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EFFECTS OF EXPERIENTIAL COOPERATIVE CONCEPT MAPPING INSTRUCTIONAL APPROACH ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN PHYSICS IN NYERI COUNTY, KENYA

Patriciah W. Wambugu[1], Johnson M. Changeiywo[2], Francis G. Ndiritu[3]

[1-2]Department of Curriculum, Instruction & Educational Management,
[3]Department of Physics, Egerton University, KENYA.

[1] patriwa@yahoo.com, [2] jchangeiywo@yahoo.com, [3] fgichukin@yahoo.com

ABSTRACT

The purpose of the study was to investigate the effects of Experiential Cooperative Concept Mapping Instructional Approach (ECCA) on students' achievement in Physics. Solomon Four Non-equivalent Control Group Design under the quasi-experimental research was used. A stratified random sample of 12 Secondary Schools was drawn. The experimental groups were taught using ECCA approach while the control groups were taught through Regular Teaching Methods (RTM). Two groups were pre-tested prior to the implementation of the ECCA treatment. After five weeks, all four groups were post-tested using the Physics Achievement Test (PAT). The instrument was validated and pilot tested before use. The reliability coefficient for PAT was 0.80. The instrument was scored and data was analyzed using t-test, one-way ANOVA and ANCOVA at a significance level of alpha (α) equal to 0.05. The results of the study showed that there was a statistically significant difference between the achievement means of students who were taught through ECCA and those taught through RTM. There was no statistically significant difference in achievement with respect to gender. The researchers recommend the use of ECCA in addressing the current low performance and gender disparity in Physics.

Keywords: Experiential Cooperative Concept Mapping (ECCA), Regular Teaching Methods (RTM), Secondary School Students, Achievement in Physics, Nyeri County, Kenya

INTRODUCTION

Physics knowledge plays a fundamental role in Science and Technology. Its application has increased productivity and improved economic and industrial development in many countries of the world. Being productive in Science and Technology depends on the adoption of scientific knowledge, skills and attitudes as a way of life (Semela, 2010). Trends of development in Kenya show that careers in Physics have contributed to socio-economic and technological transformation and especially in this era of information, communication and technology (Munishi et al., 2006). These innovations require the fundamental principles of Physics education taught in Secondary Schools. These principles are taught in major topics such as Magnetism, electricity, mechanics and electronics among others. Physics is an important subject in the secondary school curriculum because it helps the learners to apply the principles, acquired knowledge and skills to construct appropriate scientific devices from available resources. In addition it prepares learners for scientific and technological vocations.

However in spite of this importance of Physics, available data indicate that students' performance in Physics has been low. This performance is not good enough for Physics oriented courses for nations that are focused towards high technology and industrialization. Table 1 shows the results of the Kenya Certificate of Secondary Education.

Table 1. Students' Performance in KCSE Physics Examination between Years 2003 and 2010

Year	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*
% mean score	44.06	47.06	49.18	40.32	41.32	36.71	31.33	35.13

Source. Kenya National Examinations Council (2004, 2007, 2009, 2011)

The results in Table 1 show that the students' performance in Physics in Kenya has been low. Considering how useful Physics is in industrialization and technology, this performance is below the expectations that Kenya would require to achieve vision 2030 (GOK, 2007).

The poor performance, therefore, reflects the handicap the nations are confronted with in having adequate number of qualified students pursuing various science oriented courses in universities and tertiary colleges that would help them acquire careers that are in demand in this era of information technology. Hoffman (2002) in his studies on promoting girls interest and achievement in Physics classes has noted that interest in learning Physics progressively decreases with increasing age for both girls and boys however, for girls it is much more significant. The decline in enrollment and graduation rates in Physics at all levels has been the case in many countries including United States of America, United Kingdom, Germany and the Netherlands (Semela, 2010). This may lead into fewer personnel in careers that require Physics background. The Forum for African Women Educationalist (FAWE, 2007) indicates that despite notable gains in African education in recent years there is still notable gender disparity in sub-Saharan African countries, especially in Science and Mathematics. The gender disparity is reflected in Kenyan Secondary Schools where the percentage mean score for girls is lower than that of boys. This is shown in Table 2

Table 2. Students' Performance in KCSE Physics Examination by Gender between the Years 2003 and 2010

Year	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*
Female mean score %	29.07	31.41	32.85	39.07	39.04	36.10	29.93	33.46
Male mean score %	32.28	35.25	35.99	40.82	42.23	36.95	31.88	35.76

Source. Kenya National Examinations Council; 2004, 2006, 2009, 2011

Table 2 shows that although the performance of Physics for both females and males is generally below average on a scale of 0-100 that of girls is lower than that of boys. There is therefore need to address this gender disparity in a way that will improve the performance of girls also, hence giving them a greater opportunity to enter in professions that require strong Physics background (Republic of Kenya, 2005).

