Comparative Effectiveness of Problem Solving Approach Towards Students' Mathematics Self-concept: Single-sex Versus Co-educational Secondary Schools' Scenario in Kenya

Ronald Ellumbe Mutange (PhD)
Department of Science and Mathematics Education, Masinde Muliro University of Science and Technology, P.O. Box 190-50100, Kakamega, Kenya
E-mail: mutangeronald89@gmail.com
Mobile: +254710846851

ABSTRACT

The study aimed at comparing the effectiveness of Problem Solving Approach (PSA) towards students' mathematics self-concept in single-sex and co-educational secondary schools of Kenya. The study targeted a population of 10,500 students enrolled in 109 public schools in Vihiga County. Stratified random sampling was used to select twelve schools from the 109 schools. A sample of 1459 students was purposively and randomly drawn from the twelve schools. The study employed the Solomon's Four-Group design. The respondents were assigned to experimental groups 1 and 3 and control groups 2 and 4, and taught the topic Commercial Arithmetic. Groups 1 and 3 were taught using PSA, while groups 2 and 4 were taught by conventional method. Groups 1 and 2 were pre-tested prior to the implementation of the PSA treatment. Mathematics Self-Concept Questionnaire (MSCQ), with a reliability coefficient of 0.74 was face and content validated by six experts and used in data collection. After a three-week treatment period, the four groups were post-tested. The results showed that PSA significantly improved students' mathematics self-concept in the single-sex schools in comparison to that of those in the co-educational schools. It was concluded that PSA is a more effective and valuable teaching strategy to students in the single-sex schools. Therefore, the results attained in this study will allow re-focussing of the teaching strategies used in the co-educational schools so as to address the low students' self-concept in mathematics. It was recommended that the Government of Kenya through the Ministry of Education should set up more single-gender schools and stream the current co-educational schools into single-gender classes and warmly endorse PSA as the classroom instructional strategy.

Keywords: *Problem Solving Approach, Mathematics Self-Concept, Single-sex schools, Co-educational schools*

1.0 INTRODUCTION

1.1 Background to the Study

Mathematics is one of the core subjects in Kenyan secondary schools, thus it is an examinable subject for all students (Kenya Institute of Education [KIE], 2006). It is accorded paramount significance in the school curriculum and education policies, right from pre-primary to tertiary levels, in that it finds its application in social, economic, scientific and technological fields. According to Ker (2003), mathematical abilities are critical for comprehending other disciplines such as science, technology and engineering that are invaluable for preparation of new innovative professionals in the sciences and technological fields. Moreover, Maliku, Ngban, and Ibu (2009) reinforce the fact that science and technology are central to the world culture. Consequently, any nation can attain a competitive stature by pinpointing the significance of mathematics in her education. Despite its significance, students' performance in national examinations has remained poor as evidenced in the analysis of the Kenya Certificate of Secondary Education (KCSE) examination results (Kenya National examination Council [KNEC], 2010). The poor performance has been linked to teachers' attitude towards students and the subject, poor instructional strategies and students' socio-psychological factors among others (Mbugua, 2012). The incessant poor performance and the perceived fear among students that mathematics is difficult also work against their mathematics self-concept development. Research studies have barely attended to mathematics self-concept and how to develop and maintain healthy students' mathematics self-concept in various types of schools with unequal gender composition.

In an attempt to ameliorate the dwindling students' mathematics self-concept which is one of the key predictors to good performance, some studies have been conducted on the teaching strategies that could help improve students' self-concept in mathematics with the hope to raise their performance in the subject alongside (Chiakwelu & Okigbo, 2020). The search for more interactive instructional strategies is necessitated by the fact that teaching method has been one of the most implicated factors which contribute to the students' low self-concept in mathematics. However, most researches in the area of teaching strategies do not take into cognizance the role of various forms of collaboration in learning and how they could invigorate students' mathematics self-concept. Studies on the roles of such collaboration as a boost to students' mathematics self-concept are not replete in literature. For this reason, it was essential to investigate on the effectiveness of Problem Solving Approach (PSA) towards students' mathematics self-concept.

