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Analysis of the Impact of Problem Solving Teaching Approach Towards Gender Differences in Mathematics Self-Concept: Kenya' s Perspective

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Abstract:
The study aimed at analysing the impact of problem solving teaching approach towards gender differences in mathematics self-concept in Kenyan secondary schools. Students from one hundred and nine (109) schools from Vihiga County formed the population of the study. Stratified random sampling was used to select twelve schools from the 109 schools. The sample of the study was 1459 students constituting 742 males and 717 females, purposively and randomly drawn from the twelve schools. Solomon Four-Group design was adopted in the study. The students were assigned to two experimental groups and two control groups. Both groups were taught Commercial Arithmetic. The experimental groups were taught using PSA treatment while control groups were taught by conventional methods. One experimental group and one control group were pre-tested before the implementation of the treatment. Mathematics Self-Concept Questionnaire (MSCQ), validated by the researcher and mathematics education experts was used in data collection. It yielded a reliability coefficient of 0.739 by using Cronbach's alpha. After the treatment, the four groups were post-tested. The study lasted for three weeks. The findings revealed that; there was no statistical difference between mathematics self-concept of boys and girls taught using PSA, though it enhanced their self-concept the most in comparison to the conventional methods. Hitherto, gender had no impact on students' self-concept in mathematics when taught by PSA. It was concluded that PSA positively enhances mathematics self-concept of both genders. It was recommended that the content of PSA should be included in the regular in-service courses organised by the Ministry of Education for practicing teachers to enable them to acquire competencies needed in the use of PSA so as to militate against the low self-concept of students in mathematics.

Keywords: *Problem solving approach, Gender differences, Mathematics, Self-concept, Kenya*

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I. Introduction

Background to the Study

Mathematics is seen by society as the wheel of social, economic and technological developments. In Kenya, mathematics is a compulsory subject at the secondary school level and is used as pre-requisite to enter any of the prestigious courses in tertiary institutions. The knowledge of mathematics as a tool for use in everyday life is important for the existence of any individual and society (Cockroft, 1982). Mathematics qualifications are commonly used as a critical entry requirement to employment and further training in Kenya. Mathematics in our society is a form of training for logical reasoning. Moreover, the logical designs of computing machines are mathematics oriented (ACO, 1979). Consequently, mathematics is required in all spheres of life; at home, in the office, sciences, engineering, commerce, military, technological development and researches of all forms. Despite the important role it plays in society, there has always been poor performance in the subject at national examinations (KNEC, 2010). The poor performance has been attributed to various factors such as; instructional strategies, teachers' attitude and enthusiasm, learning environment, students' background and their low self-concept (Eze, Ezenwafor & Molokwu, 2015).

Students' learning difficulties are attributed to ineffective or inappropriate cognitive processes. However, meaningful learning occurs when students choose to relate new knowledge to relevant concepts and propositions they already know (Novak & Gowin, 1984). This calls for commitment on the part of the learner to link new concepts with higher order and more inclusive concepts that are already comprehensible to the learner and thus can anchor new knowledge and assimilate new ideas. The commitment aspect calls for interest and positive self-esteem towards the learning process and the subject being learnt by the student. This is why mathematics education researches posit the need to foster affective relationships in mathematics instructions. Affective aspects thus form a premise upon which meaningful learning can be hinged.

The importance of good teaching cannot be overemphasized. Good teaching encourages high quality learning (Ramsden, 1995). Thus, the instruction of mathematics does not just concern 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. Students should be given the opportunity to elaborate on mathematical ideas if meaningful learning has to be realised. Lau (2009) opines that the mathematics skills required for the youth of today and the adults of tomorrow to function in the workplace are at variance with those of the youth and adults of yesteryears. The 21st century pedagogical accomplishments envisage that the development of education currently requires teaching strategies that emphasize students' involvement (Chakwelu & Okigbo, 2020). Students' success relies upon them being able to communicate, share and use gained knowledge to solve mathematics oriented problems. Chakwelu and Okigbo reemphasize the fact that success in mathematics instruction relies upon learners being given the opportunity to reason and communicate mathematically; and also to develop a sense of self-confidence to solve mathematics problems.

To compound the problem of dismal performance due to poor teaching strategies, there is overwhelming evidence that the proportion of girls passing mathematics in KCSE is less than that of boys (KNEC, 2010). The poor performance is attributed to girls' low self-concept in mathematics that commensurate with the poor instructional strategies.

