectives for the four year biology course at secondary school education cycle. The objectives are that by the end of the four year biology course, learners should be able to; communicate biological information in a precise clear and logical manner, apply the knowledge gained in school to improve and maintain the health of the individual, family and the community, develop positive attitudes towards biology and the relevant practical skills, develop awareness of the value of cooperation in solving problems and acquisition of a firm foundation of relevant knowledge, skills and attitudes for further education and training in related scientific fields (KICD,2003). These objectives are a further recognition of the critical role that the knowledge of biology plays in the socio-economic development of a country. The study of biology equips learners with knowledge, skills and attitudes that are necessary for controlling and conserving the environment (KICD, 2002).

Biology is a pre-requisite for careers in health sciences, agriculture and environmental science, and is also the precursor of biotechnology which is a tool for industrial and technological development. Biological knowledge lays the foundation for commercial agriculture, the engine for economic growth in Kenya (Government of Kenya, 2003). Researchers have used biological knowledge to develop high yielding, disease resistant and fast maturing food crops and animals to meet the food requirements of an ever increasing world population (Burns & Bottino, 1989). The knowledge of genetics which is a branch of biology has revolutionalised determination of paternity disputes and identity of serious crime culprits with precision and certainty through Deoxyribo-Nucleic Acid (DNA) sequencing and profiling (Institute of Biology, 2007). Biological knowledge has contributed towards conservation of the environment and endangered species (Muraya & Kimamo, 2011; UNESCO, 1986).

Although Biology is a key science subject in secondary schools in Kenya, the Kenya National Examinations Council indicates low achievement in biology at Kenya Certificate of Secondary Education (KCSE) over the recent years (KNEC, 2014). This is an indication that mastery of biological concepts has been faced with challenges. Besides low achievement in biology, there is a worrying gender disparity in favor of boys. In Nakuru North Sub-county, achievement in biology has been lower than the national average. Among the reasons given for this is the application of ineffective teaching approaches by biology teachers, with Traditional Teaching Methods (TTM) being pre-dominant. Evidence available in the literature indicates that application of a combination of existing approaches in teaching has enhanced academic achievement and interest towards a subject (Novak & Gowin, 1984; Cicognani, 2000; Basque & Lavoie, 2006; Shihusa & Keraro, (2009**);** Smith, 2010). Table 1 gives a summary of candidates' overall performance in biology per paper for the years 2008 to 2013.

Table 1.
Candidates' Performance in KCSE Biology per Paper in 2008-2013

Year	Paper	Candidature	Max. Score	Mean Score (%)
2008	1		80	27.8
	2		80	26.4
	3		40	43.3
	Overall	274,215	200	30.3
2009	1		80	25.2
	2		80	23
	3		40	39.7
	Overall	299,302	200	27.1
2010	1		80	26.7
	2		80	23.3
	3		40	46.1
	Overall	317,135	200	29.2
2011	1		80	28.4
	2		80	29.1
	3		40	47.1
	Overall	363,817	200	32.4
2012	1		80	24.7
	2		80	25.9
	3		40	29.9
	Overall	389,523	200	26.2
2013	1		80	35.0
	2		80	28.0
	3		40	32.2
	Overall	397,319	200	31.6

Source: KNEC Report (2014)

Table 1 indicates fluctuating biology percentage mean scores for the sampled years (2008 to 2013). These scores are also below average since they range from 23% to 47.1%, a level that is far lower than 50%. A student who scores 50% is said to be of average achievement and indicates reasonable mastery of biological content and science process skills. Scores that are lower than average are regarded as weak which implies that a student who attains these grades has weak and poor mastery of the subject matter (KNEC, 2014). Such a student is regarded as having failed to attain the expected basic mastery of the subject content and skills. This has implications on future career prospects of students due to the fact that the grades that a student attains in different subjects at KCSE examination determine admission for further education and training at universities and other tertiary institutes (Muraya & Kimamo, 2011).

Paper 3 which tests practical skills has the lowest means scores. This indicates lack of mastery of biological concepts and skills hence raising concern among education stakeholders. Some of the factors contributing to low achievement in sciences at KCSE include: Students' negative attitude towards the subjects which they perceive as difficult; ineffective teaching approaches that are teacher rather than learner-centered; inadequate mastery of subject content and pedagogical skills by teachers; inadequate teaching and learning resources such as text books and laboratory equipment and apparatus (Muraya & Kimamo, 2011). In addition to low attainment in KCSE in general, there is a glaring gender disparity in favor of boys. Table 2 indicates candidates' achievement by gender for the years 2009-2013 KCSE Science Examinations.

