Effects of the Cooperative Class Experiment Teaching Method on Secondary School Students' Chemistry Achievement in Kenya's Nakuru District

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Successful teaching and learning of chemistry depends partly on correct use of a teaching method whose activities target most learning senses. Though chemistry enhances students' learning of biology, physics and agriculture on which Kenyan industries and prosperity depend, most secondary school students in Kenya perform poorly on the subject. This study sought to examine how the co-operative class experiment (CCE) teaching methods affect students' achievement. Using a non-equivalent control group design with 521 randomly selected students, the study found that CCE method facilitated students' chemistry learning more than regular methods. Gender did not affect achievement. Neither did school type significantly affect girls' achievement when CCE method was used but it significantly affected boys' achievement with boys in boys' schools attaining higher scores. Since CCE method benefited students irrespective of school type, education authorities should encourage chemistry teachers to use it and teacher educators to make it part of the teacher-training curriculum.

Cooperative Class Experiment Teaching Method, Secondary School, Chemistry Achievement, Kenya

INTRODUCTION

Though teachers with high morale, motivation and a mastery of knowledge, learner difficulties and capacity to facilitate learning are important (Grauwe, 1999; Zadra, 2000), correct use of an appropriate teaching method is critical to the successful teaching and learning of chemistry. Students may learn names and definitions of chemical substances theoretically. But to master chemical reactions, they need to mix the chemicals and observe subsequent reactions. Knowledge of how teaching methods affect students' learning may help educators to select methods that improve teaching quality, effectiveness, and accountability to learners and the public. It may also help them keep up with information technology, globalisation and to avoid the *status quo* (Foster, Pinkest and Husman, 1991).

During the last four decades, Kenya's secondary school students' chemistry achievement has remained low (KNEC, 1999) necessitating several curriculum reviews. The first post-colonial chemistry curriculum, developed soon after attaining independence in 1963, was teacher and book centred and therefore inappropriate because it neglected students' abilities, interests and potential (Kenya Government, 1976; Kimiti, 1984). Later curricula attempted to ensure appropriate teaching methods but were not implemented successfully for lack of qualified chemistry teachers

(Kimiti, 1984; Mullei, 1987). They include the 1967 UNESCO Chemistry Pilot Project, the 1970 School Science Project and the 1973 Kenya National Examinations Council Chemistry Syllabus.

With the introduction of the 8-4-4-education system in 1985, the study of chemistry became compulsory in Forms 1 and Form 2 but many schools now offered it from Forms 1 to Form 4. The chemistry syllabus encouraged small group teaching and teaching through experiments and projects and although curriculum developers wanted chemistry taught through these learner-based approaches, its teaching in secondary schools remained largely expository (KIE, 1992; Kiboss, 1997; Mullei, 1987). The class experiment teaching method involves supervised learning activities with students doing practical work individually or in-groups (Das, 1985) while the Cooperative Class Experiment teaching method (CCE) incorporates co-operative learning into class experiments.

Cooperative learning is a comprehensive approach to teaching that derives from a theory of education and encompasses key assumptions about what students should learn and how they learn (Duke, 1990). Lessons in the cooperative learning strategy are arranged so that each student, ranging from the fastest to the slowest learner, has a contribution to make (Sapon-Shevin and Schniedewind, 1990). Because the students, in this approach, tutor one another, they are likely to acquire greater mastery of the material than in the common individual study with recitation pattern. Furthermore, the shared responsibility and interaction are likely to generate better inter-group relations, and result in better self-images for students with histories of poor achievement (Joyce and Weil, 1980).

Kenya's need for trained chemistry teachers is being met by her public universities (Egerton, Maseno, Kenyatta, Nairobi and Moi) and diploma colleges (Kenya Science Teachers' College and Kagumo Teachers' College). However, having trained teachers does not necessarily improve the quality of education (Mullei, 1987) as students' poor results in the Kenya Certificate of Secondary Education (KCSE) Physical Science Examination demonstrate. In 1998, for instance, only 17 per cent of the candidates obtained grade D+ and above (KNEC, 1999) while in the 1995 KCSE Chemistry Examination, over 62 per cent of the candidates obtained grade D+ and below. This number rose above 74 per cent in 1996 (Kariuki, 2001).