Successful mathematics teaching is associated with explicit teaching of a coherent conceptual framework rather than simply involving students in activities and hoping that meaningful learning results. Thus it is important that mathematics teaching focuses on the quality of understanding rather than on the quantity of information presented. Unfocussed or purposeless activity in the classroom leads to little if any learning. Duffy and Jonassen (1992) argue that teachers should develop instructional strategies that engage learners actively in the process of knowledge construction to enable them learn meaningfully. Learning is considered to be an active, constructive, cumulative, self-regulated and goal-oriented process in which the learner plays a critical role (Trowbridge & Bybee, 2004). There is need to develop teaching strategies that conform to this new perception of learning to enhance meaningful learning and foster a sense of confidence among the students.

In the same vein, Zechariah (2005) reaffirms that instructional methods employed by the teacher play a significant role in the acquisition of skills and meaningful learning. Instructional methods such as lecture make students become passive and have less interaction with each other in performing tasks. According to Eze and Osuyi (2018), lecture teaching method is the one in which the teacher is the major actor while the learners watch with the intention to act later. This method impedes meaningful learning as it shows no regard for individual differences among the learners and does not provide opportunity for adequate class preparation in the teaching process. As a result, students learn comparatively little of what has been taught as they only hear and see the teacher. Moreover, the students are passive and boredom is easily associated with the method. Therefore the continual use of lecture method in schools reduces the ability of students to grasp relevant concepts (Mba, 2012). Onwusa, Eze and Ezenwafor (2020) concur with Changeiywo (2000) that the lecture method causes; dissatisfaction, inadequate knowledge and low self-concept development, and high dependency of students on teachers. Thus students are not able to retain their learning and apply it to new situations. This may lead to high failure rate in sciences and mathematics. Positive changes take place when a teacher changes the teaching method towards a more student-centred approach. Consequently, an alternative method for the delivery of mathematics knowledge is Problem Solving Approach (PSA).

Problem Solving Approach 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. PSA is the instructional use of small groups through which students work together to maximize their own and each others' learning as well as their self-worth. It has its roots in social-constructivist perspective of learning. In this approach, the classroom environment is characterized by co-operative tasks and incentives structures and by small group activities. It may be used to teach 'hard' topics in mathematics and also help teachers to accomplish significant social learning and human relations goals. Moreover, it may enhance students' self-concept towards mathematics and also their social skills (Mangle, 2008).

In studying students' self-concept in mathematics, gender cannot be ignored. There is a general notion that boys are superior to girls in terms of mathematics self-concept as a result of factors such as; mathematics learning strategies (Carry & Jessup, 1997), biological factors (Mondoh, 2000), learner motivation factors (Githua, 2002), sex hormones on brain organization and symbolic gender (Kimura, 2002). Research evidences disagreed with this claim and posited that gender differences in mathematics self-concept does not exist (Adekoya, 2010; Yusufu, 2012).

The PSA teaching strategy if effectively used, it could metamorphosise the classroom instructional process. It will make it more collaborative, active and interactive. It could as well improve students' self-concept in mathematics. The perceived gender differences in students' mathematics self-concept may also be eliminated. These assumptions prompted the current study; analysis of the the impact of PSA towards gender differences in mathematics self-concept in Kenya.

Purpose of the Study

The purpose of the study was to analyse the impact of Problem Solving Approach (PSA) on gender differences in mathematics self-concept in comparison to the conventional methods.

Objective of the Study

The specific objective that guided the study was; to determine whether or not there is any gender differences in mathematics self-concept of students taught using PSA as compared to those taught by the conventional methods.

Hypothesis of the Study

The following null hypothesis was tested at an alpha level of 0.05:

HO_1: There is no significant gender differences in mathematics self-concept scores of students taught using PSA compared to those taught by the conventional methods.

II. Research Methodology

Research Design

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 authorities do not allow such classes to be broken up and re-constituted for research purposes (Gall, Borg & Gall, 1996). 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 design is shown in Table 1.