Table 2

Candidates' Performance by Gender in the Years 2009- 2013 KCSE Science Examinations

Year	Subject	Female		Male	
		No. sat	Mean(%)	No. sat	Mean (%)
2009	Biology1	43,359	25.15	155,943	29.08
	Chemistry	149,755	17.56	179,167	20.43
	Physics	29,233	29.93	74,955	31.88
2010	Biology	148,729	26.99	166,334	31.24
	Chemistry	155,725	22.80	191,653	26.62
	Physics	29,964	33.46	79,108	35.76
2011	Biology	170,764	30.07	193,053	34.53
	Chemistry	179,645	21.47	223,462	25.42
	Physics	32,489	34.55	87,604	37.42
2012	Biology	183,595	24.36	205,926	27.86
	Chemistry	193,426	25.95	237,293	29.54
	Physics	32,295	36.22	87,329	38.48
2013	Biology	190,334	30.15	206,980	32.99
	Chemistry	200,735	23.08	239,206	26.30
	Physics	32,703	38.19	87,159	40.82

Source: KNEC Report (2014)

Analysis of candidates' performance in KCSE by gender in the Years 2009 to 2013 indicates poor performance in science subjects. Enrolment in biology suggests that it is a compulsory science subject in most schools, further highlighting its critical role in achieving socio-economic development of a country (OECD-PISA, 2003). Though enrolment for both boys and girls is almost at par in biology, achievement for boys is higher than that of girls. However, the overall achievement in the subject is poor given that the maximum score is 100%. Namasaka (2009) reported that girls attained lower scores in biology than boys at KCSE. He attributed girls' low achievement to their low motivation to learn the subject. This is the subject of this study.

Learner-centered teaching approaches promote imaginative, critical and creativity skills resulting in better achievement of instructional objectives (Ministry of Education, 2001). However, teacher-centered Traditional Teaching Methods (TTM) are pre-dominant in teaching school biology. The most widely used TTM is the Lecture Method (Taylor & Francis, 2011). UNESCO (1986) suggested adoption of teaching approaches that have the potential to motivate learners and involve them in active knowledge construction. Collaborative Learning (CL) is one such approach that engages learners in active learning where they work and learn together in small groups to accomplish shared goals (Panitz, 1996). This approach is characterized by group discussions which allow learners' expression and revision of their beliefs in the context of discourse (Sharan & Sharan, 1992; Bereiter & Scardamalia, 1993; Olson & Bruner, 1996). In CL, students explore their ideas, clarify them for themselves and to one another, expand and modify them, and finally make them their own. Collaborative Learning has positive effects on students' discussions in which they elaborate on the subject, challenge and modify one another's ideas, and thus remember these ideas more easily (Cohen, 1984). In small groups, students can share strengths, develop their weaker skills, interpersonal skills and also learn to deal with conflict. When guided by clear objectives, students engage in numerous activities that improve their understanding of a subject explored.

Concept maps are graphical tools for organizing and representing knowledge. They include concepts and relationships between them indicated by a preposition that links two concepts (Ebenezer & Conner, 1998). Concept mapping is the process of organizing concepts in a hierarchical manner from more inclusive to more specific, less inclusive concepts (Novak & Gowin, 1984). To construct a concept map, concepts have to be identified or generated and the interrelationships between them articulated. Concepts are then placed in a hierarchical order with more general concepts at the top and progressively specific concepts at the bottom. Linking a concept to another via a linking word or phrase identifies a relationship leading to a rich connectivity.

Concept mapping has been reported as effective in helping students learn meaningfully by making explicit the links between concepts (Fisher, Wandersee & Moody, 2000; Novak & Gowin, 1984). This strategy has also been reported to aid collaborative learning (Sizmur & Osbourne, 1997) and to improve students' problem-solving ability (Okebukola, 1992). The Collaborative Concept Mapping Teaching Approach (CCMTA) brings together Collaborative Learning and Concept Mapping Teaching Approaches. It is a hybridized approach of Collaborative Learning and Concept Mapping thus lending itself as a powerful tool for science education. This approach is therefore likely to motivate learners by bringing in the benefits of concept mapping and collaborative learning. A relationship exists between motivation, cognitive engagement and conceptual change thus; learners who are highly motivated engage themselves more actively in learning activities which would also translate to high achievement (Nelson, 2000).

Statement of the Problem

Studies have shown that Concept mapping and collaborative learning are individually useful for instruction and diagnosis of students' misconceptions by facilitating meaningful learning and enhanced cognitive gain (Kinchin, Hay & Alan, 2000; Novak, 1990; Okebukola, 1992). However, it is not clear how a hybridized CCMTA would enhance meaningful learning of biology among secondary school students in Nakuru North Sub-county, Kenya. This study aimed at investigating the effects of CCMTA learners' motivation to learn biology.