STATEMENT OF THE PROBLEM

Kenya secondary school students' continued poor performance concerns many Kenyans particularly because knowledge of chemistry facilitates the learning of biology, physics and agriculture (KNEC, 1992 and 1999; Royal Society, 1986). Out of the 52,096 boys and 36,753 girls entered for the 1998 KCSE examination, for instance, only 14 per cent and 10 per cent respectively scored grade D+ and above. Effective teachers generate the greatest opportunity for students to learn and technically manage instruction but teaching methods that allow students to use hands, eyes, ears and the mind also enhance effective learning and students' achievement (Mills, 1991; Sogomo, 2001; Waihenya, 2000). Expository teaching encourages competition among students but students who compete and fail or who do not even try to compete, resent those who succeed (Dembo, 1994; Sapon-Shevin and Schniedewind, 1990). Cooperative learning, on the other hand, enables students to help one another to learn in small groups. However, grouping students and telling them to work together does not, in itself, produce cooperation and higher achievement because some students seek a so-called 'free ride' on others, while high ability students may take over in ways that benefit themselves at the expense of the lower achievers (Johnson and Johnson, 1990). Pressure to conform may also suppress individual efforts. For cooperative group work to benefit students, they should trust one another, communicate effectively, accept and support one another, and resolve conflicts constructively (Johnson and Johnson, 1990). Hence the need to determine how CCE method improves students' learning and achievement.

OBJECTIVES OF THE STUDY

The study sought to investigate how CCE method affected students' achievement, to ascertain whether the cognitive achievement of students taught through CCE was statistically different from that of students taught through regular teaching (RT) methods, and to examine whether gender and group composition affected students' achievement.

NULL HYPOTHESES

The following hypotheses were tested at 0.05 α-level.

Ho_1 There is no statistically significant difference between the achievement scores of students exposed to CCE and those who are not so exposed.

Ho_2 There is no statistically significant difference in achievement scores between boys and girls who are exposed to CCE.

Ho_3 There is no statistically significant difference in achievement scores between girls exposed to CCE and those who are not so exposed.

Ho_4 There is no statistically significant difference in achievement scores between boys exposed to CCE and those who are not so exposed.

Ho_5 There is no statistically significant difference in achievement scores between girls in co-educational classes and girls in girls' classes.

Ho_6 There is no statistically significant difference in achievement scores between boys in co-educational classes and boys in boys' classes.

The conceptual framework (Figure 1) of this study was based on the systems theory developed by Ayot and Patel (1987) and Gerlach and Ely (1980) that portrayed the teaching-learning process as dynamic with inputs and outputs. With the assumption that teaching methods that involved students' cooperation led to worthwhile learning (Hanrahan, 1998), the study involved guided discovery in which teachers played key roles in planning and facilitating learning. Unlike expository teaching in which teachers explain all the information that students must learn, discovery learning helped students to take responsibility for their learning, emphasized high-level thinking, focused on intrinsic rather than extrinsic motivation, and helped the students remember important information (Bruner, 1961; Dembo, 1994).

