

## EFFECTS OF CONCEPT MAPPING TEACHING STRATEGY ON STUDENTS' ATTITUDE TOWARDS SECONDARY SCHOOL BIOLOGY

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### Abstract

This study investigated the effects of concept mapping teaching strategy (CMTS) on secondary school students' attitude towards biology. A non equivalent control group design under quasi- experimental research was used in which a random sample of four co-educational secondary schools was used. The four schools were randomly assigned to four groups. Each school provided one form two class. The study sample comprised of 186 form two secondary school students in Bondo District, Kenya. Students in all the groups were taught the same biology content but two groups were taught using CMTS while the other two (the control groups) were taught using regular methods. Two groups, one experimental and one control were pre-tested prior to the implementation of the CMTS intervention. After four weeks, all the four groups were post-tested using the Student Attitude Questionnaire (SAQ). Data were analyzed using t-test and ANOVA. The results show that students exposed to CMTS intervention have a significantly higher attitude than those taught using regular methods. The researchers conclude that CMTS is an effective teaching strategy which biology teachers need to incorporate in their teaching.

### Key Words:

- *Concept mapping*
- *Teaching strategy*
- *Attitude*

### Introduction

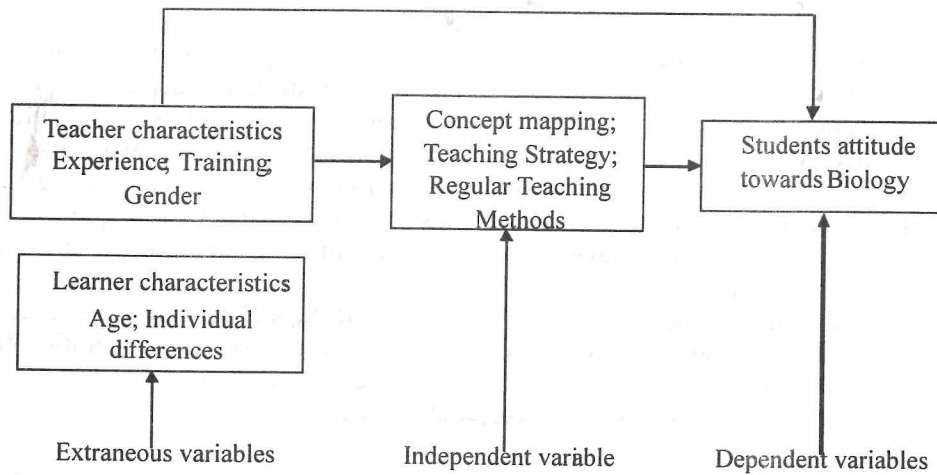
Biology plays an important role in society. It is applicable in fields such as health, agriculture, environmental and education. The subject is a precursor of biotechnology, which is a tool for industrial and technological development (KIE, 2002). The Kenya Certificate of Secondary Education (KCSE) examination results show that most students have been performing poorly in biology (Kenya National Examinations Council [KNEC], 2004). This trend has been of concern to researchers in biology education in Kenya (Orora, Wachanga & Keraro, 2005; Wekesa, 2003). The teaching strategy used in teaching biology is a key factor that leads to this poor performance and specifically the expository teaching approaches (KNEC, 2006).

Concept mapping teaching strategy (CMTS) is a teaching approach which is learner-centered and activity oriented. It is a technique for schematic organization and representation of knowledge. This approach is an active, creative, visual and spatial learning activity in which the student organizes concepts according to their hierarchical relationship. To accomplish this, the student must be able to relate and integrate concepts used in the concept map (Novak, 1990). It provides the student with the opportunity to organize, evaluate, summarize, and analyze many ideas. It, therefore, promotes the development of thinking skills, which can then be used for other meaningful learning activities (Angelo & Howard, 1997). The teaching strategy a teacher adopts is a strong factor that may affect the students' attitude towards learning a subject and ultimately affect their performance (SMASSE, 1998). The study attempted to find out from an experimental mode how students' attitude is affected by the use of CMTS.