A number of reasons have been identified by previous researchers as contributing to this poor performance in Physics. Smithers (2006) noted that the study of Physics in schools and Universities is spiraling into decline as teenagers believe it is too difficult. There is a perception among students that the subject is difficult to grasp conceptually. Williams, Stanistreet, Spall, Boyes and Dickson (2003), observed that major reasons for students finding Physics uninteresting are that it is seen as difficult and irrelevant. Another reason identified is that the teaching method used may not be interesting thereby resulting in more students dropping Physics in upper secondary schools (Gunasingham, 2009; Changeiywo, Wambugu & Wachanga, 2011). The domain of electricity is the field where most researches on students' learning difficulties is available. Psillos (1998) found that the emerging picture

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world-wide is not promising given that an adequate knowledge, for example electrical circuits has rarely been acquired by students by the end of secondary education.

Students find the concepts in electricity and magnetism difficult due to the invisible nature of electricity and magnetism that make these topics abstract. There is need therefore to improve the students' performance in Physics especially for girls. Research findings of researchers who focus on teaching various topics in Physics indicate that regular teaching methods hardly improve the teaching of the principle concepts of Physics (Adeoye, 2010, Crouch & Mazur, 2001; Tanel & Erol, 2008). The foundation for better achievement in Physics takes its root from the first two years of the secondary school cycle. The Physics curriculum at this level emphasizes the development of lower level cognitive domain that is knowledge, comprehension and application before that of the other higher levels of analysis, synthesis and evaluation (Muni et al., 2006). This enables the students understand Physics concepts at their early introduction to the subject. The teaching method employed by a teacher has been shown to reflect on students' understanding of the subject. It is also important for teachers to understand and interpret the objectives of Physics. Lack of attention to these aspects of the Physics curriculum by the respective Physics teachers, could lead to students' perception of Physics as a difficult, irrelevant and boring subject, hence performing poorly. It is therefore necessary to use methods which utilize instructional activities that students are involved in doing and thinking of the applications of what they are carrying out. Teaching needs to be participatory where all the domains of the student are engaged in learning, hence there is need to introduce, adopt and adapt the latest instructional techniques that are capable of sustaining the interest of the learners, and helping them to understand the concepts. (Adesoji & Ibraheem 2009; Muindi, 2008 Muni et al., 2006; Shakham & Barak, 2007; Soong, 2010; Wachanga, 2005).

Research findings in Science Education show that active learning has many positive outcomes. It can enhance motivation, increase inquisitiveness, facilitate retention of material, improve classroom performance, and foster development of critical thinking skills. Active learning promotes the personal relevance and applicability of course material to students and often improves overall attitudes toward learning (Kalkanis, 2002; Minas, 2003 & Vlachos, 2004).

ECCA is a composite instructional approach which combines experiential learning, cooperative learning and concept mapping. The amalgamation of ECCA is such that the elements of experiential learning are combined together with those of concept mapping and cooperative learning. The diversity of learning styles which characterize students' populations makes it necessary for teachers to constantly look for variety in the methods they use (Biggs, 2003). The full involvement of students in the learning process could be achieved through active rather than passive learning approaches. Active learning involves students directly in the learning process. This means that instead of simply receiving information verbally and visually students should actively participate in construction of meaning from learning experiences provided. Active learning includes everything from listening practices which help students to absorb what they hear to complex group exercises in which students' apply course material to real life situations and/ or to new problems (Arnold, Warner, & Osborne, 2006; Dembo, 1994;Deryakulu, Sener & Huseyin, 2010; Johnson, Johnson & Smith, 1998; Novak & Gowin, 1984; Pascul & Uribe, 2005;Slavin, 1994).

ECCA instructional approach may address diversity of learning styles, allow for critical thinking skills and engage students in active learning. This is made possible because of the elements of experiential learning, cooperative learning and those of concept mapping found in this teaching strategy. These elements when they complement each other may enhance the teaching of Physics. Experiential learning emphasizes systematic involvement of learners, as they reflect on the experience and apply them to real life situations. While cooperative learning encourages students of all performance levels to work together in small groups towards group goals and concept mapping helps learners fulfil high quality and meaningful learning outcomes as they visualize the structure of knowledge. This gives students an opportunity to express their understanding about various concepts and to show relationships with other similar concepts even as they go through the cycles of experiential learning in groups (Asan, 2007; Kolb & Kolb, 2005; Johnson, Johnson & Roseth, 2010; Novak, 2010; Newsome, Wardlow & Johnson, 2005).