Purpose of the Study

The purpose of this study was to find out the effects of CCMTA on students' motivation to learn biology in public secondary schools.

Objectives of the Study

This study was guided by the following objectives

(i) To compare students' motivation to learn biology between those taught through CCMTA and those taught using the TTM.
(ii) To find out whether there is a gender difference in students' motivation to learn biology when exposed to CCMTA.

Hypotheses

The following null hypotheses were tested during the study;

Ho_1: There is no statistically significant difference in motivation to learn biology between students taught using CCMTA and those taught using the TTM
Ho_2: There is no statistically significant gender difference in the level of motivation to learn biology among learners exposed to CCMTA

Conceptual framework

Figure 1 indicates the effect of CCMTA on learners' motivation to learn biology in secondary schools in Nakuru North Sub-county. However, there were intervening variables that could have affected both the independent and the dependent variables as indicated.

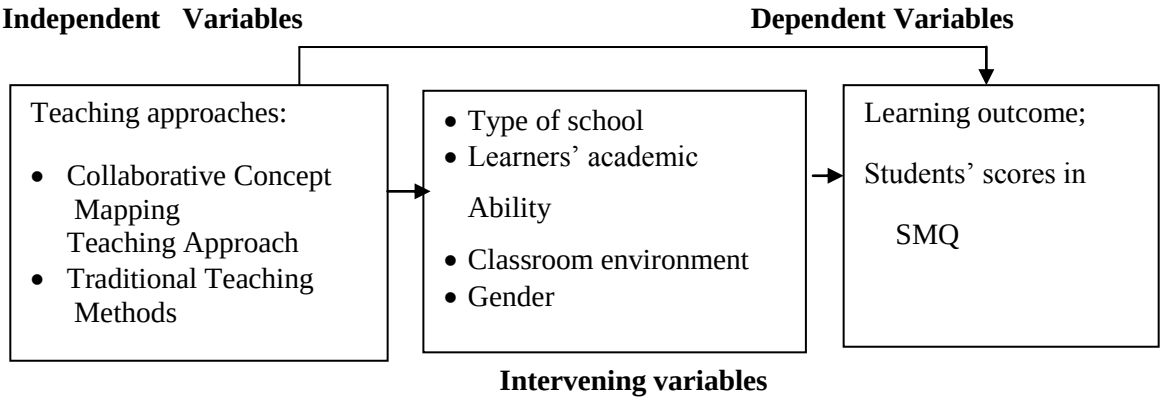

Fig.1: Conceptual Framework on Effect of CCMTA on Student's Motivation to learn Biology.

Figure 1 indicates independent variables as Collaborative Concept Mapping Teaching Approach and the Traditional Teaching Methods. The dependent variable is learners' Motivation to learn biology. In an ideal situation, the teaching method may affect learners' motivation to learn. However, various intervening variables such as class room environment, type of school and learners' academic ability may affect the expected outcome.

Gender was built into the study as a moderating variable that affects the association between independent and dependent variables (Baron & Kenny, 1986). To control for classroom environment, the study involved co-educational schools where boys and girls learn together in the same classroom. Type of school was controlled by involving Sub-county secondary schools because they enroll learners of comparable academic ability.

Research design

The study adopted the Solomon's Four Non-Equivalent Control Group design. This is a quasi-experimental design that is considered sufficiently rigorous and appropriate for quasi-experimental studies (Fraenkel & Wallen, 2000). It assesses the plausibility of pretest sensitization effects, that is, whether the mere act of taking a pretest influences scores on subsequent test administration (Clark & Elen, 2006). It also ensures the administration of pre-test to two groups and post-test to all the four groups (Gall, Borg & Gall, 1996; Wachanga & Mwangi, 2004).

Quasi-experimental design was considered ideal for this study because participants were already constituted into intact classes hence it was not ethical to randomly select them individually for experimental purposes (Gall *et al*, 1996; Trochim, 2006). Besides, school administrators normally do not allow breaking of classes for random assignment of learners into groups for experimental purposes. An important component of the quasi-experimental study is the use of pre-testing or the analysis of prior achievement to establish group equivalence. The Solomon Four Non-equivalent Control Groups Design is represented in Figure 2.

Group I (E1)	O1	X	O2
Group II (C1)	O3	C	O4
Group III (E2)	-	X	O5
Group IV (C2)	-	C	O6

Figure 2: Solomon Four Non-Equivalent Control Group Design (Source: Best & Kahn, 2003)

Solomon Four Non-Equivalent Control Group Design has been used successfully in studies to determine the effect of teaching approaches on student achievement in Kenya (Wambugu & Changeiywo 2008; Wachanga & Mwangi, 2004; Keraro, Wachanga & Orora 2007). In this study, the symbols proposed by Wiersma (2000) were adopted. Groups I, II, III and IV were co-educational schools randomly assigned to experimental and control groups. O1 and O3 were pre-tests while O2, O4, O5 and O6 were post-tests.