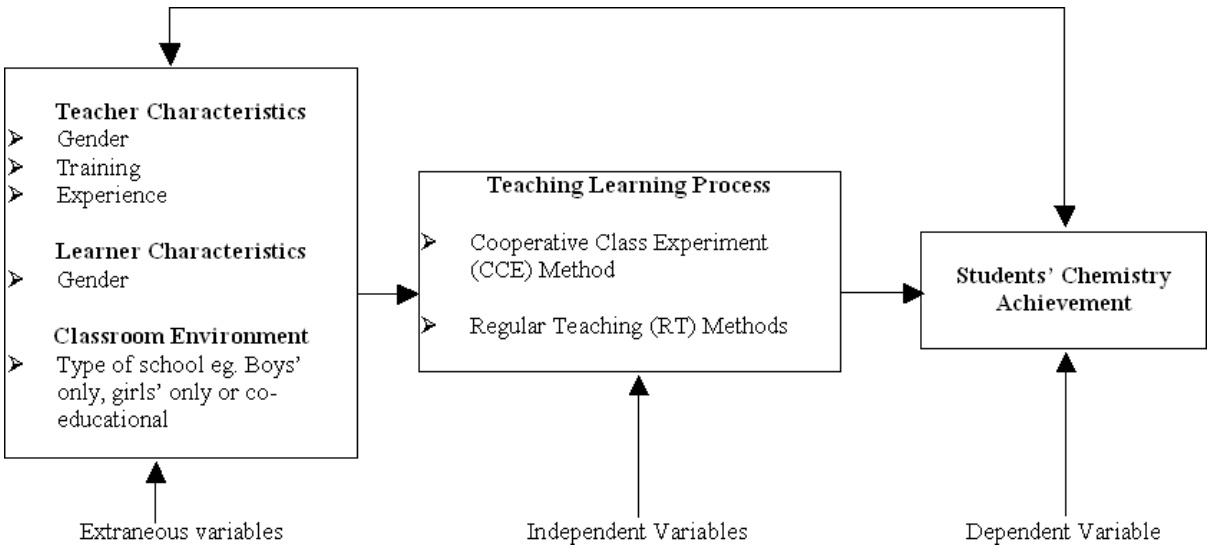

Figure 1. The conceptual framework used to investigate the effect of the CCE teaching method on students' chemistry achievement

RESEARCH METHOD

Since the classes existed as intact groups and could not, for ethical reasons, be re-constituted for research purposes, the study used Solomon's four-group, non-equivalent control group design, shown in Figure 2, which was rigorous enough for experimental and quasi-experimental studies (Borg and Gall, 1989). This design controlled all major threats to internal validity except those associated with interactions of selection and history, selection and maturation, and selection and instrumentation (Cook and Campbell, 1979). To control for teachers' gender, training and experience as sources of internal invalidity, only male teachers of equivalent training and experience were chosen. Form 1 students of approximately the same age were used to avoid the threat of maturity to internal validity.

Group 1 (N=142)	O_1	X	O_2	(Experimental Group)
Group 2 (N=129)	O_3	*	O_4	(Control Group)
Group 3 (N=120)	*	X	O_5	(Experimental Group)
Group 4 (N=130)	*	*	O_6	(Control Group)

Key: Pre-tests: O_1 and O_3; Post-tests: O_2, O_4, O_5 and O_6; Treatment: X

Figure 2. Solomon's Four Group, Non-Equivalent Control Group Design

Group 1 received the pre-test, X and post-test; Group 2 received a pre-test and post-test; Group 3 was not given the pre-test but received X and post-test; and Group 4 received the post-test only. Groups 2 and 4 were taught through the RT methods.

A stratified random sample of 12 schools, comprising four boys', four girls' and four co-educational schools was drawn from Nakuru District. The District Education Office (DEO) provided a list of secondary schools, information on Chemistry teachers' demographic characteristics, Form 1 class gender composition, school resources (science laboratory, chemicals, equipment and library), and students' ability based on their KCPE examination results while school records provided information on class composition and learner characteristics. Only schools with adequate apparatus and chemicals for teaching acids, bases and indicators were selected.

The four schools in each category were randomly assigned to treatment and control conditions. Each group had one boys', one girls' and one co-educational school. Randomly assigning the schools to the four groups controlled interaction between selection and maturation while interaction between selection and instrumentation was controlled by ensuring that administration of the instruments across schools was kept as similar as possible (Zechmeister and Shaughnessy, 1994). The instructional materials used were those approved by Kenya Institute of Education (KIE) and contained descriptions of chemistry experiments, safety precautions and two manuals, one for teachers and one for students. A 30 short answer Chemistry Achievement Test (CAT) whose Kuder-Richardson K-R20 reliability coefficient was 0.82 (Popham, 1990), which is above the 0.70 threshold for acceptable reliability (Fraenkel and Warren, 1990), tested knowledge, comprehension and application of acids, bases and indicators. Before administration, the CAT was pilot tested in girls', boys' and co-educational schools that were not part of the study but with similar characteristics.

