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M.A. Adeleke
Obafemi Awolowo University

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Gender Disparity in Mathematical Performance Revisited: Can Training in Problem Solving Bring Difference Between Boys and Girls?

M.A. Adeleke

Obafemi Awolowo University

Abstract

This study examined the problem solving performance of male and female students' mathematical problem-solving performances using Conceptual Learning Strategy (CLS) and Procedural Learning Strategy (PLS). A sample of 124 science students assigned into CLS, PLS and Conventional Method (CM) groups were involved in the study making use of pretest, post test control group design. The sample was drawn from three intact Senior Secondary School Two (SSII) classes from three local government Areas of Osun State in Nigeria and were taught for a period of eight weeks. Findings of the study showed a non significant difference in the performance of boys and girls in the two learning strategies. But a significant difference was recorded in the performance of boys when comparing the two groups also in the performance of girls in the two groups. The study therefore concluded that when training of problem solving is carried out in mathematics using Conceptual and Procedural Learning Strategies boys and girls will perform equally well without significant difference.

Introduction

Available literatures have not been able to identify a single direction of difference in performance in mathematics between male and female students subject to the inequalities in their physiological structures (Kadiri, 2004). Although most researchers have found boys performing better than girls (Fennema and Sherman, 1978) especially on higher order knowledge, a few others saw girls out-performing boys while some others established no significant difference particularly during early education. A review of some gender based studies that were carried out between 1985 and 1995 by Brandy and Eister (1995) showed that there is a considerable inconsistency in the literature as to the nature, extent and sources of bias in the differential performances between boys and girls in mathematics. They noted that with the inconsistent findings and significant methodological flaws observed, more empirical researches are needed to investigate the existence of gender bias in the classroom.

In the area of problem solving in mathematics, Aiken (1971) has noted that sex difference is present in the abilities of kindergarten and even earlier stage pupils. Report of Tyson's (1996) study on the differential performance of girls on standardized multiple-choice mathematics achievement tests, compared to constructed response tests of reasoning and problem solving showed that males performed significantly better than females on the pretest although no significant differences were found on the posttest. The pretest difference was explained as a measure of difference in the pre-requisite knowledge of the two sexes. Likewise the study of Blithe, Forbes, Clark and Robinson (1994) reports a consistent difference in mean performance in favour of boys at the secondary school level in New Zealand. However, the same analysis carried out on set of students taking certain first year mathematics courses in the University of New Zealand

showed that gender differences in performance were neither as marked nor always in favour of boys. In the same vein, the work of Armstrong (1981) showed that no sex differences existed in mathematics achievement throughout the junior school but that as the end of high school males have higher achievement scores and perform better on higher level cognitive tasks. Manger (1996) investigated the relationship between gender and mathematical achievement with Norwegian 3rd graders using an achievement test covering numeracy problems, fraction problems, geometry problems and word problems. Boys were found to have higher total test scores than girls, but the difference was small.

In a study by Alao and Adeleke (2000), investigating the prevalence of mathophobia, girls were found to exhibit more math phobias than boys and consequently were likely to record lower performance than boys in mathematical activities. In Nigeria, it is a common tradition to regard males as better problem solvers than females in general life issues. Mathematics is more or less regarded either wrongly or rightly as a subject in the male domain. There is therefore the tendency to believe that males will do better. Fennema and Sherman (1978) also reasoned along this line when they reported that the differential performance observed as a result of gender difference in mathematics is possibly attributable exclusively to the community in which the students live. They also believe that rather than due to age, the difference in performance could be attributed to the fact that mathematics content of the high school tends to favour higher level tasks. This is an area in which boys have been reported to have higher performance. In high schools mathematics problem solving is regarded as a higher level task. But to assume that boys are higher problem solvers will have to be handled with care because of the hierarchical nature of mathematics.

Since problem solving is taught, the strategies of its teaching should also be considered in an attempt to contribute to resolving the inconsistencies in answering the question of the gender disparity in mathematical achievement. This study will therefore look into the differential performances of boys and girls in mathematical problem solving when they are taught problem solving making use of conceptual learning strategy (CLS) and procedural learning strategy (PLS).

The differences in the two strategies are shown in their requirements for what constitute knowledge. For instance, conceptual knowledge enables learners to recognize, identify, explain, evaluate, judge, create, invent, compare and choose when dealing with mathematical facts and concepts. Whereas procedural knowledge enables learners to apply skills in a routine manner with fluency.

