EFFECT OF COLLABORATIVE CONCEPT MAPPING TEACHING STRATEGY ON STUDENTS' ATTITUDES TOWARDS MATHEMATICS IN SECONDARY SCHOOLS IN KENYA

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ABSTRACT

Conceptual understanding and attitudes have emerged in recent discoveries as the critical factors contributing to the continued inertia in performance in the subject. This study sought to establish the effect of Collaborative Concept Mapping teaching strategy on secondary school students' development of affective domain. Specifically, the study sought to find out if there was any difference in Students' attitude toward Mathematics subject when taught using the Collaborative Concept Mapping Teaching Strategy and the Conventional Methods of Instruction. The theoretical framework is based on constructivist theory which views learners as active constructors of meaning from input by processing it through existing cognitive structures and retaining it in the long-term memory. This study used a Quasi-experimental Solomon Four-Fold research design. The sample for the study comprised 161 forms three students and 4 teachers of mathematics from 4 randomly selected sub-county co-educational secondary schools in the 4 sub-counties of Bomet County. The four co-educational schools were randomly assigned into two experimental (E_1 & E_2) and two control (C_1 & C_2) groups. Students in the experimental group were taught using Collaborative Concept Mapping (CCM) Teaching Strategy for three weeks while the control group was taught using Conventional Methods of Instruction. Students' Attitude Towards Mathematics Questionnaire (SATMQ) was used to collect data. Descriptive and inferential statistics were used in data analysis which included frequencies, mean, t-test and ANOVA. All the statistical tests were subjected to a test of significance at alpha (α) level of 0.05. The results revealed that there were statistically significant difference attitudes towards mathematics in favour of CCM between students exposed to Collaborative Concept Mapping teaching strategy and those taught using Conventional Method of Instruction. From the findings it can be concluded that the attitude towards mathematics is marked higher when the students are taught using the Collaborative Concept Mapping Teaching Strategy than when the conventional method is employed. Based on the findings, recommendations were made on the need for teachers to integrate Collaborative Concept Mapping Teaching Strategy (CCM) teaching strategy in the mathematics instruction to foster positive attitude in the subject. There is also need for teacher training institutions to incorporate CCM as one of the strategies in mathematics instruction and that the serving teachers can be retooled to enable them to integrate CCM teaching strategy effectively in Mathematics learning. Mathematics curriculum developers need to restructure and integrate CCM among learner-centred strategies in Mathematics education.

(Key Words: Collaborative Concept Mapping, Attitude, Achievement)

1.0 Introduction

Kenya Vision 2030 aims at making Kenya an industrialized, middle income country providing high quality life for all its citizens by the year 2030. In her vision it's apparent that Kenya's economy requires a steady supply of scientifically and technologically knowledgeable human resource (Mutahi, 2009). In the current highly competitive knowledge-based economy of the 21st century, education is the most vital strategy for socio-economic development across the world (Aikman & Unterhalter, 2005). For individuals and states it is key to creating, applying, and spreading knowledge and thus to the development of dynamic, globally competitive economies (World Bank report, 2011). It also helps the individual to realize their highest potential by preparing them for the future challenges in life (Sharma, 2012). Kenya's economy like other countries' economies requires a steady supply of scientifically and technologically Knowledgeable human resource (Mutahi, 2009). This underscores the immense role science and technology play in the development of a country. Hence, students should be well-equipped with the necessary knowledge and skills in science and technology to perform in the modern economy. Mathematics is the cradle of all innovations, without which the world cannot move forward. Certain qualities that are nurtured by mathematics are power of reasoning, creativity, abstract or spatial thinking, critical thinking, problem-solving ability and even effective communication skills. Be it a cook or a farmer, a carpenter or a mechanic, a shopkeeper or a doctor, an engineer or a scientist, a musician or a magician, everyone needs mathematics in their day-to-day life (Guwahati, 2015*)*. Mathematics has not only found its usefulness in academic areas such as Science, Medicine, and Engineering but also in the day to day operations of businessmen, sportsmen, and even farmers (Thomaskutty, 2010).

The Kenya Government recognizes the importance of Mathematics and the subject was made compulsory both at primary and secondary school levels soon after independence in 1963 (K.I.E, 1979). Secondary mathematics aims at producing a person who is numerate, orderly, logical, accurate and precise in thought. The person should also be competent in appraising and utilising mathematical skills in playing a positive role in the development of a modern society (K.I.E: 2002). History of Mathematics reveals that whenever a society gave the knowledge of mathematics its due significance the society made tremendous progress. Thomaskutty (2010) gives examples of the Egyptian, Mesopotamian, and Greek civilizations, which were advanced alongside Mathematics. Mathematics is not only important for its practical use but also for its aesthetic appeal just like the study of poetry, music, painting, and literature. Simply put, people study mathematics because it is one of the loveliest disciplines known to humankind (Phillips, 2008). The elegance and gracefulness of Mathematical relationships touches our emotions, much like music and art can reach inside the psyche and make one feel truly alive (Thomaskutty, 2010).