Table 1: Solomon's Four Group Design

Groups	Pre-test	Treatment	Post-test
1	O_1	X (Problem Solving Approach)	O_2
2	O_3	C (Conventional Methods)	O_4
3		X (Problem Solving Approach)	O_5
4		C (Conventional methods)	O_6

Source: *Adapted from Gibbon and Herman (1997)*

In this design, subjects were assigned randomly to four groups. Groups 1 and 3 received the experimental treatment (X) that was the use of the Problem Solving Approach (PSA) in teaching. Group 1 received a pre-test (O_1) and group 2 received a pre-test (O_3). Groups 2 and 4 constituted the control and the use of conventional methods in instruction. Finally all the four groups received post-test (O_2, O_4, O_5 & O_6).

Target Population

The target population of the study constituted of 10,555 Form Three students from the 109 public schools in Vihiga County that has 114 schools, of which two are national schools, ten county schools, 97 sub-county schools and five private schools.

Sampling Procedure and Sample Size

The sampling frame consisted 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. This involved assigning a numeral to each of the schools, placing the numbers in a container and then picking a number at random without replacement. Schools corresponding to the numbers picked and having at least three streams at the Form Three level were included in the study sample.

According to Mugenda and Mugenda (2003), at least 30 students per group are required for experimental research. Twelve schools were sampled. The twelve classes in the twelve schools were assigned to the four groups in the Solomon Four-Group experimental design. Although it was assumed that the average enrolment was forty students per class, giving the approximate sample size of the study as 1440 students, the actual sample size that participated was 1663 students. However, during data coding it was found that some students had incomplete data. This reduced the sample size for data analysis to 1459 students. These 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.

Research Instrument

Mathematics Self-Concept Questionnaire (MSCQ) was used in data collection. It was developed by the researcher and used as pre-test and post-test. It was pilot tested on 42 Form Three students that were non-participants in the study.

Validity of Instrument

MSCQ was face and content validated by mathematics education experts from within and without the Department of Science and Mathematics Education. Each panel member assessed the items in MSCQ for language usage, purposefulness and appropriateness of the distracters. Their responses were measured on a five-point Likert scale. They were scored and transcribed into a percentage score. An average score of above 70% for both face and content validity implied that the instrument was appropriate. The average of the responses of the face and content validity of the instrument is shown in Table 2.

Table 2: Summary of Assessment of Instrument Validity by Percentage

Instrument	Type of Validity	Mathematics Teachers	Academic Supervisors	Mathematics Educators	Average Percentage	Conclusion
MSCQ	Face	84	90	88	87.33	Appropriate
	Content	94	92	96	94.00	Appropriate

Reliability of Instrument

The reliability of MSCQ was ascertained by test-retest method. A correlation coefficient of 0.739 was yielded by using Cronbach's Coefficient Alpha method.

Data Collection Procedures

Before the treatment started, the research assistants from participating schools were inducted for a period of two days by the researcher as pertains to the use of PSA teaching strategy. They oriented the students in the experimental groups pertaining to the pre-requisites of PSA for a three-day period. The teachers in the experimental groups were issued with teaching manuals tailored towards the topic Commercial Arithmetic.

After the orientation period, a thirty-minute MSCQ was administered to the students in groups 1 and 2. The MSCQ scripts were collected and scored for three days in each respective school by the researcher and his assistants. 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 Commercial Arithmetic using PSA for a three-week treatment period. Control groups 2 and 4 were taught the same topic using conventional methods. Two days after the treatment period, a thirty-minute MSCQ was administered to the four groups at the same time. The data collected was scored and coded for analysis.

Data Analysis Techniques

The data yielded in the study consisted of MSC pre-test scores and post-test scores. The descriptive statistical tests (percentages, means & standard deviations) and inferential statistical tests (t-test & Analysis of Variance [ANOVA]) were used in data analysis at an alpha level (α) of 0.05.

III. Results

Results of Pre-test

The Solomon Four-Group Design used in the study enabled the researcher to have two groups sit for pre-test. The aim for pre-testing was to ascertain whether or not the students selected to participate in this study had comparable characteristics before presenting the topic Commercial Arithmetic. The students in groups 1 and 2 sat for the pre-test MSC. This made it possible for the researcher to assess whether there was any interaction between the pre-test and the treatment conditions and the similarity of the groups before the administration of the treatment (Borg & Gall, 1989).

A total of 711 students (323 males & 388 females) in the experimental group 1 and control group 2 were administered with pre-test MSC. Table 3 shows a summary of the pre-test scores on MSC based on the student's gender.