The significance of quality mathematics instruction cannot be undermined. Quality mathematics instruction boosts learning and fosters a sense of self-confidence among the learners (Ramsden, 1995). Mathematics instruction does not just concern itself about dispensing rules, definitions and algorithms for students to memorize. There is need to engage students as active participants through discussions and collaboration in problem solving among themselves. If learners are accorded the opportunity to explain or clarify mathematical ideas, then more meaningful learning crops up. Silva (2009) remarks that the 21st century pedagogical paradigm shift in mathematics education require instructional strategies that emphasize learners' active involvement. According to Johnson and Johnson (1995), to excel in learning mathematics, learners should be given the opportunity to communicate, share and reason mathematically so as to develop self-confidence to solve mathematics problems.

Arguably, teachers have been blamed for using teacher-centred instructional techniques in teaching mathematics. Desirable instructional techniques that promote learner-oriented learning are seldom used. However, collaborative teaching strategies through PSA may give learners the opportunity to master learning in mathematics by being actively involved in the learning process. Learners may thereby improve on their mathematics self-concept. According to Mangle (2008), PSA involves students working in small groups to achieve a common goal, under conditions of positive interdependence, individual accountability, appropriate use of collaborative skills and face-to-face interactions. It is in this PSA that learners work as a team to maximize their own and each others' learning. Moreover, the PSA classroom environment is characterized by co-operative tasks, incentives structures and small group activities. Further, Mangle argues that PSA develops students' mathematics self-concept. On the same line of thought, Segzin (2009) supports Samuelsson (2008) to claim that PSA improves students' self-concept in mathematics. Segzin further opines that during PSA sessions, learners tend to enjoy mathematics and the enjoyment motivates them to learn more. Consequently, PSA may be used to teach mathematics and also help teachers to accomplish important social learning and human relations goals which will hitherto boosts students' mathematics self-concept. However, there was lack of adequate empirical evidence in single-sex and co-educational schools in Kenya to cushion such allegations. Researches into the effectiveness of PSA towards students' mathematics self-concept in single-sex and co-educational schools seem to be lacking. Anchoring on this background, the current study sought to investigate and compare the effectiveness of Problem Solving Approach (PSA) towards students' mathematics self-concept in single-sex and co-educational schools in Vihiga County of Kenya.

1.2 Purpose of the Study

The purpose of this study was to investigate and compare the effectiveness of Problem Solving Approach (PSA) towards students' mathematics self-concept in single-sex and co-educational secondary schools in Kenya.

1.3 Objectives of the Study

The main objective of the study was to determine whether there is any difference in mathematics self-concept of students taught with PSA and conventional methods in single-sex and co-educational schools. Specifically, the study sought to determine the:

(i) Mathematics self-concept mean scores of boys taught with PSA in boys-only schools in comparison to those in co-educational schools;
(ii) Mathematics self-concept mean scores of boys taught with conventional method in boys-only schools in comparison to those in co-educational schools;
(iii) Mathematics self-concept mean scores of girls taught with PSA in girls-only schools in comparison to those in co-educational schools; and
(iv) Mathematics self-concept mean scores of girls taught with conventional method in girls-only schools in comparison to those in co-educational schools.

1.4 Research Questions

The following research questions guided the study:

(i) What are the mathematics self-concept mean scores of boys taught with PSA in boys-only schools and of those in co-educational schools?
(ii) What are the mathematics self-concept mean scores of boys taught with conventional method in boys-only schools and of those in co-educational schools?

(iii) What are the mathematics self-concept mean scores of girls taught with PSA in girls-only schools and of those in co-educational schools?

(iv) What are the mathematics self-concept mean scores of girls taught with conventional method in girls-only schools and of those in co-educational schools?