Although mathematics is an important subject in the school curriculum, the performance of students in the subject at KCSE level has been dismal over the years. Research findings have also cited the following factors as responsible for the dismal performance of students at this level: students' negative attitudes towards the learning of Mathematics (Eshiwani, 1986; Ogoma, 1987; Badmus, 2002 & Obodo, 2004), parents/guardians educational level (Kipkemoi, 2006), insufficient learning materials (Kiragu, 1988; Muraya and Kimamo , 2011), gender difference (Agwagah, 2000) and teachers' use of inappropriate teaching methods which make students become passive and have less interaction with each other in doing task (Zakaria, Solfitri, Daud & Abidin, 2012, Muraya and Kimamo , 2011; Harbour□Peters, 2001; Gambari, 2010). Poor teaching method is cited as one of the major factor influencing poor achievement and retention (Osemwinyen, 2009; Tolu, 2009).

Research has demonstrated that affective factors, such as beliefs, attitudes, predispositions based on prior learning experiences, personal experience, goals, subjective perceptions, confidence, and motivation, also greatly affect students' abilities to learn and apply statistical reasoning skills (Gal & Ginsburg, 1994; Gal, Ginsburg, & Schau, 1997; Gordon, 1995). Perepiczka, Chandler, and Becerra (2011) found that attitudes toward statistics along with statistics anxiety significantly relate to self-efficacy to learn statistics, which Finney and Schraw (2003) linked to course performance measures. Attitudes towards subjects are the important determinants of academic success and achievement. Attitudes are defined as positive or negative emotional dispositions (Aiken, 2000; McLeod, 1992). However, the exact definition of attitudes toward mathematics varies (Akinsola & Olowojaiye, 2008). To succeed in a subject, positive attitude towards a subject is a prerequisite. This also applies to mathematics, especially in case of girls as compared to boys. According to Reid (2006), attitudes express our evaluation of something or someone. They are based on our knowledge, feelings and behavior and they may influence future behavior.

Attitudes are generally regarded as having been learnt. They predispose an individual to action that has some degree of consistency and can be evaluated as either negative or positive (Fishbein & Ajzen, 1975;1980). They are linked to beliefs and for each belief an individual would have a corresponding attitude. Klein (2004) used poststructuralist analysis on earlier studies to argue that the beliefs and attitudes of pre-service teachers because of their school mathematics experiences and the pedagogical practices in their teacher education were obstacles in promoting inquiry-based learning and pedagogy in the primary classroom. Other studies have shown that classroom strategies used to teach a subject are influenced by teacher attitudes that, in turn, influence pupil attitudes (Carpenter & Lubinski, 1990). Positive teacher attitudes contribute to the formation of positive pupil attitudes (Relich, Way, & Martin, 1994). Of interest is how mathematics teachers produce positive attitudes in their students by use of collaborative concept mapping instructional strategy.

Several efforts to improve mathematics instruction were done through the Japan International Co-operation Agency (JICA), initiative of an In-Service Education and Training (INSET) programme for Strengthening Mathematics and Sciences in Secondary Education (SMASSE) in 1998 in Kenya. A baseline study conducted in 1998 in secondary schools identified negative attitude toward mathematics and science, poor teaching methodology, inadequate mastery of teaching subject content, inadequate teaching and learning materials that include ill-equipped laboratories, and school management among other factors (Waititu and Orado, 2009). In another research by Keitany (2014) in Marakwet West Sub-County to assess the impact of SMASSE in-service training, found that despite the launching of the SMASSE INSET to cover the whole country in the year 2003, it was found that the performance of secondary school students in mathematics at KCSE level has been very low. The use of teacher-centered Traditional Teaching Methods (TTM) is pre-dominant in the teaching of Mathematics. The most widely used TTM is the Lecture Method (Taylor & Francis, 2011). This points to the need to improve mathematics instruction by use of innovative methods that are student centred. While in students centred learning process teacher is merely facilitator or guide is the focal point of modern systems of education. In all active learning process, the learners learn according to their own needs and pace (Orhan & Ruhan, 2006).

According to constructivist theories of learning, conceptual change in learners should be facilitated by activities such as having students actively engaged in processing materials; confronting their conceptual framework; confronting defending alternatives perspective; linking new concepts to old;

and using strategies that encourage both meta-cognition and higher order thinking (Toblin & Tippins 1993). Constructivists view learning as encouraging students to use active techniques (experiments, real-world problem solving) to create more knowledge and reflect on and talk about what they are doing and how their understanding is changing. This transforms the student from a passive recipient of information to an active participant in the learning process and teacher functions more as a facilitator who coaches, mediates, prompts, and helps students develop and assess their understanding, and thereby their learning (2014 Educational Broadcasting Corporation).

Mathematics instruction should provide students with opportunities to engage in mathematical inquiry and meaning making through discourse. Teachers should encourage this process by creating a conducive classroom environment and remaining flexible and responsive to students' response and feedback (NCTM, 2000). Learner-centered teaching approaches promote imaginative, critical and creativity skills resulting in better achievement (Ministry of Education, 2001). Collaborative Learning has positive effects on students' discussions in which they elaborate on the subject, challenge and amend one another's ideas, and thus remember these ideas more easily (Cohen, 1984). When in small groups, students can share their strengths, develop their weaker skills, improve their interpersonal skills and learn to deal with conflicting issues. Guided by clear objectives, students engage in numerous activities that improve their understanding of a subject content.