The three learning approaches to instruction will be treated in the study as teaching learning arrangements, which inherently integrate deep approach to learning constructivism. To improve the student learning capability experiential learning is amalgamated with cooperative learning and concept mapping, with both cooperative learning helping small groups organizing and concept mapping helps in the organization of the knowledge content in a pictorial way. The students will learn best when they connect learning with real life experience thus making learning not only interesting but also relevant and satisfying. Further, the interactions among students on learning tasks will lead in itself to improved student achievement. Students will not only learn through experience and reflection but will also learn from one another because in their discussions of the content, cognitive conflicts will arise and adequate reasoning will be exposed leading to high quality understanding of concepts. This will lead to conceptual change rather than in fusion of knowledge (Rogers & Freiberg, 1994; Slavin, 2007).

OBJECTIVES OF THE STUDY

The following were the objectives of the study.

1. To compare students' achievement in Physics between those taught using ECCA and those taught using Regular Teaching Method (RTM).
2. To determine whether gender has an effect on students' achievement when they are exposed to ECCA instructional approach.

HYPOTHESES OF THE STUDY

To achieve these objectives, the following null hypotheses were tested at 0.05 alpha level of significance:

Ho1: There is no statistically significant difference in achievement in Physics between students exposed to ECCA and those that are not exposed to it.

Ho2: There is no statistically significant difference in achievement in Physics between boys and girls who are exposed to ECCA.

CONCEPTUAL FRAMEWORK

The conceptual framework that was used in this study was based on constructivist model of learning, and the systems approach theory of learning. Learning involves active cognitive processing of new information on existing knowledge. The knowledge imparted to the leaner must be constructed in such a way that it will be useful for long term recall and for applications in a variety of real life situations (Mestre, 1994). This study was based on the assumption that an instructional approach that involves students' cooperation and activity, using concept mapping and applying the new knowledge to real life situations may lead to worthwhile learning than a transmission approach (Hanrahan, 1998). ECCA allowed the learners to go through the four-stage learning cycle in order to effectively learn and apply

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concepts to real life situations. The learners were involved in the construction of knowledge. This was done through doing, reflecting, thinking and planning. Diagrammatic representation of the framework is represented as follows.

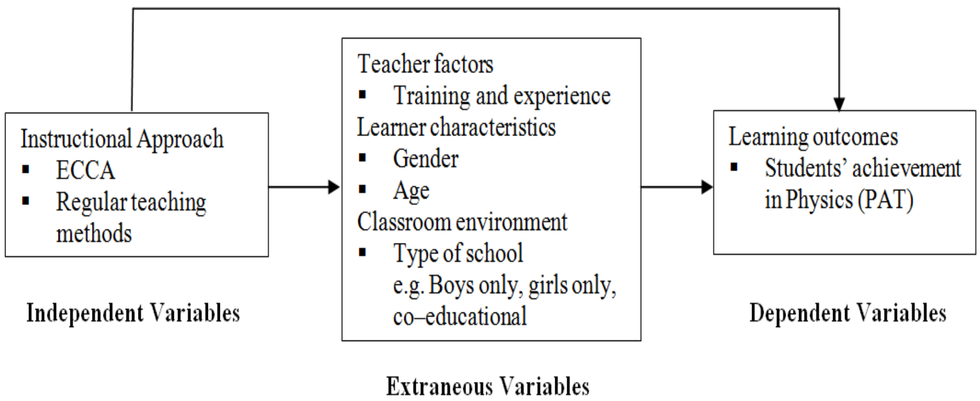

Figure 1. Conceptual framework for determining the effect of using ECCA instructional approach on students' achievement and motivation to learn Physics

Figure 1 illustrates the conceptual framework that relates the various factors considered to have an effect on students' achievement in Physics. In an ideal situation, the teaching method would affect the students' achievement in Physics. The extraneous variables in this study were teacher characteristics, type of school, age and gender of the students. The teacher characteristics were controlled by involving trained teachers who have taught secondary school Physics for at least one year. This is because the teacher training and experience determines how effectively a teacher uses the approach. The age of the students was controlled by involving Form Two students who had comparable age. Gender of the students was studied by determining their effects on students' achievement in Physics. The instructional approach used was then hypothesized to influence the students' achievement in Physics.