Before pre-tests, teachers trained students in the experimental Groups 1 and 3 for two months on cooperative learning. Each week during the five-week treatment period had one lesson of 80 minutes in which students performed experiments and one of 40 minutes in which they discussed the topic or performed additional experiments. Students in the control Groups 2 and 4 were taught

through regular methods whose experiments involved teacher demonstrations. A post-test was given soon after the treatment ended supervised by one of the researchers. ANOVA was used to estimate differences in the four means of post-test scores while an F-test tested whether the differences were significant. For two means, a t-test was used because of its superior power in detecting differences between two means while ANCOVA was used to detect initial differences in the treatment and control groups (Borg and Gall, 1989; Coolican, 1994).

RESULTS

The CAT pre-test mean scores for Groups 1 and 2 and for male and female students were not significantly different, implying that the groups had comparable characteristics and therefore suitable for the study (Table 1 and 2). The independent sample t-test of CAT pre-test scores, based on school type, showed that students in co-educational schools were weaker compared with students in boys' and girls' schools (Table 3). ANCOVA was used to correct for initial group differences.

Table 1. Independent Samples t-test of Pre-test Scores on CAT

Variable	Group	Mean	Std. Dev.	t-value	p-value
CAT	1 (N=142)	5.32	2.4	0.40	0.69 (ns)
	2 (N=129)	5.19	3.0		

ns = not significance at $p<0.05$ level; CAT maximum score = 50

Table 2. Independent Samples t-test of Pre-test Scores on CAT Based on Gender

Variable	Gender	Mean	Std. Dev.	t-value	p-value
CAT	Male (N = 152)	5.14	2.24	0.85	0.40 (Ns)
	Female (N = 119)	5.42	3.22		

Table 3. Independent Samples t-test of Pre-test Scores on the CAT Based on School Type

Gender	School Type	N	Mean	Std. Dev.	t-value	p-value
Male	Boys'	98	5.88	2.16	6.15	0.00 (s)
	Co-ed	54	3.79	1.69		
Female	Girls'	81	6.53	3.28	6.33	0.00 (s)
	Co-ed	38	3.05	1.16		

Effect of CCE on Students' Achievement

One-way ANOVA was used on students' post-test CAT scores to estimate the effect of CCE on student's chemistry achievement (Table 4 and 5). The differences in achievement among the four groups were significant ($F(3, 517)=14.17$, $p<0.05$).

The Least Significant Difference (LSD) test shows that the CAT mean scores of Groups 1 and 2, 1 and 3, 1 and 4, and 2 and 3 were significantly different at 0.05 a-level but the mean scores of groups 2 and 4, and 3 and 4 were not significantly different. Using students' KCPE examination scores as covariates (Table 6 and 7), ANCOVA confirmed that the differences between the means were significant at 0.05 a-level ($F(1, 516) = 23.27$, $p<0.05$). The post hoc pair-wise comparisons based on the ANCOVA show significant differences between Groups 1 and 2, 1 and 4, 2 and 3 and 3 and 4. Differences between Groups 1 and 3, and 2 and 4 were not significant. The mean scores of Groups 1 and 3 were almost similar but higher than for Groups 2 and 4 (Table 6). The pre-test did not interact significantly with treatment and did not affect students' learning. The use of CCE resulted in higher students' achievement compared to the RT methods since Groups 1 and 3 obtained significantly higher scores. Therefore, H_{01} was rejected.