1.5 Hypotheses of the Study

The following null hypotheses were formulated and tested at an alpha level of 0.05;

HO_1: There is no statistically significant difference between the mathematics self-concept mean scores of boys taught with PSA in boys-only schools in comparison to those in co-educational schools.

HO_2: There is no statistically significant difference between the mathematics self-concept mean scores of boys taught with conventional method in boys-only schools in comparison to those in co-educational schools.

HO_3: There is no statistically significant difference between the mathematics self-concept mean scores of girls taught with PSA in girls-only schools in comparison to those in co-educational schools.

HO_4: There is no statistically significant difference between the mathematics self-concept mean scores of girls taught with conventional method in girls-only schools in comparison to those in co-educational schools.

2.0 RESEARCH METHODOLOGY

The study adopted Solomon's Four Group Design that employed the quasi-experimental procedures. This is because secondary schools classes once constituted exist as intact groups and school administrators do not allow such classes to be broken up and re-constituted for research purposes. Thus, the schools selected were randomly assigned to the treatment and control conditions as intact groups. The pre-test – post-test approach was used to partially eliminate the initial differences between the experimental and control groups (Gibbon & Herman, 1997)

The target population of the study consisted of 10,555 Form Three students from the 109 public schools in Vihiga County. The sampling frame constituted of all national, county and sub-county schools. The first stage was the purposive selection of Vihiga County and the two national schools. The remaining schools were stratified into boys' only, girls' only and co-educational schools. Balloting method was employed to sample ten schools from the remaining 107 schools. A sample size of 1459 students was then drawn from the 12 schools. The subjects were assigned to experimental groups 1 and 3, with 367 and 360 students respectively; and control groups 2 and 4, with 344 and 388 students respectively.

The instrument used for data collection was Mathematics Self-Concept Questionnaire (MSCQ). It was developed by the researcher and used as a pre-test and post-test. It was face and content validated by six mathematics education experts, who vetted the items in the instrument for language clarity, purposefulness and plausibility of the distracters. It was pilot tested on 42 Form Three students and yielded a correlation coefficient of 0.74 by Cronbach's Coefficient Alpha method.

Prior to the commencement of the study, the research assistants were inducted for two days by the researcher. Thereafter, they inducted the students in the experimental groups pertaining to the use of PSA for three days. The experimental group teachers were issued with instructional guides tailored

towards Commercial Arithmetic. After the orientation period, a thirty-minute MSCQ was administered to the students in the experimental group 1 and control group 2. The pre-test scores were used to assess the entry level and homogeneity of the students in the randomly assigned experimental and control groups. The experimental groups 1 and 3 were taught with PSA for a three-week treatment period, while control groups 2 and 4 were instructed using conventional method. At the end of the treatment period, a 30-minute MSCQ was administered to the four groups after a week interval. Data collected for the study were analysed using mean scores and standard deviations to answer research questions while Analysis of Variance (ANOVA) was used to test the hypotheses at an alpha level (α) of 0.05.

3.0 RESULTS

3.1 Result of Pre-test

The Solomon's Four-Group Design allowed the researcher to have duo groups sit for the pre-test MSC that ascertained the homogeneity of the participants. The t-test results of the MSC pre-test scores are presented in Table 1.

Table 1: Independent Samples t-test of the Pre-test Scores on MSC

Variable	Group	Mean	SD	t-value	P-value
MSC	1	88.79[a]	22.42	0.568*	0.570
	2	89.88[b]	28.29		

*[a, b] denote similar mean scores * Not significant at p<0.05 level df = (1,709)*

From Table 1, the experimental group 1 (n = 367) and the control group 2 (n = 344) obtained means of 88.79 and 89.88 in MSC respectively. From the results, the pre-test mean scores of both groups (1 & 2) attained were similar on MSC measure. The t-test results analysis reveal that the pre-test mean scores for groups 1 and 2 on MSC measure are not statistically different; since the t-value (0.568) is not significant at 0.05 α-level, df = (1, 709). This indicates that the four groups used in the study were comparable and had similar entry behaviour, hence homogeneous. This made them appropriate for the study.