### Conceptual Framework

The study was based on Ausubel's theory of meaningful learning (Ausubel, 1978). According to him, learning takes place by assimilation of new concepts and propositions into existing conceptual and propositional framework held by the learner. According to him meaningful learning results when learners consciously and explicitly tie new knowledge to relevant concepts they already possess. He further asserts that when meaningful learning takes place it produces a series of changes within our entire cognitive structure, modifying existing concepts and forming new linkages between concepts.

The study was based on the assumption that a teaching method that involves students' cooperation and activity is more likely to lead to worthwhile learning than a transmission method (Hanrahan, 1998). The study, therefore involved students in constructing and reconstructing concept maps. Diagrammatically, the framework is represented as in Figure 1.0.



**Figure 1.0: Conceptual Framework for Determining the Effects of Using Concept Mapping Teaching Strategy on Students' Achievement and Attitude to Biology**

This study involved trained biology teachers who had at least teaching experience of at least three years and above. It also involved form two students who were approximately of the same age in order to control for the student age variable.

**Purpose and Objectives of the Study**

This study was designed to determine the effect of using the CMTS on students' attitude. Its specific objectives were:

- To determine whether there is a statistically significant difference in attitude between students taught using CMTS and those taught using regular methods.
- To determine whether there is a statistically significant gender difference in attitude towards learning biology when students are exposed to CMTS.

**Hypotheses of the Study**

The following null hypotheses were tested.

- There is no statistically significant difference in attitude of students taught using CMTS and those taught using regular methods.
- There is no statistically significant gender difference in attitude towards learning biology when students are exposed to CMTS.

**Research Design**

The study adopted quasi-experimental, Solomon Four-Group design, which is considered sufficiently robust and appropriate for experimental studies (Gall, Borg &Gall, 1996). This study adopted the design because secondary school classes once constituted exist as intact groups and school authorities do not normally allow such classes to be broken up and re-constituted for research purposes. The table below shows the diagrammatic representation of the research design.

**Diagram of the Non-randomized Solomon Four- Group Design**

Group 1	O1	X	O2
Group 2	O3	C	O4
Group 3	X	O5	
Group 4	C	O6	

Source: Adopted from Cook and Campbell (1979) page 108.

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**Key:**

- X - Experimental treatment where students were taught using concept mapping teaching strategy.
- C- Control treatment
- O1 and O3- Pre-test observations
- O2, O4, O5, O6 - Post- test observations

- Group 1 is the experimental group that received the pre-test, the treatment X and the post-test.
- Group 2 is the control group that received a pre-test followed by the control condition and lastly a post-test.
- Group 3 received the treatment X and a post-test but did not receive the pre-test.
- Group 4 is control group that received post-test only.
- Groups 2 and 4 were taught using regular methods (Ary et al, 1972; Gall et al, 1996; Cook & Campbell, 1979; Ogunniyi, 1992). The selected groups to be used in the study were randomly assigned to either experimental or control groups.

This research design was used because it was considered suitable in achieving the following purposes:

- Assessing the effect of the experimental treatment relative to the control treatment;
- Assessing the effect of the pretest relative to no pre-test;
- Assessing the interaction between pre-test and treatment conditions;
- Determining the extent to which the groups are uniform before giving the treatment (Gall et al, 1996).

**Sampling Procedures and Sample Size**

The sampling unit was the secondary schools and not the individual students since students operate as intact groups. The study used district secondary schools to ensure that students involved had comparable abilities. A list of district secondary schools in Bondo district was used as the sampling frame. Purposive sampling technique was used to select four schools that formed the study sample. The sampled schools had to be at least 10km apart to minimize experimental treatment diffusion. In schools that had more than one Form two stream, simple random sampling was used to pick one stream for the study. The schools in each group were as follows:-

- Group 1 (Experimental group), N=47, Akoko Secondary School.
- Group 2 (Control group), N= 48, Gobei Secondary School.
- Group 3 (Experimental group), N= 45, Siger Secondary School.
- Group 4 (Control group), N= 46, Majango Secondary School.