Table 3: Independent Samples t-test of the Pre-test Scores on MSC based on Student's Gender

Variable	N	Gender	Mean	SD	t-value	P-value
MSC	323	Male	96.47^{a}	24.56	0.782*	0.434
	388	Female	95.02^{b}	24.74		

$^{a, b}$ denote similar mean scores ** not significant at p<0.05 level* *df = (1,709)*

The results in Table 3 show that the male and female students had mean scores of 96.47 and 95.02 respectively. The t-test result reveals that the MSC pre-test mean scores of the male and the female students are not statistically different, since the t-value for MSC (0.782) is not significant at $p<0.05$ α-level, df = (1, 709). An examination of the results in Table 3 indicate that the pre-test MSC mean scores of the male and female students in the experimental group 1 and the control group 2 on MSC are not statistically different at $p<0.05$ α-level. This implies that the four groups used in the study were comparable and had similar entry behaviour, hence homogeneous. This made them suitable for the study.

Influence of Problem Solving Approach on Mathematics Self-Concept of Boys and Girls

In order to determine the influence of PSA on MSC among the boys and girls, an analysis of the students' post-test MSC mean scores was carried out. This was done in order to test hypothesis one (HO_1) of the study that sought to find out whether there was any significant gender differences in MSC scores of students who were taught using PSA and those who were taught by the conventional methods. The MSC post-test mean scores obtained by the boys and girls in the experimental and the control groups are presented in Table 4.

Table 4: MSC Post-test Mean Scores Obtained by Boys and Girls in the Four Groups

Group	N	Mean Score	SD
Experimental Boys (EB)	400	99.59	22.69
Control Boys (CB)	342	86.30	27.55
Experimental Girls (EG)	327	97.80	27.34
Control Girls (CG)	390	97.77	26.36
Total	**1459**	**95.59**	**26.36**

From Table 4, the experimental groups constituted of 400 boys and 327 girls while the control groups had 342 boys and 390 girls. The results reveal that the boys in the experimental group attained a higher mean score of 99.59 than that of the boys 86.30 of the control group. Similarly, the girls in the experimental group scored a mean score of 97.80 that was higher than that of the girls of the control group which was 97.77. The highest mean score of 99.59 was attained by the boys of the experimental group, followed by 97.80 for girls of the experimental group, then a mean score of 97.77 for girls of the control group and finally a mean score of 86.30 for boys of the control group. These means are presented graphically in Figure 1.

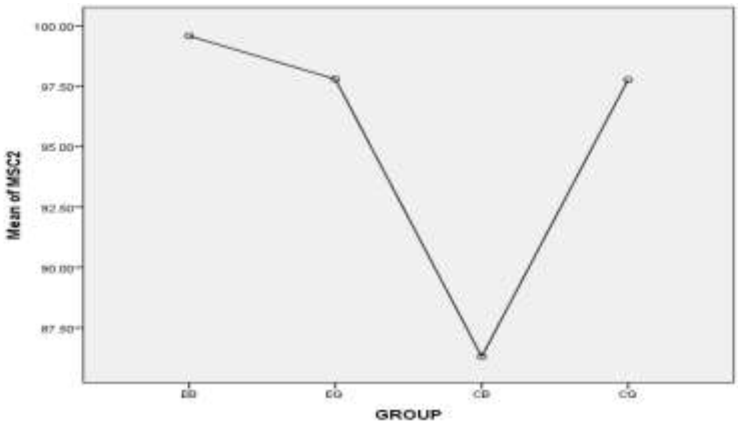

Figure 1: *Post-test Means on MSC for Boys and Girls*

From the results presented in Table 4 and Figure 1, it is evident that the boys and girls of the experimental groups outperformed their counterparts of the control groups. The results portray that PSA exerted a significantly higher influence on the MSC of the boys and girls than the conventional methods.

In order to determine whether the difference in the MSC post-test mean scores was statistically significant, a one-way ANOVA was performed. The results of the one-way ANOVA based on these mean scores are shown in Table 5.