Concept mapping is a visual representation of an individual's knowledge structure on a topic (Novak & Gowin, 1984; Novak, 1990). This representation takes the form of a finite graph with nodes that depict the mathematical concepts and links (lines or arcs) which in turn represent the relationships among them. Basic attributes of concept mapping according to Novak (Novak & Gowin, 1984) are: Hierarchy, Progressive Differentiation and Integrative Reconciliation. Concept Mapping organizes knowledge in an understandable visual way and connects prior knowledge with new concepts by utilizing a visual structure for planning and thinking (Christodoulou, 2010). Christodoulou further argues that the human mind can organize knowledge in an orderly fashion. In learning mathematics, it is important for students to use the correct mathematical terminology, learn how to translate mathematical expressions into verbal problems and how to translate verbal problems into mathematical expressions that can be worked with (Askey, 1999). In addition, noting the importance of communication in the mathematical process, Kotsopoulos (2007) points out that students experience interference when they borrow language from their everyday lives to use in their mathematics world, such that their inability to minimize this interference could potentially undermine their ability to learn.

Githae, Keraro and Wachanga (2015) suggest that a learner can use concept mapping to extract relationships between key concepts because knowledge is broken down into simple and more easily understandable parts. Concept mapping-based instruction is one of the instructional strategies advocated by CEMASTEA as a learner-centred learning approach (Makoba, 2012). Collaborative Concept Mapping Teaching Approach (CCMTA) is a hybrid teaching/learning strategy involving an interaction between two or more individuals during concept mapping to create a shared understanding of a concept, discipline or area of practice that none had previously possessed or could have come to on their own (Johnson, Johnson & Smith, 1991). Collaborative concept mapping is a great tool to use during a learning session for students to check their understanding together and build on what they already know. Collaborative Concept Mapping Teaching Strategy (CCMTS) is likely to be an effective summative assessment technique that enhance rich discussions

amongst students who have already individually engaged with the concept mapping activity. Collaborative concept mapping benefits from the interactions with others by allowing learners to blend their thoughts and experiences while trying to achieve understanding of a subject content. In the light of enlisted benefits of using CCMTS, the study reported in this paper investigated its effects on learners' attitude towards Mathematic in secondary schools.

2.0 Purpose and Objective of the Study

This study sought to establish the effect of Collaborative Concept Mapping (CCM) teaching strategy on students' development of affective domain. Specifically, it sought to find out if there is any difference in students' attitudes toward mathematics when taught using the Collaborative Concept Mapping teaching strategy and Conventional Methods of Instruction.

The following null hypothesis were tested at an alpha (α=0.05) level of significances.

Ho: There is no statistically significant difference in the attitudes towards mathematics subject between students taught using Collaborative Concept Mapping teaching strategy and those taught using Conventional Methods of Instruction.

3.0 Theoretical and Conceptual Framework of the Study

This study was conducted within an interpretive paradigm with a constructivist view of learning. In constructivist teaching and learning, learners are expected to actively construct meanings of concepts. They are expected to construct meanings from input by processing it through existing cognitive structures and then retaining it in long term memory (Okere, 1996). The social constructivist view of learning is the theoretical model that informed this study. It is based on the notion that knowledge is first constructed in a social context and is then taken up by individuals (Guba & Lincoln, 1994; Eggan & Kauchak, 2004). According to social constructivists, the process of sharing each person's point of view, called collaborative elaboration (Meter & Stevens, 2000), results in learners building understanding together that wouldn't be possible if they worked individually (Greeno, Collins & Resnick, 1996). The internal construction of knowledge is viewed as being driven primarily by social interaction (Wertsch, 1985). Collaborative Concept Mapping Teaching Strategy was found to be consistent with social constructivism in its dimension of learning as learners engaged in active knowledge construction through social negotiation rather than competition. The dependent variable in this study was learners' attitude towards mathematics. However, various intervening variables such as teacher and learner characteristics including teacher's gender, training and experience, the class room environment, type of school and learners' age, academic ability may affect the expected outcome. Type of school was controlled by involving one category of schools, the Sub-county secondary schools which enroll most learners at the secondary school level in the County and generally in Kenya. Learners in each category of schools are of comparable academic ability because the Kenya Certificate of Primary (KCPE) examination scores is used for placement in secondary schools.

The relationship between the variables is as illustrated in figure 1.