RESEARCH METHODS

The research study was quasi-experimental. The researchers used Solomon Four Non-equivalent Control Group Design. This design is particularly strong in quasi-experimental procedure because it ensures the administration of pre-test to two groups and post-test to all the four groups (Gall, Borg & Gall, 2003; Lammers & Badia, 2005; Wachanga & Mwangi, 2004). The design was appropriate because random assignment of the subject was not done, since secondary school classes once constituted exist as intact groups and they cannot be reconstituted for research purposes (Gall et al., 2003; Trochim, 2006). The research design may be represented as shown in Figure 2.

Group 1	0_1	X	0_2
Group 2	0_3	_	0_4
Group 3	_	X	0_5
Group 4	_	_	0_6

Figure 2. The research design used in the study

Where 0_1 and 0_3 were pre-tests, 0_2, 0_4, 0_5 and 0_6 were post-tests. X represents the

Experimental treatment, where students were taught using Experiential Cooperative Concept Mapping Approach (ECCA).

The broken lines indicates that the experimental and control groups were not formed randomly.

I. Group 1 was the experimental group which received a pre-test, the treatment condition X and the post-test.
II. Group 2 was the control group, which received a pre-test followed by the control condition and a post-test.
III. Group 3 was the experimental group which received the treatment X and a post-test but did not receive the pre-test.
IV. Group 4 was control group which received the post-test only.

Group 2 and 4 were the control groups and were taught using regular teaching methods while Group 1 and 3, the experimental groups were taught using ECCA.

Sampling Procedures and Sample size

The sampling unit was the secondary schools and not individual students since schools operate as intact groups. The sampling technique that was used in the study was Stratified sampling procedure (Sanders & Pinhey, 1979; Trochim, 2006). The various types of schools were considered as groups (strata) and then the independent samples were selected from within each of the stratum using simple random sampling. This enabled the researchers to have three strata, namely boys', girls' and co-educational a total of twelve secondary schools were selected through stratified random sampling (Fraenkel & Wallen, 2000; Gall et al., 2003). There were four boys' schools, four girls' schools and four co-educational schools and, they all had trained physics teachers with at least one year experience. The four schools in each category were randomly assigned to each of the four groups in the study. Each school provided one Form Two class for the research work. There were eight boys', nine girls' and thirty co-educational schools that were selected. Four schools from each category were randomly selected. The four schools in each category were randomly assigned to the treatment and control schools such that each group in the experiment had three schools; one boy's only, one girls' only and one co-educational school. A summary of the school and number of school is shown in Table 3.

Table 1. Summary of Schools and Number of Students Involved in the Study

School	*Female*	*Male*	*Total*
Boys' alone	-	176	176
Girls' alone	168	-	168
Co-educational	79	90	169
Total	247	266	513

A total of five hundred and thirteen form two students were assigned to the four groups as shown in Table 3. They were exposed to the same content of Magnetic Effect of Electric

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Current. Fraenkel and Wallen (2000) recommend at least 40 subjects per treatment or control group. Hence these numbers were adequate for the study.

Construction and Use of Instructional Materials

The PAT was developed from past KCSE examinations and modified to suit the study. The test had forty structured shot answer questions on magnetic effect of electric current and had a total of fifty marks. The items tested knowledge, comprehension and application of learnt material. The questions were scored dichotomously, where a score of one was given to the correct answer and zero to the wrong answer. The questions were used as a pre-test and also were re- reorganized for post-test. This allowed for comparison between the pre-test and the post-test results.

The instructional materials that were used in the study were based on the Kenya Institute of Education syllabus (KIE, 2002). The Physics topic of Magnetic Effect of Electric Current was chosen for the study and is normally covered in form two. The topic has been reported to be difficult and it is a foundational topic that combines the effects of magnetism and electricity. The instructional materials included a training manual on ECCA for teachers and a teachers' guide to implementing ECCA on Magnetic Effect of Electric Current. The manuals were used throughout the treatment period.

The teachers in the experimental groups were trained by the researcher on skills of ECCA. The treatment started and the experimental groups were taught using ECCA while the control groups were taught using RTM on the topic of Magnetic Effect of Electric Current. Each week had four lessons, one double lesson of eighty minutes and two single lessons of forty minutes. Experiments were done during the double lessons. The lessons for the experimental groups were planned such that the learning process involved the four cycles of experiential learning and students held discussions in their various groups. Also the students discussed and drew concept maps that were later presented on the chalk board for further discussions. The control groups were taught through the regular teaching methods for the same period. All Form Two students in a particular school were taught using a similar method.