X represents the treatment variable which in this study was the Collaborative Concept Mapping Teaching Approach, while C represents the control condition which in this study was Lecture Method. The dotted line between groups 1, 2, 3 and 4 indicates that the groups used in this study existed as intact groups and therefore there was no randomization of students when establishing the treatment and control groups. Groups I and III were the experimental groups that received treatment (X) while group II and IV were the control groups that were kept under the control condition (C). Groups I and II were pre-tested (O1 and O3) while groups III and IV were not pre-tested. All the four groups were then post tested (O2, O4, O5 and O6) at the end of the three weeks treatment period.

Solomon Four Non-Equivalent Control Group Design is designed to deal with a potential testing threat which occurs when the act of taking a test affects how people score on a retest or post tests (Trochim, 2006). The treatment and control groups were situated in different schools to avoid contamination hence control reactive effects of experimentation since learners were less aware of being subjected to experimental treatment (Koul, 1984).

Location of the study

This study was carried out in Secondary Schools in Nakuru North Sub County. Nakuru Count**y** is located in the former Rift Valley Provinceof Kenya, about 165 km to the North of Nairobi. It borders 7 (seven) Counties namely: Laikipia to the North east, Kericho to the West, Narok to the South West, Kajiado to the South, Baringo to the North, Nyandarua to the East and Bomet to the West. The approximate area of Nakuru County is 7,496.5 km^2. It is easily accessible from Nairobi by road, a journey that takes about three hours. Nakuru North Sub County is one of the eleven sub counties that constitute Nakuru County. These include; Nakuru Town East, Nakuru Town West, Bahati, Rongai, Subukia, Kuresoi North, Kuresoi South, Gilgil, Naivasha, Njoro and Molo.

This study location was purposely selected because the Sub County has consistently posted poor results in KCSE science, especially biology. There is also a clear gender disparity in achievement in

favor of boys in the Sub County. The Sub County is cosmopolitan with a large number of public secondary schools attended by most students.

Target and accessible population

The target population in this study was secondary school students in Nakuru North Sub County, Kenya while the accessible population was Form Two Biology students in the sub county. Form two students were considered appropriate for this study because they have been exposed to the secondary school science curriculum for one year hence are considered to be adjusted to secondary school curriculum. Biology is offered as a compulsory subject in form one and two in Kenyan public secondary schools.

Sample size and sampling procedure

The sampling unit was the secondary schools and not individual students since secondary school learners operate as intact groups (Gall *et al*, 1996). Each School was therefore treated as a group. The study used Sub County secondary schools because a majority of students attend these schools. A list of 56 Nakuru North Sub County secondary schools was obtained from the Sub-County's Director of Education Office and used as a sampling frame. Out of the 56 schools, 19 were co-educational. Purposive sampling technique was used to select four co-educational schools that offer biology. This technique allowed application of the researchers' expert judgment based on prior experience to select the participants with desirable information (Mugenda & Mugenda, 2003).

A total of 4 biology teachers and 202 form two students were involved in this study. The total number of students per stream was 47, 54, 55 and 46 respectively. In schools that had more than one form two stream, simple random sampling was used to pick one stream to provide the four groups for the study. The four schools were randomly assigned to treatment and control groups to control for interaction between selection and maturation (Best & Kahn, 2003). However, biology teachers in the experimental schools were encouraged to expose all the students in form two to CCMTA for ethical reasons, but only data from the sampled class was analyzed in this study.

Instrumentation

The instrument used in this study was the Students' Motivation Questionnaire (SMQ). It was used in assessing students' motivation and interest to learn biology and was based on Keller's ARCS motivation theory (Hohn, 1995; Kiboss, 1997). It contained 50 five point likert- type items designed to find out students' opinion and perception of Biology and the strategies used for instruction. The SMQ was used to measure students' motivation and interest towards Biology when they were taught using CCMTA. Students' motivation is a good indicator of effort and devotion in studying the subject and it is an important factor in determining achievement (Nitcher, 1984). The 50 five point likert- type items that were used to generate data on students' motivation to learn biology were scored as follows; SD (1), D (2), U (3), A (4), SA (5). A higher number on the scale represented agreement with the item on the scale and a more favorable disposition of that item. Such scale scoring was consistent with typical scale interpretations in Kenya's education system where, in normal ranking or in rating candidates on achievement measures, larger numbers represent higher and desirable achievement and smaller numbers represent poorer and undesirable achievement (Namasaka, 2009).