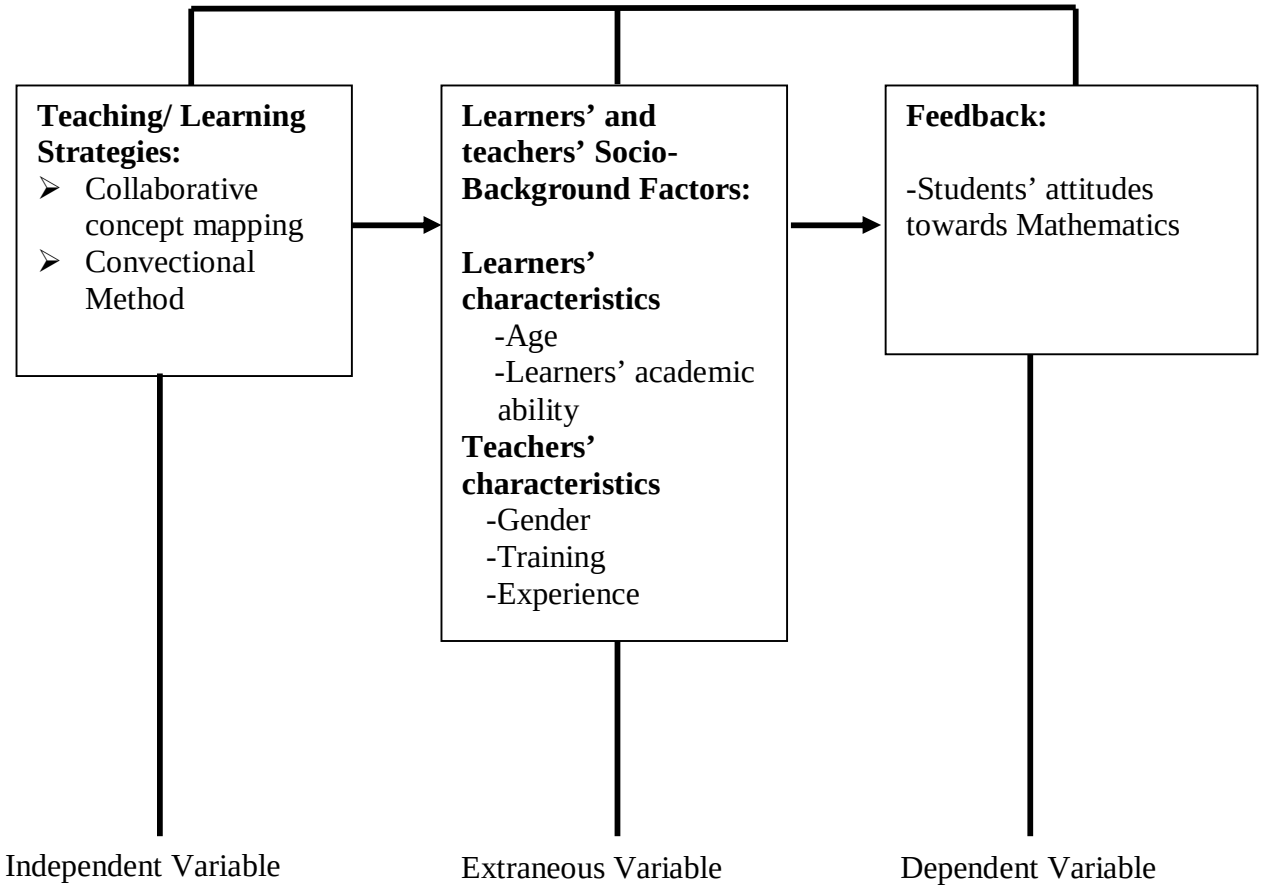

Figure 1: Conceptual Framework of the Study

Source: Author

In the figure, the direction of the arrows indicates the hypothesized direction of cause-effect relationship in the model. Hypothetically, CCM teaching strategy influence attitudes towards Mathematics directly or indirectly through complex interaction with learners' and teachers' socio-background factors as shown by the direction of the arrows in in Figure 1. Learners' age and academic ability was controlled by selecting form three class and involving one category of schools, sub-county co-educational schools, respectively. Teachers' characteristics including gender, training and experience was controlled by purposely selecting male trained teachers with teaching experience of at least three years in the service.

4.0 Methodology

The study involved Form three students in co-educational secondary schools in Bomet County, Kenya, participated in the study. Secondary schools in Bomet county were stratified into Boys,

Girls and Co-educational secondary schools. Co-educational schools formed sampling frame for this study. Co-educational schools were purposely selected for the study because they constitute 79.1% of all the schools in Bomet County.

4.1 Quasi Experimental Design

This study employed the Quasi Experimental design in which the researcher used the Solomon Four Non-Equivalent Control Group Design approach using both quantitative and qualitative analysis frameworks. The design is considered rigorous enough and appropriate for quasi-experimental studies (Fraenkel & Wallen, 2000). Non-equivalent group is deemed appropriate because classes in secondary school once constituted exist as intact groups and school authorities do not normally allow such classes to be broken up and reconstituted for research purposes (Borg & Gall, 1989; Fraenkel & Wallen, 2000; Trochim, 2006). Hence it was not possible to break classes into research groups and randomly assign treatment as required in true experimental designs. The schools therefore were randomly selected and assigned treatment and conditions as intact groups. The Quasi -experimental design is considered appropriate because it allows for assessment of causal effects of CCM teaching strategy on students' attitudes towards mathematics learning. The research design is represented as shown figure 2 below:

Figure 2. 1: The Solomon Four-Fold Design

Group 1(E_1)	O_1	X	O_2
Group 2(C_1)	O_3	C	O_4
Group 3(E_2)	_	X	O_5
Group 4(C_2)	_	C	O_6

Where: O_1 and O_3 are pre-tests
O_2, O_4, O_5 and O_6 are the post-tests
X is the treatment in which the students were taught using CCM
C is control condition.
_ indicates no pre-test
…. indicates non-equivalent groups

Group 1 represents the experimental group which received the pre-test (O_1), the treatment (X) and the post-test (O_2). Group 2 is the true control group which received a pre-test (O_3), the control condition and a post-test (O_4). Group 3 received treatment and post-test (O_5) only while Group 4 received post-test (O_6) only. Groups 1(E1) and 3(E2) were taught using CCMTS while groups 2(C1) and 4(C2) were taught using conventional method of instruction.