3.2 Comparison of the MSC of Boys in the Co-educational Class with that of Boys in the Boys-only Class

The MSC post-test mean scores obtained by boys were analysed in order to test hypothesis one (HO_1) of the study that sought to find out whether there was any significant difference between the mathematics self-concept mean scores of boys taught with PSA in boys-only schools in comparison to those in co-educational schools. Table 2 shows the MSC mean scores for the boys in the two types of schools.

Table 2: MSC Post-test Mean Scores of Boys in Experimental Groups based on School Type

School Type	N	Mean Score	SD	Mean Difference
Boys-only schools	256	104.70	22.25	8.63
Co-educational schools	144	94.07	22.50	
Total	**400**	**99.59**	**22.69**	

Table 2 indicates that the boys who were taught with PSA in boys-only schools were 256 while those in co-educational schools were 144. An examination of the results shows that the boys in the boys-only schools had a mean of 104.70 which is higher than 94.07 that was obtained by the boys in

the co-educational schools when they were taught with PSA. The net difference in the means between the two types of schools was 8.63. This indicates that the boys in the boys-only schools improved more in their MSC than the boys in the co-educational schools.

In order to determine whether the difference in the MSC post-test mean scores among the two types of schools was significant, an ANOVA was performed. The results of the ANOVA are presented in Table 3.

Table 3: ANOVA of the MSC Post-test Scores for Boys in Experimental Groups based on School Type

Source of Variation	Sum of Squares	Df	Mean Square	F	P-value
Between Groups	6863.43	1	6863.43	13.76*	0.00
Within Groups	198599.15	398	498.99		
Total	**205462.58**	**399**			

*Denotes significant mean difference at $p < 0.05$ level Df = (1,398)

An examination of the results in Table 3 shows that the difference in the post-test MSC mean scores is significant, the F-value (13.76) from ANOVA is significant at $p<0.05$ α-level, Df = (1, 398).

The mean difference between the boys in the boys-only schools and the boys in the co-educational schools was significant in favour of the boys in the boys-only schools. Overall, the results showed that the boys in the boys-only schools attained significantly higher mathematics self-concept in comparison to those in the co-educational schools. This implies that PSA as a teaching strategy had a significantly higher boost on the mathematics self-concept of boys in the boys-only schools. The MSC for boys in the boys-only schools towards mathematics was higher than that of boys in the co-educational schools. Thus it is worth noting that PSA boosts MSC for boys in boys-only schools more than for boys in the co-educational schools. Therefore, the null hypothesis HO_1 indicating that there is no statistically significant difference in the mathematics self-concept mean scores of boys in the boys-only schools and those boys in the co-educational schools when taught with PSA was rejected.

Analysis of the MSC post-test mean scores of the boys in the control groups was also carried out. Table 4 shows the MSC mean scores for the boys in the two types of schools.

Table 4: MSC Post-test Mean Scores of Boys in the Control Groups based on School Type

School Type	N	Mean Score	SD	Mean Difference
Boys-only schools	225	83.65	26.53	7.75
Co-educational schools	117	91.40	28.83	
Total	**342**	**86.30**	**27.55**	

From Table 4, the boys who were taught with conventional method in boys-only schools were 225 while those in co-educational schools were 117. An examination of the results shows that the boys in the boys-only schools got a mean of 83.65 which is lower than 91.40 that was obtained by the boys in the co-educational schools when they were taught with conventional method. The net difference in the means between the two types of schools was 7.75. This indicates that the boys in the co-educational schools attained higher improvement in their MSC than the boys in the boys-only schools.