Table 4. Students' CAT Post-test Mean Scores

Group	1	2	3	4	Total
N	142	129	120	130	521
Mean Score	27.95	21.03	23.64	22.00	23.76

Table 5. ANOVA of Post-test Scores on the CAT

	Sum of Squares	df	Mean square	F	p value
Between Groups	3861.44	3	1287.15	14.17	0.00
Within Groups	46972.55	517	90.86		
Total	50833.99	520			

Table 6. Adjusted CAT Post-test Mean Scores for ANCOVA with KCPE Mark as Covariate

	N	Adjustment CAT Mean Score
Group 1	142	26.45
Group 2	129	21.58
Group 3	120	26.20
Group 4	130	20.74

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

	Sum of Squares	df	Mean Square	F	p-value
KCPE	201912.46	1	20912.46	414.075	0.00
GROUP	3526.08	3	1175.36	3.27	0.00
Error	26060.10	516	50.50		

Table 8 shows adjusted CAT post-test mean scores for ANCOVA with pre-test CAT as Covariate while Table 9 shows ANCOVA of the CAT post-test scores with CAT pre-test as Covariate. The difference between Groups 1 and 2 is highly significant ($F(1, 268) = 37.73$, $p<0.05$). Since Group 1 was taught through CCE while Group 2 was taught through RT methods and the CCE method resulted in higher achievement, H_{01} was rejected.

Table 8. Adjusted CAT Post-test Mean Scores for ANCOVA with Pre-test CAT as Covariate

Group	N	Mean	Std. Error
12	142129	27.8321.16	0.7490.786

Table 9. ANCOVA of the CAT Post-test Scores with CAT Pre-test as Covariate

	Sum of Squares	df	Mean Square	F	p-value
CAT (Pre-test)	7462.36	1	7462.36	93.69	0.00
GROUP	3005.49	1	3005.49	37.73	0.00
Error	21346.47	268	79.65		

Table 10 shows the mean gain between students' CAT pre-test scores and post-test scores, which was higher for the experimental than the control group. The paired samples t-test between pre-test and post-test mean scores indicated that both Group 1 and 2 ($t(141) = 38.33$, $p<0.05$, $t(128) = 16.03$, $p<0.05$), gained significantly from the teaching. However, the CCE group had a higher mean gain than the control group implying that the CCE method resulted in higher achievement than the RT method.

Table 10. A Comparison of Students' Mean Scores with their Mean Gain in the CAT

	Overall (N = 271)	Group 1 (N = 142)	Group 2 (N = 129)
Pre-test Mean	5.26	5.32	5.19
Post-test Mean	24.66	27.95	21.03
Mean Gain	19.40	22.63	15.84

Effect of CCE on Gender

There was no significant difference between the 145 boys and 117 girls exposed to the CCE method (Groups 1 and 3) but girls had a slightly higher mean score than boys did (Table 11) ($t(260) = 0.62$, $p>0.05$). An ANCOVA done to account for initial differences in achievement, showed no significant difference between boys and girls ($F(1, 259) = 1.36$, $p>0.05$), implying that when exposed to the CCE method, the boys and girls performed equally well (Table 12). Therefore, H_{02} was retained.

Effect of CCE on Girls' Achievement

ANCOVA done on girls' post-test scores (Tables 13 and 14) shows that the 117 girls taught through CCE method did significantly better than the 119 girls, in the control condition, taught through the RT methods ($F(1, 233) = 5.26$, $p<0.05$). Therefore, H_{03} was rejected.

Table 11. Independent Samples t-test of Post-test CAT scores of Boys and Girls Exposed to CCE

Gender	N	Mean	Std Dev.	t	df	p-value
Boys	145	25.69	8.6	0.62	260	0.54
Girls	117	26.33	8.0			

Table 12. ANCOVA of Post-test CAT scores of Boys and Girls Exposed to CCE

	Sum of Squares	df	Mean Square	F	p-value
GENDER	65.18	1	65.18	1.36	0.25
KCPE	5683.21	1	5683.21	118.46	0.00
Error	12425.33	259	47.97		

Table 13. ANCOVA of Post-test CAT Scores of Girls Exposed to CCE and Girls in the Control Condition (KCPE Score as Covariate)

	Sum of Squares	df	Mean Square	F	p-value
KCPE	14118.07	1	14118.07	307.65	0.00
GROUP	241.16	1	241.16	9	0.02
Error	10692.07	233	45.89	5.25	

Table 14. Girls' Adjusted CAT Post-test Mean Scores (KCPE Score as Covariate)

Treatment	N	Mean	Std. Error
CCE	117	26.89	0.63
Control	119	24.86	0.62

Effect of CCE on Boys' Achievement

Boys exposed to CCE performed significantly better ($F(1, 282) = 89.53$, $p<0.05$), than boys in the control groups (ANCOVA: Tables 15 and 16). Therefore, H_{04} was rejected.