A total of 186 students were assigned to the four groups.

**Instrumentation**

This study used one instrument of data collection namely: Student Attitude Questionnaire (SAQ). The SAQ was developed by the researcher and used as pretest and later re-organized to be used as posttest after treatment. Due to the fact that the topic of respiration is part of biology, SAQ was based on biology as a whole. It used a 5-point likert scale that was designed to assess the students' attitudes before and after treatment. The SAQ contained 18 items. There was no right or wrong answers in the SAQ. The likert style items were specifically concerned with attitude of students towards biology. The students were required to indicate whether they strongly Agree, Agree, Undecided, Disagree or Strongly Disagree with the statements.

To achieve construct validity of SAQ, the instrument was presented to five experts in science education in the faculty of education and community studies for examination and recommendation.

**Reliability of Instruments**

The SAQ was pilot tested in a Form two class similar in characteristics to the schools in the sample but not taking part in the study. The Cronbach's Correlation Coefficient alpha ( $\alpha$ ) formula was used to test for the reliability of SAQ. This is considered appropriate for both essay and structured questions, especially where the items are of varying difficulty (Ary et al., 1972; Ebel, 1972; Anastasi, 1982). A reliability



coefficient of 0.7 and above is considered acceptable (Ebel, 1972; Ogunniyi, 1992; Gall et al, 1996). SAQ was found to have a reliability coefficient of 0.85. The instruments therefore met the standards required for this study.

### The Construction and Use of Instructional Materials

The researchers developed an instructional manual for the teachers to use during the treatment period. The manual was based on the revised Kenya secondary school biology syllabus. The teachers of the experimental groups were trained by the researchers on the skills of concept mapping teaching strategy three days. Before treatment in the experimental groups, a pre-test of SAQ was administered to groups 1 and 2. After the pre-test, teachers of the experimental groups taught their students using CMTS. The treatment period was four weeks and the biology topic was respiration. The control groups were taught using regular methods. At the end of the treatment period, a post-test on SAQ was administered to all groups.

### Data Collection

In this study, SAQ was used to collect data. The researchers administered the instruments with the assistance of the biology teachers in the respective schools. Groups 1 and 2 were given pre-tests before the start of the experiment. This was followed by treatment which took four weeks. After the treatment, the researchers, with the assistance of biology teachers for the groups in the study sample administered post-tests to the four groups. The researchers then scored the questionnaires. This generated quantitative data.

### Data Analysis

Data were analyzed using one way Analysis of Variance (ANOVA) and t-tests. ANOVA was used to determine if the four groups differed significantly among themselves on variables being studied. In detecting the differences between two means, t-test was used because of its superior quality in detecting differences between groups (Gall et al, 1996).

### Results

The Solomon Four – Group Design used in this study enabled the researcher to have two groups sit for pre-tests. Groups 1 and 2 sat for the pre-test BAT. This enabled the researcher to:-

- Assess the effects of treatment relative to no treatment.
- Assess the effects of the pre-test relative to no pre-test.
- Assess if there was an interaction between the pre-test and treatment conditions.
- Assess the similarity of the groups before administration of the treatment (Gall et al, 1996).

### Effects of CMTS on students' attitude on biology

To establish whether concept mapping teaching strategy had any statistically significant effect on the attitude of students towards learning biology, the study assessed the attitude of students in groups 1 and 2 before the concept mapping teaching strategy was introduced. Table 1 below shows independent sample t-test of the pre-test scores on SAQ.

**Table 1: Independent Sample t-test of the Pre-test Scores on SAQ**

Group 1, N= 47; Group 2, N=48						
Variable	Group	Mean	Std. Dev	t-value	df	p-value
SAQ	1	40.96	9.677	2.221	93	0.719
	2	36.77	8.682			

An examination of table 1 above shows that the mean scores for group 1 and 2 on SAQ were not statistically different,  $t(93) = 2.221$ ,  $p > 0.05$ . This shows that the groups had similar attitudes before the implementation of treatment.