Data Collection Procedures and Data Analysis

Pre-test was administered to groups 1 and group 2 before the treatment condition. After five weeks treatment condition, post-test was administered to all groups. The researchers then scored the PAT and generated quantitative data which was analyzed. Some schools had more than one stream, in such cases the results of one class were randomly selected. Data were analyzed using t-test, One-way ANOVA and ANCOVA which were undertaken with the help of Statistical Package for Social Science (SPSS, 17.0). The Least Significant Difference (LSD) Post Hoc test was used to establish where the difference in mean scores existed. ANCOVA was used to statistically cater for initial differences among the groups (Ary et al., 1979). All tests of significance were performed at a significant level of alpha equal to 0.05.

RESULTS AND DISCUSSIONS

Results of the Pre-tests

Solomon Four Non-equivalent Control Group Design was used in this study. This enabled the researchers to have two groups sit for pre-tests. Groups 1 and 2 sat for pre-tests PAT. This helped the researchers to assess the entry behavior of the students (Gall et al., 2003). Analysis of independent sample t-test for PAT was done for the two groups and the results are shown in Table 4.

Table 2. Independent Samples t-test of the Pre-test Mean Scores on PAT

Group 1, N= 125, Group 2, N= 130

Variable	*Group*	*Mean*	*SD*	*Df*	*t-value*	*P- value*
PAT	1	6.90	3.59	253	1.68	0.1(ns)
	2	6.10	3.94			

SD = standard deviation, df =253, t-critical =1.96, ns = not significant, P≤0.05

An examination of Table 4 shows that the mean scores of Groups 1 and 2 on PAT are not statistically significantly different since t (253) = 1.68, P>0.05. This means that the groups used in the study exhibited comparable characteristics. The groups were therefore regarded suitable for the study.

Effects of ECCA on Students Achievement in Physics

To determine the effect of ECCA instructional approach on students' achievement in Physics, the analysis of post-test PAT means scores was carried out. Hypothesis one, Ho1 of the study sought to find out whether there was statistically significant difference in achievement in Physics between students exposed to ECCA and those that were exposed to RTM. The mean scores of the four groups are shown in Table 5.

Table 3. The PAT Post-test Means Obtained by Students in the Four Groups

Group	*N*	*Mean*	*Sd*
1	125	28.51	6.83
2	130	11.68	6.53
3	129	29.11	7.45
4	129	12.48	5.92
Total	513		

SD = Standard Deviation.

The results in Table 5 indicate that the mean scores for Groups 1 and 3 were higher than those of Groups 2 and 4. To establish whether the mean scores were statistically different, analysis of one way variance (ANOVA) was done and the results are shown on Table 6.

Table 4. Analysis of Variance (ANOVA) of the Post-test Scores on PAT

Group	*Sum of Squares*	*df*	*Mean Squares*	*F*	*P- value*
Between Groups	35973.12	3	11991.04	266.74	0.00
Within Groups	22881.98	509	44.95		
Total	58855.1	512			

df =(3; 509), F-critical = 2.61, P ≤0.05

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The results in Table 6 show that with an alpha level of 0.05, the PAT mean scores of the experimental and control groups were statistically significant F (3,509) = 266.74, P > 0.05. To determine where the significant difference was a Post Hoc multiple comparisons was carried out. The tests were conducted using Fishers LSD procedure, at an alpha level of 0.05. The results generated from the procedure indicated that, the pairs of PAT mean scores for groups 1 and 2, groups 1 and 4 and groups 2 and 3 with an alpha level of 0.05 were statistically significant different. However, there was no statistically significant difference at alpha level of 0.05, in the mean scores of groups 1 and 3, and 2 and 4. The study involved non-equivalent control group design. This made it necessary to confirm the above results by carrying out analysis of covariance (ANCOVA) using the students' Kenya Certificate of Primary Education (KCPE) scores as the covariate. This was to reduce the effects of initial group differences statistically by making compensating adjustments to the post-test means of the groups (Gall et al., 2003). The results of the analysis of covariance are shown on Table 7

Table 7. ANCOVA of the Post-test Scores on the PAT

	Sum of Squares	*df*	*Mean score*	*F*	*P-value*
KCPE	5694.39	1	5694.39	168.30	0.00
Groups	25090.27	3	8363.43	247.19	0.00
Error	17187.60	508	33.83		

df = (3;508), F-critical = 2.61, P≤ 0.05

The results of Table 7 indicate that there was still a statistically significant difference F (3, 508) = 247.17, P< 0.05. These results of ANCOVA agree with those of analysis of variance. This therefore means that the instructional approach used on the experimental groups had significant effect on achievement as compared to the approach used on the control groups. Therefore Ho1 is rejected.