In this study, motivation was taken to be a measure along a continuum ranging from strongly negative effect to strongly positive effect. In analyzing the data, an item such as "learning biology course by applying the concepts learnt to real life situation made me feel as if I was wasting time" had the scores reversed since "strongly disagree" would reflect a high positive effect toward Biology. The SMQ was pilot-tested in the same school as BAT in order to determine its reliability coefficient. It was validated by five experts in educational research and three experienced teachers of secondary school biology. The SMQ had two sections; section 1 captured students' bio data while section 2 contained items for measuring motivation. Student's admission number, gender, age and study group

constituted bio data. Since students' names were omitted for confidentiality, admission numbers were used to match pre- and post-test scores during data analysis.

Validation of research instrument
Before pre-test, theSMQ was validated by five experts in educational research. Three experienced biology teachers who are examiners with Kenya National Examination Council (KNEC) were also involved.

Reliability of research instrument
To estimate reliability of the SMQ, it was pilot tested in two secondary schools that were not part of the study but with similar characteristics as the sampled schools. Cronbach's alpha Coefficient was used to estimate reliability of SMQ (Popham, 1990). Gall *et al,* (1996) consider this technique appropriate for rating scale items on which different scoring weights are assigned to different responses (SMQ scores range from 1-5). Test items in SMQ yield a range of scores and the tool was administered only once. It had a reliability coefficient of 0.84. This value is considered suitable to make group inferences that were accurate enough (Fraenkel & Wallen, 2000).

Development and use of instructional materials
The instructional materials used in this study were based on the KIE approved biology syllabus (KICD, 2003). They include; CCMTA teacher's manual, a form two biology teachers' guide, lesson plans on topic "Gaseous exchange in plants and animals".

CCMTA teacher's manual and teacher's guide
A CCMTA teacher's manual was developed based on the revised KIE biology syllabus for secondary schools, and used throughout treatment period. Teachers of experimental groups were trained on skills of collaborative concept mapping for one week. They taught sampled groups using CCMTA on a different topic other than Gaseous exchange in plants and animals for one week to enable them master the skills. After this, pre-test was administered to groups E1 and CI. Control groups were taught using TTM. Soon after intervention period, post-test was administered to all the groups.

For ethical reasons, all form two streams in experimental schools were taught using CCMTA and only data from the sampled class considered for analysis. Form two biology teachers' guide was used to guide teachers on recommended style of content delivery and students' learning activities. It also indicated the scope of content coverage to ensure compliance with the Revised Secondary School biology syllabus (KICD, 2003).

Data analysis
Table 3 gives a summary of statistical methods that were applied for hypotheses testing.

Table 3
Summary of Methods used to Test Hypotheses

Hypotheses	Independent variables	Dependent variables	Statistical tests
Ho1: There is no statistically significant difference in Motivation to learn biologybetween students taught using CCMTA and those taught using the TTM.	• CCMTA • TTM	• Post-test • Motivation score in SMQ	• One-way ANOVA • ANCOVA

Ho2: There is no statistically significant gender difference in the level of motivation to learn biology among students exposed to CCMTA.	• CCMTA	Motivation scores in SMQ	• t-test • ANCOVA

Results and Discussion

Pre-test results

Solomon Four Non-equivalent Control Group Design was used in this study. This design enabled the researchers to have two groups sit for the pre-test

The entry behavior of students on SMQ was analyzed. Comparison of the mean scores of groups E1 & C1 using the t-test was done and the results are presented in Table 4.

Table 4

Independent sample t-test of pre-test scores on SMQ

Group E1, N=52; Group C1, N=50, Male=44; Female=56

Variable	Group	Mean	SD	df	t-value	p-value
Teaching approach	E1	3.16	0.50	100	0.563	0.574
	C1	3.22	0.55			
Gender	Male	3.23	0.53	98	0.820	0.414
	Female	3.14	0.52			

Results in Table 4 reveal that the mean score of E1 (M=3.16, SD=0.50) was lower than that of C1 (M=3.22, SD=0.55). However, the difference between the two means was not statistically significant at 0.05 level since t (100) =0.563, p>0.05. This implies that the two groups exhibited comparable characteristics as measured by SMQ and were thus considered suitable for the study.

Results in table 4 also reveal that the mean score of male students (M= 3.23, SD= 0.53) was slightly higher than that of their female counterparts (M=3.14, SD=0.52). The difference between the means by gender was, however, not statistically significant at the 0.05 level since t (98) =0.820, P=0.414. This implies that motivation of male students towards biology was comparable to that of their female counterparts. These results show that E1 and C1 were similar on SMQ at the point of entry. The groups were therefore considered suitable for the study.