Table 15. ANCOVA of the Post-test CAT Scores of Boys Exposed to CCE and Boys in the Control Condition with KCPE Scores as Covariates

	Sum of Squares	df	Mean Square	F	p-value
KCPE	6416.84	1	6416.84	132.37	0.00
GROUP	4340.23	1	4340.23	89.53	0.00
Error	13670.80	282	48.48		

Table 16. Boys' Adjusted CAT Post-test Scores with KCPE Score as Covariate

Treatment	N	Mean	Std Error
CCE	145	25.86	0.58
Control	140	18.05	0.59

A Comparison of Girls' Achievement Between Co-educational and Girls' Classes

There were 82 girls exposed to CCE in girls' schools and 35 in co-educational schools (Tables 17 and 18). The girls' mean score in co-educational schools was higher than in girls' schools but the difference was not significant ($F(1,114)=1.86$, $p>0.05$), implying that the CCE method is more beneficial to girls in co-educational than in girls' schools. However, this finding was not conclusive and therefore, H_{05} was retained.

Table 17. Girls' Adjusted CAT Post-test Mean Scores in the Experimental Groups

Schools' Type	N	Mean	Std Error
Girls'	82	25.79	0.64
Co-ed	35	27.60	1.06

Table 18. ANCOVA of Girls' CAT Post-test Mean Scores in the Experimental Groups Based on School Type

	Sum of Squares	df	Mean Square	F	p-value
KCPE	3184.96	1	3184.96	107.68	0.00
SCHOOL TYPE	54.859	1	54.86	1.86	0.18
Error	372.03	114	29.58		

A Comparison of Boys' Achievement Between Co-educational and Boys' Classes

Eighty-eight boys in boys' and 57 boys in co-educational schools were exposed to the experimental condition (Tables 19 and 20). The boys' mean score in boys' schools was significantly higher than that of boys in co-educational schools ($F(1,142)=8.79$, $p<0.05$). Consequently, H_{06} was rejected.

Table 19. Boys' Adjusted CAT Post-test Mean Scores in the Experimental Groups

School Type	N	Mean	Std Error
Boys'	88	27.34	0.85
Co-ed	57	23.15	1.07

Table 20. ANCOVA of the Boys' CAT Post-test Mean Scores in Experimental Groups Based on School Type

	Sum of Squares	df	Mean Square	F	p-value
KCPE	883.05	1	883.05	14.82	0.00
SCHTYPE	523.68	1	523.68	8.79	0.00
Error	8463.38	142	59.60		

DISCUSSION

Students taught through the CCE method performed significantly better than those taught through the RT methods. This implies that the CCE method enhanced students' achievement more than the RT methods did. A comparison of lecture and cooperative learning on students' chemistry achievement at the university undergraduate level found no significant difference (Banerjee, 1997). However, in Barnerjee's study, chemistry experiments were not performed during the teaching process and the cooperative learning class did not get enough time to adjust to the new learning strategy. Students need sufficient time to develop the confidence and social skills necessary for effective participation in a cooperative-learning class (Johnson and Johnson, 1990). In this study, the researchers exposed students in the experimental groups sufficiently to the characteristics of cooperative learning before starting treatment.

Slavin (1990) cautions teachers who believe students can simply be placed in-groups, given interesting materials or problems to solve and allowed to discover information or skills. Successful cooperative learning should always include direct instruction because cooperative activities supplement, but do not replace, direct instruction. However, they involve individual accountability because group success depends on members' contribution to a team task. This study was done with these issues in mind and the results show that use of CCE method leads to better students' achievement than the RT methods.

Positive interdependence is critical to successful application of the CCE teaching method. It benefits both the weak and bright students because group memberships and interpersonal interaction are not, in themselves, sufficient to produce higher achievement and productivity.