In order to determine whether the difference in the MSC post-test mean scores among the two types of schools was significant, an ANOVA was performed. The results of the ANOVA are presented in Table 5.

Table 5: ANOVA of the MSC Post-test Scores for Boys in the Control Groups based on School Type

Source of Variation	Sum of Squares	Df	Mean Square	F	P-value
Between Groups	4626.60	1	4626.60	6.19*	0.00
Within Groups	254109.38	340	747.38		
Total	**258735.98**	**341**			

*Denotes significant mean difference at $p< 0.05$ level Df = (1,340)

An examination of the results in Table 5 shows that the difference in the post-test MSC mean scores is significant, the F-value (6.19) from ANOVA is significant at $p<0.05$ α-level, Df = (1, 340).

The mean difference between the boys in the boys-only schools and the boys in the co-educational schools was significant in favour of the boys in the co-educational schools. Overall, the results showed that the boys in the co-educational schools attained significantly higher boost in their MSC in comparison to those in the boys-only schools. This implies that conventional method as a teaching strategy had a significantly higher influence on the mathematics self-concept of the boys in the co-educational schools. Therefore, the null hypothesis HO_2 indicating that there is no statistically significant difference in the mathematics self-concept mean scores of boys in the boys-only schools and those boys in the co-educational schools when taught with conventional method was rejected.

Table 5 reveals that the MSC mean score is slightly higher for boys in the co-educational classes than for the boys in the boys-only classes and the difference is significant ($F(1,340) = 6.19$, $P<0.05$). This is a contrast to the case of PSA group where the boys in boys-only schools had higher MSC. Thus it can be deduced that the use of PSA produced a difference in MSC in the two types of schools.

3.3 Comparison of the MSC of Girls in the Co-educational Class with that of Girls in the Girls-only Class

The MSC post-test mean scores obtained by girls were analysed in order to test hypothesis three (HO_3) of the study that sought to find out whether there was any significant difference between the mathematics self-concept mean scores of girls taught with PSA in girls-only schools in comparison to those in co-educational schools. Table 6 shows the MSC mean scores for the girls in the two types of schools.

Table 6: MSC Post-test Mean Scores of Girls in the Experimental Groups based on School Type

School Type	N	Mean Score	SD	Mean Difference
Girls-only schools	239	100.43	27.64	9.77
Co-educational schools	88	90.66	25.33	
Total	**327**	**97.80**	**27.35**	

Basing on Table 6, the girls who were taught with PSA in the girls-only schools were 239 while those in the co-educational schools were 88. An examination of the results shows that the girls in

the girls-only schools had a mean of 100.43 which is higher than 90.66 that was obtained by the girls in the co-educational schools when they were taught with PSA. The net difference in the means between the two types of schools was 9.77. This indicates that the girls in the girls-only schools improved more in their MSC than the girls in the co-educational schools.
In order to determine whether the difference in the MSC post-test mean scores among the two types of schools was significant, an ANOVA was performed. The results of the ANOVA are presented in Table 7.

Table 7: ANOVA of the MSC Post-test Scores for Girls in the Experimental Groups based on School Type

Source of Variation	Sum of Squares	Df	Mean Square	F	P-value
Between Groups	6141.70	1	6141.70	8.40*	0.00
Within Groups	237650.38	325	731.23		
Total	**243792.08**	**326**			

*Denotes significant mean difference at $p< 0.05$ level Df = (1,325)

A look at the results in Table 7 shows that the difference in the post-test MSC mean scores is significant, the F-value (8.40) from ANOVA is significant at $p<0.05$ α-level, Df = (1, 325).

The mean difference between the girls in the girls-only schools and the girls in the co-educational schools was significant in favour of the girls in the girls-only schools. Overall, the results showed that the girls in the girls-only schools attained significantly higher mathematics self-concept in comparison to those in the co-educational schools. This implies that PSA as a teaching strategy had a significantly higher boost on the mathematics self-concept of the girls in the girls-only schools.