Effects of CCMTA on student's motivation to learn biology

The aim of hypothesis one (Ho_1) of the study was to examine the effect of CCMTA on students' motivation to learn biology. The hypothesis stated that there was no statistically significant difference in motivation to learn biology between students taught using CCMTA and those taught using the TTM. The post-test SMQ mean scores were obtained through administration of motivation questionnaires. These scores were analyzed and used to find out the effects of CCMTA on students' motivation to learn biology.

Results of SMQ post-test mean score analysis

The SMQ post-test mean scores were analyzed to determine the relative effects of CCMTA on students' motivation to learn biology. This was done using one-way ANOVA and post hoc multiple comparisons test. The results are presented in Tables 5 &6 respectively.

Table 5

SMQ Post-test Group Mean Scores Analysis

Group	N	Mean score	SD
E1	52	3.82	0.71
C1	49	3.48	0.50
E2	51	3.78	0.25
C2	47	3.38	0.67

The results in Table 5 indicate that the mean scores of treatment groups E1 (M= 3.82, SD=0.71) and E2 (M= 3.78, SD= 0.25) were higher than those of the control groups C1 (M= 3.48, SD=0.50) and C2 (M=3.38, SD=0.67). To establish whether the differences among the mean scores of the groups were significant, ANOVA test was conducted and results presented in Table 6.

Table 6

ANOVA Results of the post-test scores on SMQ

Scale	Sum of squares	df	mean squares	F-ratio	p-value
Between groups	7.019	3	2.340	7.427	0.000*
Within groups	61.428	195	0.315		
Total	68.447	198			

The results in Table 6 reveal that the difference in SMQ post-test mean scores among the four groups is significant since F(3, 195)= 7.427; p< 0.05. The Bonferroni post hoc multiple comparisons test was done to determine between which means significant differences occurred. The results are shown in Table 7.

Table 7

The Post hoc Pair wise multiple comparisons test on SMQ post-test mean scores

	(I) Group	(J) Group	Mean difference (I-J)	p- value
Bonferroni	E1	C1	0.34	0.028*
	E1	E2	0.41	0.987
	E1	C2	0.44	0.002*
	E2	C2	0.40	0.008*
	C1	E2	0.30	0.032*
	C1	C2	0.10	0.862

The results in Table 7 reveal that there were significant differences between the group pairs; E1 &C1 (p= 0.028), E1& C2 (p= 0.002), E2 & C2 (p= 0.008) and E2 & C1 (0.032). No significant differences were found between groups E1 & E2 (p= 0.987) and C1& C2 (p= 0.862). There is no statistically significant difference when one treatment group is compared to another treatment group or when one control group is compared to another control group. This observation is attributed to positive effect that CCMTA has on learner motivation. The ANCOVA test was conducted to establish whether adjusted SMQ post-test mean scores were significantly different at the 0.05 level. Results of this analysis are shown in Table8.

Table 8

ANCOVA Results of SMQ post-test mean scores

Scale	sum of squares	df	Mean square	F-ratio	P-value
Contrast	6.267	3	2.089	6.654	0.000*
Error	59.334	189	0.314		

The results in Table 8 show that the differences among mean scores of the E1, C1, E2 and C2 were statistically significant at the 0.05 level, F (3,189) =6.654, P<0.05. To establish where the differences were, Bonferroni Post hoc pair wise multiple comparisons test was carried out and the results are presented in Table 9.

Table 9

Bonferroni Post-hoc Pair wise Multiple Comparisons test results of the Post-test SMQ Mean scores of the four groups

Group (I)	Group (J)	Mean difference (I-J)	P-values
E1	C1	0.22	0.036*
E1	E2	-0.19	0.231
E1	C2	0.27	0.043*
C1	E2	0.41	0.001*
C1	C2	0.05	0.690
E2	C2	0.46	0.000*

The results in Table 9 reveal that there were statistically significant differences between groups E1 & C1 (0.036), E1 &C2 (0.043), C1 &E2 (P=0.001) and E2&C2 (P=0.000) at 0.05 level. However the differences between E1 &E2 (p=0.231), and C1 &C2 (P>0.05) were not significant. This confirms that CCMTA has superior qualities which affect learner motivation positively as opposed to TTM applied to control groups.

These results indicate that,

i. The SMQ pre-test did not interact significantly with treatment conditions. This is because there was no significant difference in SMQ mean scores between Group E1 and C1, both of which took the pre-test.
ii. The use of CCMTA resulted in higher students' motivation than the conventional teaching approaches since Group E1 and E2 obtained scores that were significantly higher than the other groups on SMQ. Hypothesis Ho1 is therefore rejected.

Motivation of boys and girls exposed to CCMTA

The SMQ mean scores for boys and girls were analyzed and compared to find out if there was significant difference between them. Table 21 shows the post-test SMQ mean scores for boys and girls exposed to CCMTA.