Table 2 shows the results of the mean attitude scores for SAQ post-test. The results of the one-way ANOVA based on these means are shown in table 3.

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**Table 2 :SAQ Post-test Mean Scores Obtained by Students in the Four Groups**

Group	N	Mean score	Standard deviation
1	47	75.489	6.272
2	48	39.583	8.977
3	45	80.778	6.230
4	46	37.956	10.068

The mean scores in table 2 shows that groups 1 and 3 which were experimental groups had higher mean scores than groups 2 and 4 which were control groups.

**Table 3: Analysis of Variance (ANOVA) of the Post-test Scores on SAQ**

Source	Sum of squares	df	Mean square	F	p-value
Between groups	72995	3	24331.880	393.829	0.000
Within groups	11244.489	182	61.783		
<b>Total</b>	<b>84240.129</b>	<b>185</b>			

Table 3 shows that there was a significant difference between the means  $F(3,182) = 393.829, P < 0.05$ . It was necessary to carry out further tests on the combinations of means to find out where the difference occurred (post-hoc tests).

Table 4 below shows the results of scheffe post-hoc comparisons

**Table 4: Post-hoc Comparisons of the post-test SAQ mean Scores for the Four Groups**

	Group (I)	Sampled Groups (J)	Mean Difference (I-J)	p-value
Scheffe	1	Group 2	36.59(*)	0.000
		Group 3	-4.59	0.053
		Group 4	37.91(*)	0.000
	2	Group 1	-36.59(*)	0.000
		Group 3	-41.18(*)	0.000
		Group 4	1.32	0.883
	3	Group 1	4.59	0.053
		Group 2	41.18(*)	0.000
		Group 4	42.50(*)	0.000
	4	Group 1	-37.91(*)	0.000
		Group 2	-1.32	0.883
		Group 3	-42.50(*)	0.000

\* = the mean difference significant at  $p < 0.05$



The results in table 8 show that the pairs of SAQ mean scores of groups 1 and 2, groups 1 and 4, groups 2 and 3 and groups 3 and 4 were significantly different at the 0.05 level. However, the mean scores of groups 1 and 3 and 2 and 4 were not significantly different. Overall, there was a significant difference in mean scores between experimental and control groups in favor of the experimental groups. Hypothesis Ho1 was therefore rejected.

#### Attitude of Boys and Girls Towards Biology Who Were Exposed to CMTS

To find the gender differences in attitude when students are exposed to concept mapping teaching strategy, the researchers computed the SAQ mean scores for boys and girls and then compared them to determine whether there was significant difference between them before the implementation of concept mapping teaching strategy. Table 5 shows the pre-test SAQ mean scores for boys and girls in groups 1 and 2

**Table 5: Pre-test SAQ Mean Scores for Boys and Girls in Group 1 and 2**

Gender	N	Mean	Std. Dev	Standard Error
Boys	47	37.574	10.979	1.607
Girls	48	38.708	8.374	1.208

The pre-test mean scores of SAQ show that the girls had a slightly higher mean than the boys, however it was necessary to perform a t-test to determine whether this difference was statistically significant. Table 6 below shows the independent t-test for SAQ pre-test for girls and boys.

**Table 6: Independent sample t-test of Pre-test SAQ scores for boys and girls in group 1 and 2**

Gender	N	Mean	Std. dev	t-value	Df	p-value
Boys	47	38.49	10.402	-0.361	93	0.719 (ns)
Girls	48	39.19	8.350			

The results show that the mean difference was not statistically significant ( $t(93) = -0.361, p > 0.05$ ). This shows that the groups were quite similar in terms of attitude before the commencement of the study.

To determine if there was gender difference in attitude towards biology when CMTS is used, independent sample t-test was carried out to determine if the attitude scores between boys and girls differed significantly or not after implementation of concept mapping teaching strategy in group 1 and 3 Table 7 summarizes the output of the t-test.