Statement of the problem

The society is tending towards assuming unified challenges for both male and female. There is therefore the need to give equal opportunities to both male and female to enable them develop the necessary required skills and capabilities to face the challenges. The need to identify the status of differences in boys and girls in mathematical problem solving so as to make for closing the gap, if any, is imperative. Hence this study.

Purpose of the study

The following specific objectives were raised for the study.

- To find out the difference in the problem solving performance of male and female
- students when exposed to Procedural Learning Strategy of acquiring problem-solving skills.
- To examine the difference in the problem solving performance of male and female students when exposed to Conceptual Learning Strategy of acquiring problem-solving skills.
- To assess the difference in the problem solving performance of males when exposed to Conceptual Learning Strategy and when exposed to Procedural Learning Strategy.
- To investigate the difference in the problem solving performance of females when exposed to Procedural Learning Strategy and when exposed to Conceptual Learning Strategy.

Research hypothesis

The following hypothesis were generated and tested in this study.

- There is no significant difference in the problem solving performance of male and female students when exposed to Procedural Learning Strategy.
- There is no significant difference in the problem solving performance of male and female students when exposed to Conceptual Learning Strategy.
- There is no significant difference in the problem solving performance of male students when exposed to Procedural Learning Strategy and when exposed to Conceptual Learning Strategy.
- There is no significant difference in the problem solving performance of female students when exposed to Procedural Learning Strategy and when exposed to Conceptual Learning Strategy.

Procedure

The study adopted a modified non-equivalent pre-test post-test control group design where three intact classes were purposively drawn from a population of Senior Secondary Class Two (SSII) in Osun State of Nigeria. The modification was the selection of science students into both the experimental and control groups. This was done based on the assumption that science students have similar characteristics in terms of attitude and readiness to the learning of mathematics. Therefore science class selection provided for uniformity of the three groups selected. The three groups, respectively, were taught same aspects of simultaneous equations using Conceptual Learning Strategy, Procedural Learning Strategy and the Conventional Method. The three intact classes were drawn from three schools randomly selected from three local government areas selected in Osun State of Nigeria. Altogether, 124 students were involved in the study comprising 42 in group 1 (Experimental group 1) 44 in group 2 (Experimental group2) 38 in group 3 (control group).

The instruments used for the study included three instructional packages designed and validated for the teaching of CLS group, PLS group and the CM group, and an achievement test. The achievement test has reliability coefficient of 0.76 and item

difficulty level ranging between 0.42 and 0.46. With the instructional packages students in the three groups were taught the selected content areas for eight weeks employing the services of three trained research assistants who are university graduate mathematics teachers. Pre-test and post-test were carried out using the achievement test. Separate post-test teaching discussions were held with the three research assistants.

Results and Discussion

The pre-test scores of the students involved in the study were compared on the bases of gender across the three groups using t-test analysis. A summary of the result of this analysis is contained in table 1.

Table 1
Summary of Difference in Performance of Boys and girls in the Pretest

Group	n	X	S.d	df	t	Remarks
Male	67	8.14	2.87	122	0.51	Not Significant
Female	57	7.66	2.11			

$p > 0.05$

Result shown in the table indicates a non-significant difference in the performance of male and female students in problem solving in simultaneous linear equations across the three groups of students ($X_1 = 8.14$, $X_2 = 7.66$, $df = 122$, $t = 0.51$ $p > 0.05$). This was done to ensure uniformity in the problem-solving skills and abilities of the students selected into the three groups before they were exposed to treatments.

Hypothesis One

There is no significant difference in the problem solving performance of male and female students when exposed to PLS. It was found out that prior to exposure to PLS no significant difference was recorded in the performance of boys and girls in finding solutions of simultaneous linear equations, this hypothesis was to test if there would be difference after exposure to PLS. Result of the analysis of data gathered on the test of this hypothesis is summarized in table 2.

Table 2
t-test Summary of Difference in Performance of Boys and Girls Exposed to Procedural Learning Strategy.

Group	n	X	S.d	df	t_c	t_t	Remarks
Male	23	24.22	3.50	20	0.34	2.09	Significant
Female	21	23.90	2.74				

$p > 0.05$

Result presented in table 2 indicates that the difference observed in the performance of male and female students exposed to PLS ($X_1 = 24.22$, $X_2 = 23.90$) is not significant when subjected to t-test analysis. ($df = 20$, $t = 0.34$, $p < 0.05$).