Table 5: ANOVA of the Post-test Scores on the MSC for Boys and Girls

Source of Variation	Sum of Squares	df	Mean Square	F	P-value
Between Groups	39376.30	3	13125.43	19.61*	0.00
Within Groups	973876.78	1455	669.33		
Total	**1013253.08**	**1458**			

**Denote significant mean differences at p< 0.05 level   df = (3, 1455)*

From the results in Table 5, the F-value (19.61) from ANOVA is significant at $p<0.05$ α-level, df = (3, 1455). This indicated that the MSC post-test mean scores of the groups were significantly different.

Having established that there was a significant difference between the means, it was necessary to carry out further tests on the various combinations of means to find out where the difference occurred. Table 6 shows the results of the Least Significance Difference (LSD) post hoc comparisons.

Table 6: Post Hoc Comparisons of the Post-test of MSC Means for Boys and Girls in the Four Groups

	(I) Group	(J) Group	Mean Difference (I–J)	P-value
LSD	EB	EG	1.79	0.35
		CB	13.29*	0.00
		CG	1.82	0.32
	EG	EB	-1.79	0.35
		CB	11.50*	0.00
		CG	0.03	0.99
	CB	EB	-13.29*	0.00
		EG	-11.50*	0.00
		CG	-11.47*	0.00
	CG	EB	-1.82	0.32
		EG	-0.03*	0.99
		CB	11.47*	0.00

** = The mean difference is significant at the p<0.05 level*

The results in Table 6 show that there was a statistically significant difference in the pairs of MSC post-test mean scores of: boys of the experimental group and boys of the control group; girls of the experimental group and boys of the control group; and boys of the control group and girls of the control group. Conversely, the difference between the mean scores of: both boys and girls of the experimental groups; boys of the experimental group and girls of the control group; and girls of both the experimental and control groups are not significant $p<0.05$ α-level. It is also evident from Table 4, that the MSC post-test mean scores of the experimental groups were almost similar and higher than those of the control groups.

The results indicate that the MSC pre-test did not interact significantly with the treatment conditions. If this were the case, the groups, which took the pre-test, would have obtained different results from those that did not take it (Borg & Gall, 1989). The pre-test MSC did not affect the boys' and girls' mathematics self-concept. If this were the case, the boys and girls who sat for pre-test would have different results from the others. This made the pre-test suitable for the study (Kothari, 2003). The use of PSA resulted in higher students' MSC post-test mean scores than the conventional methods since the boys and girls of the experimental groups obtained significantly higher post-test mean scores.

From the results presented in Tables 4, 5 and 6, it suffices that the MSC post-test mean scores of the boys and girls of the experimental groups 1 and 3 (99.59 & 97.80 respectively) are not statistically different at p equal to 0.05. Similarly, the MSC post-test mean scores of the boys of the experimental group and girls of the control group (99.59 & 99.77 respectively); and girls of the experimental group and girls of the control group (99.80 & 99.77 respectively) are not statistically different. However, the mean scores obtained by; boys of the experimental group and boys of the control group; girls of the experimental group and boys of the control group; and boys of the control group and girls of the control group are significantly different at $p<0.05$. Thus, the boys and girls that were taught by PSA had higher MSC post-test mean scores than those that were taught by the conventional methods.

Since the MSC pre-test mean scores indicated that there was no significant gender difference in MSC between the students involved in the study, then it was not necessary to confirm the post-test results by performing Analysis of Covariance (ANCOVA).

The results indicate that PSA significantly improved the MSC of both genders in mathematics. This implies that the PSA treatment influenced MSC of both genders of the experimental groups. Conversely, gender does influence students' self-concept in mathematics when conventional methods are used in teaching. It is worthy noting that gender does not impact on students' mathematics self-concept when PSA is used in mathematics instruction. In view of the findings, the null hypothesis HO_1 indicating that there is no significant gender differences in mathematics self-concept of students who are taught using PSA and those who are taught by the conventional methods is rejected.

IV. Discussion

Results of the Pre-test

This study employed the Solomon's Four-Group Design. The students were assigned to experimental groups 1 and 3 and control groups 2 and 4. Groups 1 and 2 took the pre-test while groups 3 and 4 did not take the pre-test. This enabled the researcher to determine the presence of any interaction between the pre-test and the PSA treatment as well as determine the similarity of the groups before applying the treatment and generalise to the groups that had not been pre-tested.