Table 10

Post–test SMQ Mean Scores for Boys and Girls Exposed to CCMTA

Gender	N	Mean	Std. Deviation
Boys	39	3.72	0.59
Girls	62	3.83	0.49

Results in Table 10 reveal that girls attained a slightly higher mean score (M=3.83, SD=0.49) than boys (M=3.72, SD=0.59). An independent sample t-test was conducted to find out whether the observed difference was significant. The results are represented in Table 11.

Table 11
T-test results of Post-test SMQ Mean Scores for Boys and Girls Exposed to CCMTA

Gender	N	Mean	SD	df	t-value	p-value
Male	39	3.72	0.59	99	1.027	0.307
Female	62	3.83	0.49			

Results of Table 11 indicate that there is no significant gender difference in motivation when students are exposed to CCMTA, t (99) = 1.027, p > 0.05. This indicates that the difference in SMQ post-test means is not statistically significant. Therefore, both boys and girls were motivated to the same level by the teaching approach. Therefore, Hypothesis Ho_2 is accepted.

Discussion

The effects of CCMTA on students' motivation in biology

The results of this study indicate that CCMTA resulted in higher student motivation than the traditional teaching approaches. This is probably because the approach emphasized active participation of learners in the learning process. This may have led to meaningful understanding of concepts in biology arising from enhanced thought process triggered by the procedures involved in CCMTA. Enhanced achievement in tasks as learners engaged in group activities may have increased their confidence and motivation in knowledge construction as they solved problems in biology.

These findings are consistent with those of previous researchers such as Keraro, Wachanga & Orora (2007). In their study on Effects of Cooperative Concept Mapping Teaching Approach on Motivation of students in biology, they reported significantly higher motivation among students exposed to CCM than those taught through regular methods. Their results further indicate that there is no statistically significant gender difference in motivation towards the learning of biology among secondary school students exposed to CCM. In this study, boys and girls of mixed abilities were placed together in different groups and all were treated equally by their teachers. Every student was given an equal chance to contribute during the biology lessons. When students exchange ideas with one another in the group, new concept become clearer, are retained in memory and connected to what the learner already knows. This enhances achievement and motivation to learn (Ajaja, 2013).

An earlier study by Slavin (1997) reported that provision of group goals based on the individual learning of all group members might affect cognitive processes directly, by motivating students to engage in peer modeling, cognitive elaboration, and/or practice with one another. Group goals may also lead to group cohesiveness, increasing caring and concern among group members, making them feel responsible for one another's achievement, thereby motivating students to engage in cognitive processes which enhance learning. Group goals may motivate students to take responsibility for one another independent of the teacher, thereby solving important classroom organization problems and providing increased opportunities for cognitively appropriate learning activities.

In contrast, regular teaching approaches such as lecture method assumes that a teacher is the source of knowledge and reduces learners to passive recipients of this knowledge. A teacher takes charge of the learning process while learners compete for grades, taking no responsibility over each other's learning. In such situations, slow learners are disadvantaged as a teacher is tempted to move at the pace of fast learners. CCMTA offers learners a chance to apply knowledge gained in real life situations through emphasis on hands-on experience in knowledge construction in collaborative groups. Since the major objective of science instruction is to enable students learn effectively, the most appropriate approaches for teaching and learning biology should be those that enhance learner achievement and motivation, such as CCMTA. These approaches will however be most effective only if the laboratory facilities for science teaching and learning are available in schools. Where laboratory facilities for biology teaching and learning are not available, a better alternative to the lecture method

remains concept mapping since the method does not essentially demand the use of laboratories for practice (Ajaja, 2013).

However, before the adoption of the method as an appropriate instructional approach, both teachers and students should be well trained to acquire the skills necessary for its use. The efficient acquisition of the skills necessary for its use both by biology teachers and students will reduce the limitations associated with the approach. The findings of this study and reviewed literature indicate that the use of Concept Mapping Teaching Approach combined with other approaches leads to enhanced learner motivation.

Effect of gender on motivation of students taught using CCMTA

The results of this study indicate that there is no statistically significant gender difference in the level of motivation to learn biology among boys and girls exposed to CCMTA. This indicates that both girls and boys were equally motivated to learn biology during the treatment period. An earlier study by Keraro, Wachanga and Orora (2007) found no significant difference in motivation to learn biology among secondary school students exposed to Cooperative Concept Mapping Instructional Approach. In their study on Effects of Cooperative Mastery Learning Approach on Student's Motivation to Learn Chemistry, Keter, Barchok and Ng'eno (2014) found no significant gender difference in motivation to learn chemistry. The above findings concur with this study and imply enhanced academic abilities in girls especially in science subjects that were previously viewed as a domain of male students.