The MSC for girls in the girls-only schools towards mathematics was higher than that of girls in the co-educational schools. It suffices to point out that PSA boosts more the MSC for girls in the girls-only schools in comparison to those girls in the co-educational schools. Therefore, the null hypothesis HO_3 indicating that there is no statistically significant differences in the mathematics self-concept mean scores of girls in the girls-only schools and those girls in the co-educational schools when taught with PSA was rejected.

Analysis of the MSC post-test scores of the girls in the control groups was carried out. Table 8 shows the MSC mean scores for the girls in the two types of schools.

Table 8: MSC Post-test Mean Scores of Girls in the Control Groups based on School Type

School Type	N	Mean Score	SD	Mean Difference
Girls-only schools	263	102.87	22.89	15.66
Co-educational schools	127	87.21	29.22	
Total	**390**	**97.77**	**26.14**	

From Table 8, the girls who were taught with conventional method in girls-only schools were 263 while those in co-educational schools were 127. An examination of the results shows that the girls in the girls-only schools had a mean of 102.87 which is higher than 87.21 that was posted by girls in the co-educational schools when they were taught with conventional method. The net difference in the means between the two types of schools was 15.66. This indicates that the girls in the girls-only schools attained higher development in their MSC in comparison to the girls in the co-educational schools.

In order to determine whether the difference in the MSC post-test mean scores among the two types of schools was significant, an ANOVA was performed. The results of the ANOVA are presented in Table 9.

Table 9: ANOVA of the MSC Post-test Scores for Girls in the Control Groups based on School Type

Source of Variation	Sum of Squares	Df	Mean Square	F	P-value
Between Groups	21008.02	1	21008.02	33.29*	0.00
Within Groups	244878.12	388	631.13		
Total	**265886.14**	**389**			

*Denotes significant mean difference at $p< 0.05$ level Df = (1,388)

A closer look at the results in Table 9 shows that the difference in the post-test MSC mean scores is significant, the F-value (33.29) from ANOVA is significant at $p<0.05$ α-level, Df = (1, 388).

The mean difference between the girls in the girls-only schools and the girls in the co-educational schools was significant in favour of the girls in the girls-only schools. Overall, the results showed that the girls in the girls-only schools attained significantly higher mathematics self-concept in comparison to those in the co-educational schools. This implies that conventional method as a teaching strategy also had a significantly higher influence on the mathematics self-concept of the girls in the girls-only schools. Therefore, the null hypothesis HO_4 indicating that there is no statistically significant difference in the mathematics self-concept mean scores of girls in the girls-only schools and those girls in the co-educational schools when taught with conventional method was rejected.

When the results for girls in the experimental schools are compared with those of girls in the control schools, they showed that PSA was most beneficial to girls in the girls-only schools than to girls in the co-educational schools. The MSC for girls in the girls-only schools towards mathematics was higher than that of girls in the co-educational schools.

The results indicate that both PSA and conventional teaching methods significantly boosted the MSC of boys and girls in the single-sex schools in comparison to those in the co-educational schools. This implies that both the treatment (PSA) and the conventional teaching method significantly influenced the MSC of boys and girls of the experimental and control groups in the single-sex schools. Therefore the type of school does influence students' self-concept in mathematics irrespective of the teaching strategy (PSA or conventional method) used.

4.0 DISCUSSION

Comparison of Students' MSC in Co-educational Classes with that of Students in Boys-only or Girls-only Classes

In the case of boys who were taught with PSA, the MSC results revealed that the mean score for boys in the boys-only schools was higher than that of boys in the co-educational schools. This difference was significant, $F (1,398) = 13.76$, $p<0.05$. Moreover, for the boys in the control condition, the difference in the MSC mean scores between boys in the boys-only classes and those in the co-educational classes was significant $F(1,340) = 6.19$, $p<0.05$ (see Tables 3 & 5). Results of this study show that the MSC of boys in the boys-only schools was higher than that of boys in the co-educational schools in the PSA group. This result is consistent with the control group results.