An instructional manual for teachers was developed based on the approved Kenya Institute of Education (KIE) Mathematics syllabus (2002) and Secondary School Mathematics Teacher's Handbook (2006). The manual was used by teachers in experimental groups to ensure that there was uniformity in exposure of students to intervention. To ensure uniform delivery of the content to all the groups involved, the researcher in consultation with the teachers of the selected schools developed a common scheme of work for the topic circle concept which was used by all the teachers who participated in the study. According to Shuttleworth (2009), Campbell (1963) and

Campbell (1979)), the various combinations of tested and untested groups with treatment and control groups allows the researcher to ensure that confounding variables and extraneous factors do not influence the results.

4.2 Qualitative Research Design

There was need to supplement the empirical data with qualitative data in the present study. The qualitative aspect of the research methodology was undertaken with one purpose in mind. The sole purpose is to carry out-group and individual interviews to unravel meanings that the students attach to classroom interactions and/or experiences with the instructional material particularly the CCM strategy. As stipulated by qualitative research design (Denzin, 1989, Lincoln and Guba, 1985), the researcher/research assistants further probed the group of selected subjects to garner their views about how the instructional programs fit in with their learning and instructional needs. Also, the researcher/research assistants noted responses and remarks, queried a selected group of subjects to garner their experiences with the collaborative concept mapping strategy in addition to the conventional methods of instruction commonly used in instruction by their teachers.

At the end of each of the field sessions, the researcher recorded summary sections and related them to the research questions. The researcher also reviewed copies of the information from the interviews before giving them to the subjects concerned to verify the data. This step triangulation helped to ensure the data collected were complete and accurate. Information on interview responses were analyzed and presented in form of descriptive data. The student interview guide was designed and used to collect qualitative data.

4.3 Sampling Procedures and Sample Size

The co-educational schools in the sub-county schools' category which formed the sampling frame for this study were purposely chosen to avoid complexities arising from using the three types of strata and categories of schools. Based on the research design adopted, the researcher randomly selected four Sub-Counties from the five Sub-Counties in the County. In the school visited, the researcher interviewed the principals and Mathematics teachers. Simple random sampling technique was used to select one school from each of the four (4) sub-counties selected. The four schools were then randomly assigned treatment and control conditions. In schools with more than one stream, only one stream was selected randomly. The total number of students in each of the Groups E1, C1, E2 and C2 were 39, 40, 42 and 40 respectively

4.4 Research Instruments

The research instruments used in this study questionnaires and interview schedule. The selection of these tools was guided by the nature of data that was to be collected, time available for the study as well as objective of the study. The Students' Attitudes Toward Mathematics learning questionnaire and teachers' interview schedule were administered to establish students' attitude towards mathematics and the teachers' perceptions and feelings about the effectiveness of the Collaborative Concept Mapping teaching strategy.

The researcher used structured questionnaires that were aimed at eliciting specific information. The Questionnaire sought information on student's Bio-data and Attitudes Towards Mathematics. The

ATM questionnaire was adopted and modified from the scales developed by Fennema, E. & Sherman, J. (1976) on Instruments designed to measure attitudes towards the learning of mathematics by females and males. ATM was measured along four dimensions: Utility of mathematics as a subject in daily life, liking of mathematics, career interest in mathematics and the relevance of mathematics in the world. There were 12 items on utility of mathematics, 26 on liking of mathematics, 10 on career interest of mathematics and 8 on relevance of mathematics in the world, totaling 56 question items. In each of the four dimensions, half of the items were positive, and the other half were negative statements. These aspects have been found to bear positive relationship to achievement as well as attitudes in science and mathematics (Duncan, 1989; Wasanga, 1979). Information on students' attitudes was solicited using the 56 (fifty-six) question items (28 positives and 28 negatives) on 5-point Likert scale containing alternatives response ranging from Strongly Agree (SA), Agree, Undecided, Disagree to Strongly Disagree (SD).

The researcher used an interview schedule containing structured questions for mathematics teachers. The interview questions were similar in intent with the questionnaire. The subjects were interviewed on site, generally after the lesson and whenever possible, during the lesson. Throughout the interview sessions, the investigator was able to collect sufficient descriptive details from the teachers about students' feelings towards lessons taught conventionally and how the collaborative concept mapping strategy was perceived by the subjects.

4.5 Validity and Reliability of the Instruments

Piloting was done to establish whether the instruments could be used to collect relevant data, identify any problems likely to occur at the time of actual data collection process and to also check whether the instructions in the questionnaires are understandable to the respondents. This exercise was conducted in selected secondary schools, in the neighbouring County of Kericho, which were not included in the actual study. The results were used to test the validity and reliability of the research tools.