The results of this study indicate that ECCA instructional approach resulted in higher achievement than the RTM. The reason for the increase in students' achievement could be caused by the students' involvement in explaining and receiving explanation in which the concepts can be easily represented in maps, understood and applied to real life situations. ECCA gives more space and opportunities for students to discuss, solve problems, reflect on the concepts, provide ideas and help each other. The students reflect on the activities critically by sharing reactions and observations and then generalize by applying the ideas to real life situations. The results were in line with previous studies reported by other researchers on cooperative learning, concept mapping and experiential learning, such as Tarim and Akdeniz (2008), Zakaria, Chin and Daud (2010) and Healey and Jenkins (2002). The RTM instructional approaches are teacher based, therefore less opportunity is given to students for discussions, working with peers, constructing the concept maps and applying the experiences to real life situations.

Students in this study demonstrated by their improved performance that ECCA helped them to understand the learning process. It facilitated students to learn effectively and organize their knowledge in a meaningful way. Through this instructional approach the students were able to represent ideas and solve problems by connecting different concepts through construction of maps. This was very effective because they worked in cooperative groups.

The students were able to discuss and visualize the knowledge structure. They were able to apply their knowledge in other areas outside their original context, as they explained and applied their own learning to real life situation. This kind of active learning which involves the students enhances improved classroom performance and fosters development of critical thinking skills. It promotes the personal relevance and applicability of course material to students and improves overall attitudes towards learning. Other researchers like Vlachos, (2004) and Piliouras and Kokotas (2002) concur with these findings.

When students are placed in competitive academic situations, learning may be viewed as a commodity to be competed for, and students can be entrained to view other students as opponents because a students' success is measured against the performance of their peers. In contrast, cooperative learning situations the students experience learning as a collaborative process. Other students become resources and partners in learning, and the success of a student is, in part dependent on the involvement of their peers. This resulted in higher achievement when ECCA was used. Research studies done on cooperative learning by Johnson, Johnson and Stanne, (2000) who conducted a meta- analysis on the impact of cooperative learning on student achievement concurs with these findings since they found out that students in cooperative learning situations scored, on average almost two thirds of standard deviation higher than their peers in competitive and individualistic situations. Furthermore cooperative learning has been associated with improved attitude towards subject learnt, increased interest in schooling, expanded student faculty interactions, improved classroom behavior and climate, and the development of life-long learning skills. The elements of cooperative learning in ECCA helped to improve achievement in Physics.

ECCA helped students to understand, integrate, and clarify Physics concepts hence improved performance. Concept mapping provided effective meaningful learning as it was reflected in the improved performance. The construction of concept maps helped the students penetrate the structure and meaning of the knowledge. These findings agree with those of Chang Chiou (2008) in his study on effects of concept mapping on students' learning achievements and interests who found that adopting concept mapping strategy can significantly improve students' learning. Most new learning occurs through derivative and correlation sublimation of new concepts involving integration of new information on existing knowledge. This confirms that concept mapping is an efficient strategy for providing meaningful learning. The results agree with those of Asan (2007), who found that the use of concept mapping led to better achievement in science. In ECCA concept mapping were done in the cooperative groups even as the students went through the stages of experiential learning. This helped students to counter anxiety and encouraged them to reflect in their own thinking. The students worked together on drawing concept maps. The exercise resulted to a genuine effort to negotiate the meaning of the Physics concepts, resulting to improved achievement. Further students were able to apply the knowledge to real life situations. Interaction of students with each other when doing group activities, sharing reactions and observations, systematically examining their experiences by drawing the concepts maps and evaluating different views, provides a better understanding atmosphere as proved by the outcome of this study. Learnt information is not immediately forgotten indicating the effectiveness of ECCA as an effective instructional approach. These research findings concur with the findings of Nuhoglu and Yalcin (2006) who found an increased students' achievement when learning cycle model was used in Physics laboratory.