For the case of girls who were taught with PSA, the MSC post test results revealed that the mean scores of girls in the girls-only schools was significantly different from that of the girls in the co-educational schools, $F(1,325) = 8.40$, $p<0.05$. Likewise for girls in the control condition, the difference in the MSC post test mean scores between the girls in girls-only classes and those in the co-educational classes was significant, $F(1,388) = 33.29$, $p<0.05$ (see Tables 7 & 9).

The results of this study revealed that the students who were taught mathematics using PSA in single-sex schools attained higher mean score in the MSC than those in the co-educational schools (see Table 2 & 9). This implies that the use of PSA is more effective in improving the MSC of students in the single-sex schools than that of those in the co-educational schools.

The findings of this study further revealed that PSA is less gainful to the improvement of the MSC of the students in the co-educational schools. This is probably because the students in the co-educational schools might be having their own successful strategies, which they may fail to employ when they use PSA and thus get disadvantaged in the process. Tick (2007) remarked that the use of PSA is in itself a challenge. It could be envisaged that the students in the co-educational schools needed a lot of in-service training to master its application if they had to derive any gains from it. Contrarily, the conformity of the students in the single-sex schools to the teachers' demands as well as their consistency in the application of the PSA tenets accelerated their mastery of the new techniques as opposed to those in the co-educational schools who were probably predisposed to employ alternative learning strategies. Thus the use of PSA as a teaching strategy in the study explained the improved MSC among the students in the single-sex schools.

Herreid (2003) opines that students' MSC is negatively affected by the teachers' approach in presenting the subject matter. Consequently, the teachers' role in the classroom discourse was a major determinant factor of the classroom environment. Chin and Chia (2004) aver that students' self-concept develops best in classroom environments that give them more opportunities for more participatory interaction. Sadker and Sadker (1986) revealed that male and female teachers give more attention to boys than to girls in secondary schools. This practice has the effect of reinforcing in girls the belief that they are less capable, which in turn negatively affects their self-esteem and confidence resulting in low mathematics self-concept development as was evidenced in the co-educational classes. In contrast to this, McCoy et al. (2012) found that girls in single-sex schools developed positive attitudes towards mathematics than girls educated in co-educational settings. They also found out that though boys were more positively disposed towards mathematics than girls, there was little difference in mathematics self-concept between boys and girls educated in single-sex schools. Thus the teacher restructured the classroom environment that permitted the students to work interactively in collaborative groups. This resulted to significant improvement in the MSC of the students in the single-sex schools.

The low MSC of students in the co-educational schools as compared to those in the single-sex schools was unexpected bearing in mind that effective instructional strategy (i.e. PSA) that encompassed students' participation in learning was expected to improve on the affective aspect of the students compared to the conventional teaching method. One possible explanation for this perceived contradiction was probably the short three-week intervention period. Significant improvement on the students' MSC in the co-educational schools was unlikely to be effected over such a short period time bearing in mind that this is an affective characteristic that required reasonable period of time for the students to gain greater interest in the knowledge attained for it to

be discriminated, assimilated and accommodated into the learners' old structures of knowledge before its application.

Though there were some positive results from the use of PSA in the co-educational schools, it was apparent that both teachers and students faced some challenges. Ngeow and Kong (2001) alluded that as the PSA requires students to adopt active learning principles and become more self-directed in their learning, students in the co-educational schools faced some challenges in adapting into critical thinkers. This in line with Wood (2003) who conceded that the use of PSA requires many instructors to be involved in teaching and therefore more teacher development particularly focusing on facilitation and management of group dynamics was required. Wood's findings are in agreement with Goodnough (2003) who found that the use of PSA with large groups was hard due to the difficult in ensuring that the groups functioned successfully. Due to time constraints, information was not always properly shared or fully discussed. There was resentment because some boys and girls in the co-educational classes shouldered more responsibility than others. This emanated from the unequal gender composition in some classes. Some students indicated discomfort with the process that there was not enough direction, they requested more feedback on the success of their efforts or were uncertain if they had covered all the relevant areas. However, this study has shown that PSA resulted in improved students' MSC in the two types of schools. In view of this, it suffices to point out that PSA should be adapted for mathematics instruction in Kenyan secondary schools so as to boost students' morale that positively resonates with their mathematics self-concept improvement.