Sanders and Pinhey (1979) assert that when two experimental groups (1 & 3) are similar to each other in the post-test as opposed to the two control groups (2 & 4), then the researcher is in a strong position to attribute the differences to the experimental condition. A greater difference in the post-test between the boys and girls of the experimental groups in comparison to that between the boys and girls of the control groups results if the pre-test interacts with the treatment. This is as a result of a sensitisation effect. The post-test students' MSC result in the study did not indicate any interaction between the pre-test and the PSA treatment.

Higher post-test performance by groups 1 and 2 than that of groups 3 and 4 could have been the results if the pre-test provided a practice effect. This is not the case since a comparison of the post-test results of the four groups fails to indicate any practice effect provided by the pre-tests. The results therefore portrayed that the pre-test MSC was suitable for the study.

A comparison of groups 1 and 2 students' pre-test MSC mean scores of the male and female students revealed non-significant differences (Table 3). This results show that the groups were quite similar before the administration of the treatment.

Influence of Problem Solving Approach on Mathematics Self-Concept of Boys and Girls in Comparison to Conventional Methods

The findings of the study showed that there were non-significant differences between the MSC of the boys and girls who were taught mathematics using PSA. When MSC scores of the boys was compared to that of the girls, the results showed that the MSC post-test mean scores of the boys were insignificant compared to that of the girls of the experimental groups (Table 6). Therefore, PSA was more beneficial to both genders. However, when MSC of the girls was compared to that of boys, the results showed that the MSC post-test mean scores of the girls were significantly higher than that of the boys in the control groups. They were also statistically significant (Tables 4 & 6).

It can therefore be argued that conventional teaching methods have varying effect on MSC depending on the students' gender. Conversely, PSA has no effect on MSC when students' gender is taken into consideration. The girls seem to have obtained the greatest benefit from the conventional teaching methods. However, the overall results showed that both boys and girls who were taught using PSA developed higher MSC than those who were taught using the conventional methods. Therefore, PSA is more effective in enhancing students' MSC, irrespective of gender, than the conventional teaching methods.

The results of the study contradict the findings of Githua (2002) that gender differences in MSC are at a higher level in Kenyan secondary schools. The findings also contradict those of Rodd and Bartholomew (2006) that boys have advantage over girls in terms of MSC. Furthermore, the findings disagree with Burton (1995) who contends that the instruction of mathematics as a complete body of knowledge affects girls in a negative way than boys.

The findings of the current study are in agreement with Samuelsson (2008) who found that the use of PSA aroused and maintained a high level of motivation and interest among students during the lessons, and promoted interactions between the teacher and the students. The findings are also consistent with those of Caplan and Caplan (2005) who argued that the link between gender and MSC is very weak. Notably, the current findings have shown that the link is negligible. Moreover, the results of the study concur with Adekayo (2010) and Yusufu (2012) that gender is a non-determinant factor towards students' self-concept in mathematics.

The insignificant gender differences in mean scores on MSC between the boys and girls taught using PSA was anticipated. This may be attributed to the greater role the students played in the groups which had direct bearing on their personality. The students had to learn a concept within a group with group effort, then share with other students and further internalise the concept through intensive searching and studying independently. Throughout the PSA sessions, the student was given room for greater self-assertiveness in the group. Students did the conceptualisation of what was learnt, how it was learnt or shared with another and eventually mastered the processes as individuals. Thus, they ended up believing in their ability to solve related tasks and had their self-concept boosted.

Moreover, each group was assigned a task and group members ensured that every student in the group knew how to handle the task. Students then broke into minute groups and handled a task similar to the one that was handled as a bigger group. Furthermore, students worked individually. The various stages made the student to gauge themselves along the different stages in handling a task. It therefore completely eliminated any negative thought about students' perceptions of themselves in relation to what was being learnt. The PSA afforded students room to query themselves in the larger group and even advanced in querying each other in the much smaller group where they could ask more intuitive questions. The apex of self-evaluation was when the student solved the problem individually and excelled. Thus, the students deduced that they could solve any related problem and such thoughts enhanced their self-awareness and worthiness prompting them to esteem themselves high.

The PSA afforded the students opportunities lo learn from each other. The social atmosphere created in the PSA classrooms allowed students to actually seek and acquire knowledge while motivating others to learn concepts they could not understand in such groups. The motivation to learn arose from the fact that students had others at their disposal. Students learned the concepts and acquired the skills meaningfully thus building their mathematics self-concept. The findings are in support of Chaika (2012) that when students take the position of leading others to learn mathematics concepts, then their MSC is boosted.