ECCA offers potential for a learning atmosphere of shared partnership, a common purpose and joint management as portrayed by the cooperative groups. Concept Mapping helps students to reflect on their own knowledge, concentrate themselves in the process of group

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work. This gives the teacher information about students' knowledge. This is in agreement with the findings of (Canas, Reiska, Alberg & Novak, 2008). While experiential learning addresses the diversity of learning styles as the students are actively engaged in their own learning. The experiences are also structured to require that the learner takes initiative, makes decisions and is accountable for the results in their groups. This is in agreement with the findings of Arnold, Warner and Osborne (2006). In the learning sessions passiveness in control groups turns the students into passive listeners and after a short time they begin to lose concentration from the course, and resort to rote learning. While in the experimental groups, students spend greater efforts participating in group discussions with an involvement in personal experiences. They use a systematic approach to problem solving and focus on understanding the meaning of ideas and presentation of these ideas in concept maps. This in the long run helps the students understand the Physics subject matter and hence perform well.

ECCA provides a classroom environment in a way that is beneficial for student academic achievement and thus provide a satisfying atmosphere. As Glasser (1986) points out that there is no sense in telling learners how valuable classes are and how much they need them unless the classes are structured so that they are more satisfying to students. In competitive learning situations students compete to achieve their individual goals. This tends to create a negative interdependence in the class where students perceive they can obtain good grades when others do worse. In such an environment there is little motivation to work together while competition encourages some students to work hard to do better and other students are labeled as being failures in the class. There are also a number of students who give up because they do not believe that they have a chance to do well in the competition.

In ECCA instructional approach, learners work together to accomplish shared goals and they are focused on the practical applications and getting things done. They are therefore motivated to work together for mutual benefit in order to maximize their own and each others' learning. This creates a positive interdependence among learners. They perceive they can reach their goals when others in the same learning groups also do as much as possible (Kagan, 1989).

ECCA instructional increases improved social abilities of learners. Students are engaged in a higher rate of interaction with each other when in the cooperative groups, presentations of the concept maps, and applications to real life situations. This results in improvement of interpersonal communication skills. In addition, the students undertake the responsibility of other members and appreciate the ideas of others. The biggest challenge facing the contemporary teacher is to effectively respond to the diversity of learning styles, and successfully enable the learner to become increasingly self-directed, to work in a team, taking charge of the team-mates and be able to build organized knowledge and its application in his/her situations. From the findings of this study, ECCA is capable of meeting these challenges and therefore improve the academic achievement of secondary school Physics.

Gender of Students and the Effect of ECCA on the Achievement in Physics

The study set out to examine the effect of ECCA on the performance of boys and girls in the subject. Hypothesis two Ho2 of the study sought to establish whether there is a statistically significant difference between the achievement of boys and girls exposed to ECCA. There were 134 boys and 120 girls, these were boys in group 1 and 3 and the girls in the same groups. An independent sample t- test was carried out in order to test the hypothesis. The results of independent sample t-test for PAT post-test mean scores are shown in Table 8.

Table 8. Independent Samples t-test of the Post-test PAT Scores of Boys and Girls who were exposed to ECCA

Gender	*N*	*Mean*	*SD*	*t*	*df*	*P-Value*
Boys	134	29.38	7.08	1.33	252	0.18
Girls	120	28.18	7.19			

df=252, t-critical = 1.96, P≤0.05

The results indicate that there was no significant difference between PAT post-test means of boys and girls, t (252) = 1.33, P < 0.05. Analysis of covariance was carried out to account for any initial differences that could had existed between the boys and girls. Table 9 displays the results of ANCOVA for post-test PAT mean scores, with KCPE scores as covariate.

Table 9. ANCOVA of the Post-test PAT Scores of Boys and Girls who were exposed to ECCA

	Sum of Squares	*df*	*Mean Square*	*F*	*P- Value*
Gender	15.31	1	15.31	0.42	0.52
KCPE	3615.3	1	3615.3	98.44	0.00
Error	9218.25	251	36.73		

df= (1;251), F-critical = 3.89, P≤0.05

The results of Table 9 indicate that the difference in achievement between boys and girls were not statistically significant, F (1, 251) = 0.42, P > 0.05. Hypothesis Ho2 is therefore retained implying that boys and girls who were exposed to ECCA perform equally well. This means that ECCA has the same effect on boys as well as girls in achievement in Physics.

Gender of Students and the Effects of ECCA on the Achievement in Physics

The results of the study have shown that there is no statistically significant difference between the achievement of boys and girls who were taught through ECCA instructional approach. FAWE (2007) in a report on center of excellence reported that one of the factors stated for keeping girls out of school is failure in mathematics and Science. Teachers in the competitive classes consciously and unconsciously discouraged girls' participation in learning.