The findings of this study have some practical implications to mathematics education. PSA engaged students in constructing and altering their own psychological base that led to better perception of mathematics as a 'soft' subject. As a teaching strategy, PSA had profound effect on students in the single-sex schools by significantly improving on their mathematics self-concept. There is need however to scrutinize the learning strategies of students in the co-educational schools in order to identify ways in which the gains of PSA as an instructional strategy can be harnessed to significantly boost their mathematics self-concept too. Probably substantial number of gender-sensitive instructors and lengthy training sessions in the application of PSA and direct feedback given to students in the co-educational schools may accord them the opportunity to profit from its use.

The findings of the study also revealed that PSA as a teaching strategy had a positive and significant contribution to the development of MSC among students in the single-sex schools. This is not the case however with the students in the co-educational schools. This implies that in choosing an instructional strategy, it is imperative that mathematics teachers consider the uniqueness of each type of school in terms of gender composition in the particular classes when handling students. This is essentially necessary to avoid disadvantaging either gender particularly in the instructional strategies employed in the classroom interactions. It is worth mentioning that PSA as a teaching strategy was more advantageous to students in the single-sex schools because they are more conforming and consistent in its use within a short time span.

The development of students' MSC requires conducive classrooom atmosphere. One way of fostering students' self-concept development in mathematics was by the use of PSA which constituted such an atmosphere. The instruction in the PSA classrooms made mathematics more

exciting and enhanced the development of self-concept in mathematics among the students in the single-sex schools. This is based on the anecdotal evidence from the research findings.

With reference to the findings of this study, there is empirical evidence that PSA can enhance the development of high MSC among the students in the single-sex schools. The students in the single-sex schools attained higher MSC mean scores in the post-test analysis. This means that mathematics as a subject in the secondary school curriculum does not appear to be a disliked subject, especially among the students in the single-sex schools. The findings implies that the perception of mathematics as a 'hard' subject in the secondary school curriculum can change for the better by either abolishing the co-educational schools and setting up single-sex schools or re-streaming them into single-gender classes. Mathematics educators in Kenya therefore should not entirely blame the poor performance of students in mathematics on low levels of MSC. The current findings portray that students' MSC and school type influence each other positively when PSA is employed in class instruction. Consequently, mathematics teachers in Kenya have a pivotal role to play in maintaining and strengthening favourable trends in mathematics education by upholding positive MSC development among the students in the two types of schools. Negative disposition towards mathematics by the teachers affects students' mathematics self-concept adversely. It is prudent therefore that mathematics teachers demonstrate positive attitudes at all times in their dealings with students, especially with those in the co-educational schools, bearing in mind that teacher/student relationship and interaction is crucial for the students' self-concept development in mathematics.

5.0 CONCLUSION

The study established that PSA teaching strategy significantly influenced the MSC of students in the single-sex schools. It was concluded therefore that students' MSC could be improved through the use of PSA which was found more valuable in boosting the MSC of students in the single-sex schools than in the co-educational schools. Therefore, the results obtained in this study will allow re-focussing of the instructional strategies used in the co-educational schools to address the low students' self-concept in mathematics.

6.0 RECOMMENDATION

In reference to the findings of the study, it was recommended that the Government of Kenya through the Ministry of Education should set up more single-gender schools and stream the current co-educational schools into single-gender classes and warmly endorse PSA as the classroom instructional strategy.

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