To ensure that the research tools were valid item analysis was done. This ensured each question answered a specific objective of the study. The instruments were also given to the experts for validation. Two aspects of validity were determined for the instruments. Face validity and content validity are the validity issues most frequently reported in the literature (Parahoo, 2006). Face validity basically checks that the questionnaire seems to measure the concept being tested (LoBiondo-Wood & Haber, 2010) and this was assessed by getting mathematics education experts to test-run the instrument to see if the questions appear to be relevant, clear and unambiguous as outlined by Jones & Rattray (2010). A panel of experts is used to evaluate the content validity of the questionnaires (Polit & Beck, 2010). The questionnaire was submitted to departmental specialists (CIEM) to check and examine whether the questions reflect the concepts being studied and that the scope of the questions is adequate, in the manner proposed by LoBiondo-Wood & Haber (2010). The research tools were developed and validated before their use with expert help from supervisors and lecturers from the school of education. The researcher used the experts help to verify the content, construct and face validities of the instruments. The instruments were amended according to the experts' comments and recommendations before being administered. The reliability estimate, using Cronbach's Alpha method, for the four domains of ATC were 0.82, 0.78, 0.85, and 0.87 respectively.

4.6 Data Collection and Analysis Procedures

Data collected was analyzed using both descriptive and inferential statistics. Descriptive statistics involved frequencies and percentages and means, while inferential statistics entailed the use of Analysis of Variance (ANOVA).

5.0 Findings

The findings are discussed according to the objective of the study.

5.1 Effect of Collaborative Concept Mapping on Students' Attitudes Towards Mathematics

The objective was to find out whether there is any difference in students' attitudes toward mathematics when taught using the CCM teaching strategy and Conventional Method of Instruction. Attitude towards mathematics was taken to mean the emotional disposition of a student to respond consistently in a favourable or unfavourable manner towards mathematics as a subject. The mean scores and standard deviation on pre-test measurement on ATM for the Experimental and Control groups are as presented in Table 1.

Table 1: Pre-test Mean Score on ATM

	Group	N	Mean	Maximum Mean Score	Std. Deviation
Career	Experimental	81	38.8148	50	5.67255
	Control	80	37.7750	50	6.42774
Liking	Experimental	81	89.5432	130	12.32584
	Control	80	90.9875	130	15.21533
Relevance	Experimental	81	29.2222	40	4.17732
	Control	80	29.4125	40	6.11430
Utility	Experimental	81	45.4815	60	6.18690
	Control	80	45.3875	60	7.29747
Overall Pre-ATM	**Experimental**	**81**	**203.0617**	280	**22.55900**
	Control	**80**	**203.5625**	280	**30.76446**

As shown in Table 1, the overall Pre-ATM means were 203.0617 and 203.5625 for Experimental and Control group respectively out of a maximum score of 280 points. To check whether there was any significant difference in their means an analysis of variance was performed on the pre-ATM as shown in Table 2.

Table 2: An analysis of variance on Pre-ATM

		Sum of Squares	df	Mean Square	F	Sig.
Career	Between Groups	43.517	1	43.517	1.185	.278
	Within Groups	5838.172	159	36.718		
	Total	5881.689	160			
Liking	Between Groups	83.957	1	83.957	.438	.509
	Within Groups	30443.086	159	191.466		
	Total	30527.043	160			
Relevance	Between Groups	1.457	1	1.457	.053	.818
	Within Groups	4349.388	159	27.355		
	Total	4350.845	160			
Utility	Between Groups	.355	1	.355	.008	.930

	Within Groups	7269.210	159	45.718		
	Total	7269.565	160			
Overall Pre-ATM	Between Groups	10.093	1	10.093	.014	.906
	Within Groups	115482.379	159	726.304		
	Total	**115492.472**	**160**			

The overall results presented in Table 2 displayed no significant difference in the means of Experimental and Control groups in pre-ATM ($F_{(1,159)} = .014$, $p > 0.05$). The results implied that the two group of students had similar ATM prior to exposure to CCMTS intervention. The post-ATM mean and standard deviation after the intervention for the Experimental and Control groups on the four dimensions of; Career interest in the field of Mathematics, Liking of Mathematics, Relevance of Mathematics and Utility of Mathematics are summarized in Table 3.

Table 3: Summary of Students' Responses on the four Dimensions of Post-ATM

	Group	**N**	**Mean**	**Maximum Mean Score**	**Std. Deviation**
Career	Experimental	81	40.7531	50	5.78474
	Control	80	37.8875	50	5.90429
Liking	Experimental	81	95.1358	130	9.56785
	Control	80	91.9250	130	15.09445
Relevance	Experimental	81	31.0000	40	4.13824
	Control	80	29.8125	40	5.70608
Utility	Experimental	81	48.0864	60	5.02792
	Control	80	45.7875	60	6.76307
Overall Post ATM	**Experimental**	**81**	**211.8765**	**280**	**19.48101**
	Control	**80**	**203.9000**	**280**	**29.77791**

In Table 3 the overall means on post-ATM are 211.8765, and 203.9000 out of the maximum score of 280 points for the Experimental and Control groups respectively. This reflected a higher mean for the Experimental group than the Control group. Diagrammatically the means on Post-ATM are shown in Figure 2.