Kelly (1998) in a Meta analysis research on gender differences in teacher-student interactions in schools in UK, USA, Canada, Australia and Sweden found out that teachers spent 44% of their time giving attention to girls and 56 % of boys. The findings showed that girls were willing to take part in lessons but were not enabled to do so since boys received more attention during instruction. This practice discourages girls and affects their self confidence. ECCA instructional approach unlike these teaching methods enabled both boys and girls to participate equally well. A study done by Klahr, Triona and Williams (2006) showed that girls demonstrated a tendency to underestimate their abilities signifying low self- confidence.

These low levels seem to translate to lack of interest and low achievement levels. Not only do girls begin to shy away from sciences but they also begin to dropout of science classes as

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they progress through school (Stake, 2006). The use of ECCA instructional approach however, disagrees with these findings as it is reflected by the improved achievement of both boys and girls.

In the modern world where women make up to over half the work force (Adya & Kaiser, 2005), it seems fair that girls should have an equal opportunity to fully participate in class and therefore pursue whichever career they choose. Murphy and Whitelegg (2006) argue that girls will perform at the same level as boys when they are given the opportunities and right education tools. To ensure that boys and girls become lifelong learners with the capacity to be top academic confident and active members of society, there is need to have teaching methodologies that are gender positive. Interactive teaching methodology with a gender focus may enable more participation of girls in class.

This requires a teaching approach that will allow students to apply the acquired knowledge to real life situations, where students will relate what they learn to the world around them, especially for girls. ECCA instructional approach assists the Physics teacher in balancing the classroom interaction patterns between boys and girls. The participatory, cooperative group drawing of concept maps in groups enhances this.

Freeman (2007) found out that girls who had taken part in laboratory work intervention improved their Science achievement compared with the girls who had received traditional teaching with no laboratory component. The laboratory work demanded active participation by all students. This participation was responsible for the girls' higher achievements scores. These results concur with the findings of Wachanga, (2002b) in his study on effects of cooperative class experiment teaching method that boys and girls performed equally well when exposed to this instructional strategy.

This is in agreement with what the researcher found when ECCA instructional was used in this study. Also in the 3rd international conference on women in Physics, whose purpose was to analyze the international status of women in Physics, including recent progress in promoting their participation? And to also build each participating country's capacity to improve women's advancement in Physics and related fields among others, the following were some of the problems cited to the advancement of Physics in girls;

a. Lack of knowledgeable and enthusiastic teachers.
b. Teachers' perceptions and prejudices doubting girls' abilities.
c. Alienating classroom atmosphere.
d. Textbooks and teaching methodologies that is unfriendly to women.
e. Girls' perception of themselves; lacking assertiveness and self confidence (Zastarker, 2009).

Such problems could be dealt with if a teaching strategy that would be friendly to girls such as ECCA is used. This would not only help the girls to change their perceptions but also help to remove the teachers' perceptions and prejudices.

In this study, all students were actively involved in the cooperative groups through experiences in the activities and understanding of the Physics concepts then drawing the concepts maps in groups. Since the performance of boys and girls was no different in this study, it therefore means that ECCA as a teaching approach can be used to address the gender disparity in achievement at KCSE Physics.

CONCLUSIONS

Based on the findings of the study, the following conclusions were made:

1. ECCA instructional approach produced a significant impact on academic achievement in secondary schools Physics. This means that it facilitates students' learning of Physics better than regular teaching methods.
2. The students' achievement in Physics when the students were taught through the ECCA instructional approach was not affected by their gender.

RECOMMENDATIONS

Pedagogical competence of Physics teachers stands as a major challenge. The teachers need skills to concretize theoretical and practical notion of Physics in a manner that links acquired, knowledge, skills and attitude to students' everyday life situations. Based on the findings of the study therefore the following recommendations have been made;

1. Teacher education programmes should be focused towards preparing Physics teachers to acquire appropriate skills in instructional strategies such as ECCA instructional approach which could promote effective teaching-learning process. ECCA instructional approach should be included in the methods courses in training of Physics teachers in university and Teacher training Colleges. The teacher preparation course must emphasize the importance of using all components of ECCA instructional approach for positive student learning.
2. The findings of this study confirmed that experience, drawing of concept maps and working in groups plays a central role in the learning process. Educators and curriculum developers should place more emphasis on the concepts of ECCA instructional approach when developing the Physics curriculum.
3. ECCA offers a critical link between the classroom and the real world. Active involvement with group activities, real life situations improves students' motivation to learn Physics and understanding of abstract theories, therefore improving on achievement. Teachers should incorporate ECCA Instructional approaches into their classroom activities and encourage students to participate.

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