Weak students benefit from interaction with brighter students and when bright students explain their ideas to others, they learn the material they are explaining in more depth and remember it longer (Johnson and Johnson, 1992; Johnson, Johnson and Smith, 1998). In a cooperative group, bright students are also seen as resources and are valued by team-mates. The CCE method exhibited these qualities. Hence the higher achievement reported.

Effect of CCE on Boys' and Girls' Achievement

There was no significant difference in achievement between boys and girls exposed to CCE method but both performed significantly better than those taught through RT methods. The Forum for African Women Educationists (FAWE) (1999) indicates that science achievement for girls in Kenya was lower than for boys partly due to their poor attitudes towards science and discouragement by their teachers. Some teachers assumed, for instance, that girls could not answer certain questions or perform certain tasks. They made remarks that indicated their biased beliefs or feelings that girls were unintelligent and lazy while using positive reinforcement more on boys than on girls (FAWE, 1997). The CCE method helped chemistry teachers to balance classroom interaction between boys and girls enabling them to give similar attention to both sexes, which led to improved achievement by both. It could be used to reduce gender disparity in achievement at KCSE chemistry examination.

A Comparison of Students' Achievement Between Co-educational and Boys' or Girls' Classes

According to the pre-test, students in co-educational schools were significantly weaker, before treatment, than students in boys' or girls' schools. Post-test results indicated that the CAT mean score for girls exposed to CCE in the co-educational schools was higher than for girls in girls' schools but the difference was not significant at the 0.05 a-level. In the control condition, the co-educational girls' post-test mean score was lower than that of girls in girls' schools. It was therefore noted that the CCE method enhanced girls' achievement in co-educational classes by a large margin implying that it was particularly beneficial to girls in co-educational schools.

When boys' achievement in co-educational classes was compared with that of boys in boys' classes, the CAT post-test mean score of boys exposed to CCE in co-educational classes was significantly lower than that of boys in boys' classes. The CAT pre-test results also show that boys in boys' classes were initially better than those in co-educational classes. Use of CCE method did not change this situation for boys but boys' achievement in both types of schools improved more than for boys in the control condition implying that the method was beneficial to boys in boys' and co-educational schools. It could therefore be argued that the effect of CCE method depended on students' gender and class composition. Girls in co-educational schools benefited most from the CCE method probably because they were initially weaker than girls in girls' classes were. If the CCE method were used longer, girls' achievement in co-educational schools would probably have been better than that of girls in girls' schools.

Sadker and Sadker (1986) and Wasanga (1997) found girls in co-educational classes less active than boys and noted that boys asked more questions in class and were called upon by teachers to answer questions or to help in experiments more often. The CCE method improved girls' confidence in conducting experiments especially in co-educational schools and although FAWE (1997) recommended construction of more girls' schools in Kenya to improve their performance, establishment of girls' classes might not be necessary if the CCE method were used in teaching. This method makes positive interdependence and individual accountability key factors in learning, leading to higher students' achievement.

CONCLUSIONS

The CCE method facilitates students' chemistry achievement more than the RT methods do. While using this method, gender does not affect students' chemistry achievement. Neither does school type significantly affect their achievement but it significantly affects boys' achievement with boys in boys' schools attaining higher achievement than those in co-educational schools do.

IMPLICATIONS OF THE STUDY

Students taught through the CCE method performed better than those taught through the RT methods irrespective of gender and school type, implying that the CCE method would be suitable for teaching both male and female students whether the school was single sex or co-educational. Therefore, education authorities in Kenya should encourage chemistry teachers to use this method and teacher education institutions to make it part of their teacher training curriculum content.

In this analysis of the data, no consideration has been given to students being nested within classrooms and schools. Since the sampling and treatment conditions occur at the school level the use of ANOVA and ANCOVA can be argued to be inappropriate. As a consequence the findings reported in this otherwise excellently conducted and well-reported study must be viewed with some caution because the errors used in testing for statistical significance are inappropriately estimated (Editor, IEJ).

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