**Table 7: Independent Sample t-test of Post-test SAQ for Boys and Girls in Groups 1 and 3**

Gender	N	Mean	Std. dev	t-value	Df	p-value
Boys	47	78.51	6.597	-0.084	90	0.933
Girls	45	78.62	6.076			

From the table 7 the mean scores for boys and girls in terms of attitude for groups 1 and 3 that were exposed to concept mapping teaching strategies were not statistically different,  $t(90) = -0.084, p > 0.05$ . Hypothesis Ho2 was therefore upheld.

## Discussions

### Effects of CMTS on Students Attitude to Biology

The results of this study indicate that the concept mapping teaching strategy resulted in higher students' attitude change than those taught using regular methods. This is probably because when students were actively involved in the construction of concept maps, their enthusiasm and curiosity is enhanced. These findings agree with other studies. Jegede and Okebukola (1989) carried out a study to explore the possibility that CMTS could be a fruitful way of helping to change students' attitudes towards biology concepts perceived to be difficult. The concepts under investigation were ecology and genetics. They found out that students' perception of the biology content as difficult and their anxiety had changed after the implementation of CMTS. Keraro et al (2007) carried out a study to find out the effects of cooperative concept mapping teaching approach on the motivation of students in biology. Their results indicated that students taught using cooperative concept mapping approach had a significantly higher motivation than those taught through regular methods. Concept mapping, which is an activity oriented task made the students' attitude to be enhanced. As students engaged in concept mapping, they did semantic processing of information and as constructed meanings from the content being learnt, they were encouraged to learn.

### Effects of CMTS on the Attitude of Boys and Girls towards Biology

The results of this study have shown that there is no statistically significant difference in attitude between the boys and girls exposed to concept mapping teaching strategy. This confirms what has been documented in other studies. In a study aimed at improving the performance of and participation of girls in sciences and mathematics, it was discovered that the performance of girls in these subject was affected by their poor attitude towards sciences (FAWE, 1998). The study also indicated that teachers used discouraging remarks on girls.

Wachanga (2002) carried out a study on the effects of a cooperative class experiment teaching method on students' achievement and motivation in secondary school chemistry and noted that in regular teaching, the teachers gave more attention to boys than girls this tended to make the girls feel incapable of answering certain questions of a higher taxonomy. In another study by Keraro, Wachanga and Orora (2007) to determine the effects of cooperative concept mapping teaching approach on secondary school students' motivation in biology, they found out that there was no statistically significant gender difference in the motivation to learn biology when students are exposed to cooperative concept mapping. These studies seem to indicate that when boys and girls are given similar treatment with regard to the teaching process, then their interest and motivation to learn science will not be different.

In this study equal treatment was given to both boys in the course of the teaching and learning process. The participation of girls and boys in the learning process was monitored to ensure that all the students were actively involved. This made the attitude of boys and girls to be more or less the same. Gender differences in attitudes towards science can be reduced by using concept mapping teaching strategy that ensures active involvement of all the students in the learning process.

## Conclusions

Based on the findings of this study, the following conclusions have been reached:

- Concept mapping teaching strategy enhances the attitude of students towards learning of biology than the other regular methods.
- Gender does not affect the attitude of students towards biology when they are taught using concept mapping teaching strategy.



### Implications for the Study

The findings of this study have indicated that Concept mapping teaching strategy had a statistically significant effect on the attitudes of students towards biology. Students who were taught using concept mapping teaching strategy had higher attitude scores compared to those who were not exposed. This would imply that its incorporation in the teaching would enhance attitude change towards biology learning. One of the broad objectives for teaching biology is to develop attitudes and interest towards biology (KIE, 2002). It therefore follows that inculcating positive attitudes towards learning of biology is the responsibility of the teacher. A positive attitude towards the subject will enhance acquisition of concepts which are of useful application in real life situations.

The findings of this study have also indicated that Concept mapping teaching strategy did not produce any statistically significant gender difference in attitude towards biology. The boys and girls who were taught using concept mapping teaching strategy did not show any difference in their attitude mean scores. This implies that the incorporation of CMTS would minimize the gender differences in attitude towards biology.

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