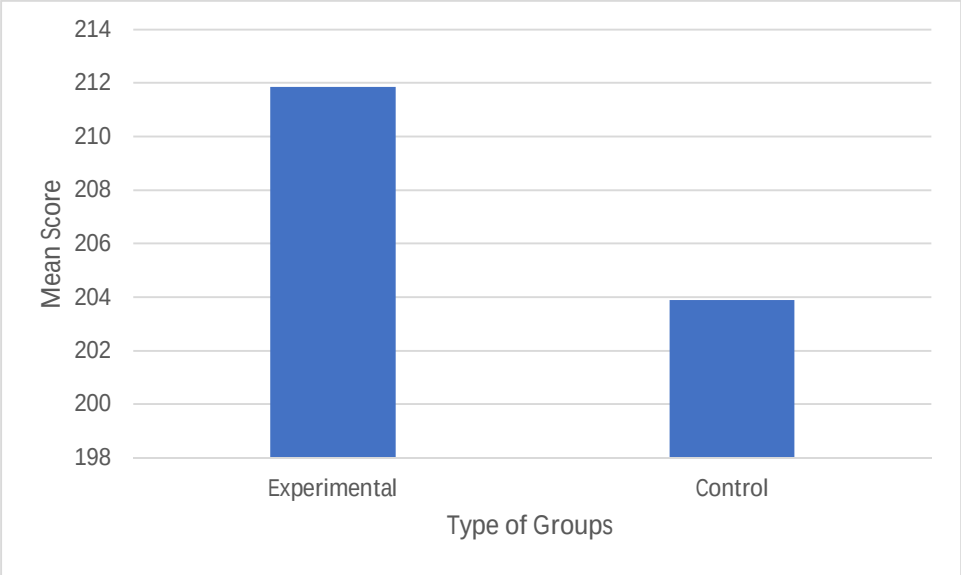

Figure 1: Means of Post-ATM

An analysis of variance on post-ATM was run to check whether there were any significant differences in the two means on the four dimensions of post-ATM as indicated in Table 4.

Table 4: An analysis of variance on post-ATM

		Sum of Squares	df	Mean Square	F	Sig.
Career	Between Groups	330.504	1	330.504	9.676	.002
	Within Groups	5431.049	159	34.158		
	Total	5761.553	160			
Liking	Between Groups	414.931	1	414.931	2.605	.108
	Within Groups	25323.056	159	159.265		
	Total	25737.988	160			
Relevance	Between Groups	56.757	1	56.757	2.289	.132
	Within Groups	3942.188	159	24.794		
	Total	3998.944	160			
Utility	Between Groups	212.714	1	212.714	6.001	.015
	Within Groups	5635.783	159	35.445		
	Total	5848.497	160			
Overall Post-ATM	**Between Groups**	**2560.817**	**1**	**2560.817**	**4.055**	**.046**
	Within Groups	**100411.965**	**159**	**631.522**		
	Total	**102972.783**	**160**			

The results presented in Table 4 showed that there were statistically significant differences in the means of students in the four dimensions of post-ATM except in liking of mathematics and Relevance of Mathematics. In overall there were significant differences in the means in the four dimensions of post-ATM in the four groups of students ($F_{(1, 159)} = 4.055$, $p<0.05$). The result suggests that the intervention of CCMTS had significant effect on students' ATM in the experimental group (E1and E2). This finding let to the rejection of the null hypothesis which stated that there is no significant mean difference in Attitudes Towards Mathematics (ATM)

subject between students taught using CCM teaching strategy and those taught using Conventional Method Instruction.

5.2 Discussion of the Results

The current study sought to investigate the effectiveness of Collaborative Concept Mapping (CCM) teaching strategy on the development of favourable Attitudes towards mathematics (ATM) among the form three secondary school students. The assumption was based on the anecdotal evidence from teachers as well as research findings suggesting that students' attitudes toward a subject is influenced by the instructional methods used.

Results on the analyses of means on Post-ATM showed that students in the experimental group had higher mean than the control group. ANOVA results showed significant difference between the experimental (E1 and E2) and control group (C1 and C2) on ATM at α=0.05 level. The results suggest that CCM teaching strategy had significant effect on the development of positive ATM among students in the experimental groups. This led to the rejection of the null hypothesis which stated that there is no significant mean difference in Attitudes Towards Mathematics (ATM) subject between students taught using CCM teaching strategy and those taught using conventional method. The implication from the above interpretation suggests that the CCM teaching strategy exerted a more positive influence on the subjects' attitudes towards the mathematics course than the conventional method of instructional.

The findings suggest that students' attitudes towards mathematics improve after working with and experiencing concept maps. These findings are consistent with the results obtained by Rao (2003) who found that concept mapping as an instructional tool influenced the achievements of students who also reflected a positive attitude towards concept mapping as an effective teaching strategy. The findings are also in agreement with those of Kilici et al (2004) who studied the effects of students' Pre- and Post-laboratory concept Maps on Students' Attitudes toward Chemistry Laboratory in University General chemistry. The results displayed a significant difference between the experimental and control groups in post-test scores on their attitudes towards chemistry laboratory. The study by International Assessment of Educational Progress (IAEP) in 1992 found that a significant majority of the 20 countries assessed had positive attitudes towards science for both male and female students. However, the findings of this study contradicted findings in other studies. Barchok, K.H., Too, J.K, Ngeno K.J. (2013) found that CCM teaching strategy as an intervention had no effect on students' Attitude Towards Chemistry (ATC) in the experimental groups.