The current study has shown the interactiveness of the lesson components. Contrary to earlier studies in America and Kenya that indicated that some students had greater interaction with their teachers than others do (Maritim, 1984; Campbell, 1995), the findings of this study placed all the students, irrespective of gender, on the same level. This implies that both genders in the PSA classrooms had equal opportunities to interact and participate fully in the lessons, leading to the attainment of higher levels of MSC. Indeed, studies have shown that collaborative socialisation during the instructional process is critically important to students' self-concept development (Chaika, 2012). This seems to have been the case for both genders in the experimental groups as opposed to the control groups who participated in the study.

The PSA assisted the mathematics teacher in balancing the classroom interaction patterns between the boys and girls. By using it, the teacher was able to give similar attention to both genders and this led to their improved mathematics self-concept. Thus, with the recent call for mathematics teachers to adopt teaching strategies that are more flexible and catering for both boys' and girls' mathematics self-concept (Oluwatayo, 2011; Okorie, 2017), the findings of this study might prove useful in providing a starting point in this direction. The findings showed that PSA resulted in higher students' mathematics self-concept, regardless of gender, and thus should be adopted in mathematics instruction at the secondary school level. In this regard, it is evident that the disparity between boys' and girls' mathematics self-concept in secondary schools in Kenya may be addressed by using PSA teaching strategy.

The findings of the study indicate that students' gender does not affect their self-concept in mathematics when PSA is used in mathematics instruction. Therefore, PSA is likely to change the trend where boys' mathematics self-concept has been much higher than that of girls in Kenyan secondary schools. Better girls' higher mathematics self-concept would lead to consistent improvement in their performance in national examinations and equal representation in scientific and technological fields.

V. Summary, Conclusions and Recommendations

Summary of the Study

The findings of the study are in affirmative of a significant impact of PSA on students' mathematics self-concept. The findings are in favour of the PSA teaching strategy. The inferential statistics revealed that there were statistically significant differences between the mean scores of the students in the PSA treatment groups and those of the control groups. Therefore, the findings show noticeable influence of PSA in engendering affective gains. The PSA enhanced the students' self-esteem and confidence towards learning. This can be inferred from the higher MSC mean gains obtained by the students taught using PSA as compared to those taught by the conventional methods.

Secondly, the results suggest that there was no significant influence of the teaching strategy on the students' mathematics self-concept by gender. The inferential statistics revealed that there was no statistically significant difference between the mean scores of the boys and girls in the PSA treatment groups. An analysis of the results buttressed the fact that the PSA teaching strategy provided equal opportunities to the boys and girls to collaborate, support and interact together as they participated in the lessons and group tasks. PSA enhanced the students' self esteem and confidence in the subject matter. The teacher serving as a facilitator structured a conducive classroom environment, in which the learner organised meaning on a personal level. Consequently, the PSA assisted the mathematics teachers to balance classroom interaction patterns between the boys and girls, enabling them to give similar attention to both genders, which led to their improved mathematics self-concept.

Conclusions of the Study

The following conclusions were derived from the findings of the study:

- ✓ The PSA positively impacted the mathematics self-concept of both genders that resulted in their autonomous learning and subsequent ownership of the lessons. Therefore, PSA facilitates students' sense of confidence in mathematics as opposed to the conventional methods.
- ✓ Gender has no impact on students' self-concept in mathematics when taught using the PSA teaching strategy.
- ✓ The difference in the students' mathematics self-concept by gender is due to conventional methods.

Recommendations of the Study

The recommendations that emanated from the findings of the study are: -

- ✓ PSA as a teaching strategy has significant impact on the mathematics self-concept of secondary school students. Mathematics teachers should therefore adapt the use of PSA to militate against the low mathematics self-concept among the students.
- ✓ Curriculum planners should include PSA teaching method as one of the instructional strategies to be used in teaching of mathematics both in primary and post primary schools.
- ✓ Extensive in-service training, workshops and seminars should be organised at the zonal, sub-county, county and national levels for mathematics teachers to equip them with the necessary skills in the use of PSA in the classroom instruction. Moreover, the content of PSA should be included in the regular in-service courses organised by the Government in collaboration with the Ministry of Education for practicing teachers.

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