This result shows that sex does not account for problem solving performance of students when exposed to PLS. The null hypothesis was therefore not rejected.

Hypothesis Two

There is no significant difference in the problem solving performance of male and female students when exposed to CLS. The hypothesis was raised to test the possible influence of sex on the problem solving performance of students when exposed to CLS in an attempt to improve students' performance. Result of the analysis of data collected in testing the hypothesis is as summarized in table 3.

Table 3

t-test Summary of Difference in Problem Solving Performance of Boys and Girls After Exposure to Conceptual Learning Strategy

Group	n	X	S.d	df	t_c	t_t	Remarks
Male	24	30.70	3.93	17	0.01	2.02	Not Significant
Female	18	30.72	5.00				

$p > 0.05$

The result indicates a non significant difference in the problem solving performance of male and female students exposed to CLS ($X_1 = 30.70$, $X_2 = 30.72$, $df = 17$, $t_c = 0.01$, $p < 0.05$).

This shows that sex does not significantly affect students' problem solving ability when exposed to CLS in solving simultaneous linear equations. Thus the null hypothesis was not rejected.

Hypothesis Three

There is no significant difference in the problem solving performance of male students when exposed to PLS and when exposed to CLS. This hypothesis sought to test the effect of sex on how either procedural or conceptual learning strategy would improve students performance in solving problems in simultaneous linear equations.

Result of the analysis of data collected in testing the hypothesis is summarized in table 4.

Table 4

t-test Summary of the Difference in the Performance of Male Students in Conceptual Learning Strategy and those in Procedural Learning Strategy.

Group	n	X	S.d	df	t_c	t_t	Remarks
Male (CLS)	24	30.70	33.93	45	8.61	2.0	Significant
Male (PLS)	23	24.22	3.50				

$p < 0.05$

Result shown in the table indicates a significant difference in the problem solving performance of male students when they are exposed to CLS and when exposed to PLS ($X_1 = 30.70$, $X_2 = 24.22$, $df = 45$, $t_c = 8.61$, $p < 0.05$). This shows that male students exposed to CLS exhibited significant higher problem solving ability that those exposed to PLS. The null hypothesis was therefore rejected.

Hypothesis Four

There is no significant difference in the problem solving performance of female students when exposed to PLS and when exposed to CLS. Like hypothesis three this hypothesis sought to find out if improvement of students' problem solving performance by Conceptual and Procedural Learning Strategies is influenced by female gender. Summary of the result obtained is presented in table 5.

Table Five

t-test Summary of Difference in Problem Solving Performance of Female Students when Exposed to CLS and to PLS

Group	n	X	S.d	df	t_c	t_t	Remarks
Male (CLS)	18	30.72	5.00	37	6.13	2.0	Significant
Male (PLS)	21	23.90	2.74				

$p < 0.05$

This result shows a significant difference in the performance of female students when exposed to CLS and when exposed to PLS. ($X_1 = 30.72$, $X_2 = 23.90$, $df = 37$, $t_c = 6.13$, $p < 0.05$). Female students in the CLS group performed better than those in the PLS group. The null hypothesis was therefore rejected.

Discussion

Results of this study have shown that no significant difference in problem solving performances exists between male and female students when exposed to either the CLS or the PLS. Thus the study has revealed that problem solving performance of students is not sensitive to gender. Although, the study revealed that significant difference existed in the performance of male students exposed to CLS and when exposed to PLS. Same significant difference was shown among female students too. These differences are as a result of the relative effective of Conceptual and Procedural Learning Strategies and not as a result of gender. This finding therefore buttresses the earlier assertion of Fennema and Sherman (1978) that available literatures have not been able to identify with a single direction of difference in performance between boys and girls. Other studies such as those of Koopman (1964), Ma (1995) and Manger and Eikeland (1996) have reported no significant association between gender and performance in mathematics.

In the PLS group boys have a slightly higher mean score than girls confirming the earlier studies of Blithe (1994) and Benbow and Stanley (1982) which rate boys significantly better than girls. And in the CLS group girls have a slightly higher mean score than boys confirming the findings of Brandon et al (1987) in which girls are rated higher than boys.

This study has added to the numerous studies that have reported that girls can equally perform well as boys do. The teacher should regard the students in his/her class as potential learners who are capable of developing sound understanding of mathematics irrespective of the sex of the students.

Conclusion

This paper concludes that problem solving performance of students can be improved equally irrespective of sex of students by employing teaching or learning strategies that are capable of enhancing problem solving skills of students.

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