The collaborative concept mapping approach has the additional benefit of promoting a better student sense of inclusion and ownership, which cultivates a positive attitude to learning and might be expected to raise student metacognitive skills (Taber, 1994). However, studies by Farrand et al. (2002) and Santhanam et al. (1998) have recently highlighted important workload and contextual motivation problems surrounding the student adoption of self-directed concept mapping. In addition, there is a wider problem that, while students may come to appreciate the value of concept mapping or indeed any other teacher- or self-directed flexible learning device, their perceived relevance to successfully completing the course may be undermined by the overall institutional teaching and in particular assessment contexts (Ramsden et al., 1986; Santhanam et al., 1998).

In terms of affective acceptance, the experimental group had a more affirmative attitude for using the collaborative concept mapping strategy. Most of the students were of the opinion that collaborative concept mapping can be a feasible instructional strategy in mathematics. Most of the students liked, and felt satisfied when taught using the collaborative concept mapping strategy. The students in the concept mapping group also believed that concept mapping could be easily applied to other topics in mathematics and in other subjects. These opinions are consistent with the successful examples of using concept mapping in other disciplines (Ahlberg et al., 2005; Chang et al., 2002; Freeman & Jessup, 2004; Harpaz et al., 2004; Ritchie & Volkl, 2000).

In the current study, the research question focused on the differences in perceptions of students taught mathematical concepts using the collaborative concept mapping teaching strategy and those taught using conventional methods of instruction. The whole experimental group was more positive about the usefulness of collaborative concept mapping in enhancing learning effectiveness after they took the mathematics course in circle concepts. Almost all students in the experimental group expressed the view that the collaborative concept mapping strategy was helpful for learning mathematical concepts and understanding the structure and inter-relations of the curriculum content. The findings of this study have several implications to the teaching and learning of mathematics as they point to the need to use collaborative concept mapping strategy to reduce barriers to learning and increase learner's interest in the subject.

The null hypothesis (H_0) was rejected. The inference made as regards these findings was that, there existed significant mean difference in achievement between the experimental and the control groups in favour of the former groups. The evidence derived from the data; seem to suggest that, the students who were taught the mathematical concepts using the Collaborative Concept Mapping teaching strategy performed better than those who were taught using the conventional instruction method. There was significant difference between the control and experimental groups. Basing on the students' attitudes towards the mathematics course, the evidence adduced from the data showed that there was higher score on the attitudinal rating in the experimental groups than in the control groups.

a) The results of the study indicated that was no statistically significant difference in the Pre-test Scores (CCAT1) between experimental and control group
b) The results of the study showed that there was statistically significant mean difference in Attitudes Towards Mathematics (ATM) subject between students taught using CCM teaching strategy and those taught using Conventional Method.

The students indicated that they used concept mapping for revising and relating new information to the old. Additionally, students stated that they would use concept maps in other mathematics topics. The use of Collaborative Concept Mapping teaching strategy had significant influence in the development of attitude towards mathematics among the experimental group of students. This is in agreement with the findings of other studies. Zekele (2000) noted that achievement and attitudes towards a subject influence each other positively. This a clear manifestation that teachers and all education stake holders in Kenya have played key role in the development of positive attitude in Mathematics learning.

6.0 Conclusion

The study sought to find out whether collaborative concept mapping approach encourages students' classroom participation and interest and impacting positively on the attitude of students towards mathematics. The study has revealed that Collaborative Concept Mapping method of teaching is more effective than the conventional methods of instruction in fostering the interest of students in mathematics and thus offers a remedy to the negative attitude towards the subject that has affected student performance in mathematics and other subjects.

Based on these findings, it is advanced that the use of CCM strategy in mathematics was probably the factor influencing the student's attitude towards mathematics. These findings provide empirical evidence and basis for concluding that the use of a strategy such as CCM facilitates learner's interest in mathematics. The implication from the above interpretation, suggests that the level of achievement in learning of mathematical concepts, is marked higher when the students are taught using the Collaborative Concept Mapping Teaching Strategy (CCM) than when the conventional method is employed. Therefore, serious considerations should be given to the adoption of collaborative concept mapping strategy as a teaching and learning tool in mathematics.

7.0 Recommendations

a) CCMTS has beneficial effects on the development of positive attitude towards Mathematics learning hence teachers of Mathematics should continue to demonstrate and foster positive attitude in Mathematics education.
b) There is need for teacher training institutions to incorporate CCM as one of the strategies in the teaching and learning of Mathematics. The current teachers in service can be retooled through seminars, workshops and symposiums to enable them to integrate effectively CCM as a teaching strategy in the learning of Mathematics.
c) There is need for Mathematics curriculum developers to integrate and lay emphasis on collaborative concept mapping teaching strategy in the curriculum to help students achieve meaningful learning.

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