Previous study by Changeiywo, Wambugu and Wachanga (2009) indicate that students exposed to Mastery Learning Approach (MLA) have significantly higher motivation than those taught through regular methods. Gender has no significant influence on their motivation to learn physics. The researchers conclude that MLA is an effective teaching method in motivating students. However, results of earlier study by Shihusa and Keraro (2009) on Use of Advance Organizers to Enhance Students' Motivation in Learning Biology indicate significant gender difference in motivation to learn biology in favor of boys. This seems to contradict earlier studies that show girls having more positive attitudes towards biology hence have higher motivation to learn. One of possible reasons for this scenario is the preferential treatment teachers give boys as opposed to girls and which end up de-motivating girls and curtailing their learning (Wachanga, 2002).

Since motivation is an important predictor of achievement in science, measures need to be taken to develop and implement novel teaching approaches that eliminate gender bias and enhance positive teacher characteristics that will promote teaching of science subjects. This will eliminate perception of science subjects as being difficult especially to the girls. In this study, all students were actively engaged in group activities that involved construction of concept maps during which concepts were discussed and elaborated among the group members. This enhanced mastery of content leading to meaningful learning. The new method (CCMTA) enhanced girls' confidence in learning biology especially in co-educational schools.

Conclusions

The findings of this study provide the evidence that CCMTA is a viable strategy to enhance students' motivation to learn biology. The conclusions drawn from the findings of this study are that Students who are taught Biology through CCMTA acquire higher motivation than those who are taught through TTM. Furthermore, Gender does not affect student's motivation when they are taught Biology through CCMTA.

Implications of the findings

The evidence elicited by findings of this study implies that gender has no effect on the positive influence that CCMTA has on motivation to learn biology. The approach is therefore likely to assist in improving the achievement of girls which has been low as compared to that of boys at KCSE. Their

improved performance would lead to better representation of girls in science based occupations. This would go a long way in assisting Kenya achieve the goals of vision 2030. CCMTA can make girls to be equally motivated towards learning biology as boys thereby assist them overcome their negative attitude towards science subjects. The superiority of CCMTA over the regular teaching method can be attributed to the fact that it is an integration of two learning approaches (collaborative learning and concept mapping). The strength of CCMTA is in the elements of collaborative learning that make students develop a positive attitude towards self and learning in general. As learners work in collaborative groups, they teach one another and also learn to be responsible for one another.

In concept mapping, learners engage in knowledge consultation and discover new ways of linking concepts thus enhancing their cognitive abilities. This improves learner confidence and determination which in turn enhances their motivation to learn biology. CCMTA may therefore assist in enhancing the objectives of teaching biology in Kenyan secondary schools. The Ministry of Education should encourage biology teachers to use CCMTA for more effective teaching that enhances understanding of concepts and discourages rote learning.

The use of CCMTA is however quite demanding on both teachers and students. CCMTA requires that students assume greater responsibility in negotiating and shaping knowledge within social groups by engaging in rich discussions amongst themselves. They have to be involved in organization of learning situations, setting instructional objectives, gathering content and are individually engaged with the concept mapping activity. Teachers on the other hand require ample time to prepare for lessons. They act as facilitators to coach, mediate, prompt and help students in understanding content. They also assess the level of understanding of learners.

Recommendations

Competence in the application of effective teaching methods stands as a major challenge in teaching of biology. Teachers require skills to enhance both theoretical and practical teaching of biology so as to motivate learners and impart skills and attitudes for use in everyday life. The findings of this study strongly suggest that CCMTA should be introduced in both teacher education and in teaching of secondary school biology to supplement existing approaches. This will assist in overcoming challenges that lead to low achievement in biology at KCSE. This approach has been proved useful in addressing gender disparity in secondary school course since both boys and girls seem to draw equal benefits in terms of motivation. Based on the findings of this study, the following recommendations have been made;

i. CCMTA has shown that it can enhance students' motivation in biology. It should therefore be adopted to supplement existing approaches to improve the teaching of biology.
ii. Students should be encouraged to practice use of CCMTA through contests, symposia, science club activities and science congress with the aim of inculcating science process skills in order to improve achievement at KCSE. This approach has superior qualities that would reduce gender disparity in achievement in school biology.
iii. Teachers should incorporate CCMTA in their teaching. This is because it enhances understanding of abstract concepts through active involvement of learners in group activities and application in real life situations. This would lead to motivational gains in learning biology.
iv. Practicing biology teachers should be trained in the use of CCMTA through in-service courses, seminars, workshops and symposia. This would go a long way in minimizing gender motivational disparities among students as they play an active role in acquisition of biological knowledge.

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