Role of Grouping on Senior Secondary School Students' Mathematics Self-Efficacy and Performance in Geometry

By

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Abstract

The study investigates the role of grouping on senior secondary school students' mathematics self-efficacy and performance in geometry. The design for the study was a pre-test post-test experimental research design. Five research questions guided the research. The population for the study was 18589 senior secondary school students in Plateau Northern Educational Zone. A sample of 74 students was selected using a convenience sampling technique. The mathematics self-efficacy questionnaire and geometry performance test were used for data collection. The instruments had reliability coefficients of 0.98 and 0.70 respectively. Grouping was found to have improved the experimental group compared to the control group. The study finally recommends incorporating grouping into normal classroom activities to enhance students' mathematics self-efficacy and performance in geometry.

Keywords: Grouping, Vicarious, Experience, Self-efficacy, Performance.

Introduction

Mathematics is a "critical filter" to students' progress at all levels. However, studies have shown that students' mathematics performance needs improvement (Dauda, Galadima & Dibal, 2022; Sunday & Olugbenga, 2022). Several factors have been associated with low performance of students in mathematics (Ochoche & Oguche, 2022; Dauda, Galadima & Dibal, 2022). One such factor is a lack of mathematics self-efficacy (May, 2009; Odiri, 2020), which is the belief an individual has in his/her ability to perform a mathematics task. Studies have shown that one of the ways of developing mathematics self-efficacy in students is through grouping (Benton, 2014). Grouping involves carefully chosen members who are capable of coping with a mathematical task and are ready to help one another perform the same by letting go of self-doubt (Benton, 2014).

Although many studies have been conducted on students' mathematics self-efficacy and grouping, not much is known about using grouping to improve students' mathematics self-efficacy and performance in geometry in Nigeria. This study is an attempt to fill this gap.

Literature Review

The performance of students in mathematics still leaves room for improvement (Onyeka & Arokoyu, 2018). Studies have revealed that low mathematics self-efficacy is one of the major causes of poor performance in mathematics (Odiri, 2020; Sipniewski, 2020; Amenah & Jimoh, 2020).Studies have shown that one way of improving students' performance in mathematics is through improving their mathematics self-efficacy (Spaniol, 2017; Oh, 2019; Odiri, 2020). Bandura (1986) put forward that self-efficacy is people's judgment of their capabilities to organize and execute some actions required to attain a level of success or achievement. According to Bandura (1994) there are four sources of self-efficacy which are Mastery Experience, Vicarious Experience, Social Persuasion, and Physiological State. He explained that Mastery Experience is the belief one has in his/her ability as a result of previous success, individuals use past performance to establish the belief of succeeding in future tasks. Bandura (1994) also explained that Vicarious Experience is a source of self-efficacy in which a person observes a model similar to oneself succeeds in a task and then develops the belief that he/she is capable of performing the same task. Social Persuasion is a source that has to do with verbally persuading an individual while assuring him/her of his/her ability to succeed in a task, Bandura (1994). Social Persuasion also refers to feedback that may come as an encouragement or discouragement from people within us such that a favorable appraisal of an individual sustains self-efficacy while an unfavorable appraisal reduces self-efficacy Ozcan, Kontas, and Unisen (2021). Lastly, Bandura (1994) explained that the Physiological State is a source of self-efficacy that is influenced by the emotional, psychological, and physical well-being of an individual to perform a task. These factors influence a person's belief in his or her ability to perform a task. Self-efficacy is high when the physiological arousals such as anxiety, stress, and depression are low while self-efficacy is low when these arousals are high (Ozcan, Kontas, & Unisen, 2021).

On the other hand, mathematics self-efficacy is the belief an individual has in his/her ability to learn mathematics and succeed in it (Larnang & Bondoc, 2020). It is the belief in the ability to perform a more specific task or the capability to solve a particular mathematical problem (Bone & Lawes, 2012). Mathematics self-efficacy generally determines the goal students pursue (Calik, 2014). It influences the ability to face challenges in mathematics (Omolola, 2020). Studies have shown that students with high mathematics self-efficacy found it easy for them to apply mathematical concepts to real-life situations (Gates, 2014; Pangburn, 2020), and it is a determinant of performance in mathematics (May, 2009; Odiri,

2020). Research has shown that a lack of mathematics self-efficacy makes students avoid mathematics (Sipniewski, 2020), reduces analytical thinking ability (Mulyono, Ramadan & Masrukan, 2019), and also increases students' anxiety levels (Spaniol, 2017; Sipniewski, 2020).

Grouping is an educational practice where an entire class is subdivided into small units to achieve a set goal or perform a given task (Ward, 1987). There are many types of grouping intervention, these include visibly randomized groups (Baldwin, 2018; Nhan & Nhan 2019); group research (Algani, 2021); jigsaw (Algani, 2021); vertical non-permanent surface (Baldwin, 2018); students selected groups (Nhan & Nhan, 2019); Razalas' method (Salazar, 2015); two-stay two-stray grouping technique (Habibullah, Puspitarani & Prasetyo, 2020); formal cooperative learning (Yasin, Razak & Maasum, 2018); base-group cooperative learning (Maasum, 2018); group work and advising (Yushau & Omar, 2010); grouping with interim goal setting (Oldham, 2018); learning cycle (Ward, 1987); group investigation (Ward, 1987); peer tutoring (Ward, 1987).

Research has also shown that grouping improves the mathematics self-efficacy of students, and it is a predictor of the performance of students in mathematics (Oh, 2019). This study investigates the role of grouping on students' mathematics self-efficacy and performance in geometry.

Methodology

The study used pre-test and post-test Experimental Research Design. The convenience sampling technique was used to select 74 students from a population of eighteen thousand five hundred and eighty-nine (18,589) Students of Senior Secondary Schools in Plateau Northern Educational Zone. Two instruments were used for data collection. The first instrument is an adapted mathematics self-efficacy questionnaire developed by Usher and Pajares (2009). This instrument consists of 24 items: six (6) items for measuring Mastery Experience, six (6) items for measuring Vicarious Experience, six (6) items for measuring Social Persuasion, and six (6) items for measuring Physiological State. The questionnaire items were coded as Definitely False = 0, Mostly False = 1, Mostly True =2, and True =3. The study adopted Usher and Pajares (2009) Mathematics Self-Efficacy Survey Scale where 0.0 – 0.4 means no self-efficacy, 0.5 – 1.4 means little self-efficacy, 1.5 – 2.4 means much self-efficacy and 2.5 - 3 means complete self-efficacy. The second instrument is the Geometry Performance Test adopted from Chimuka (2017) consisting of 30 items. The geometry assessment test questions scored 100 marks.

The study used grouping with interim goal setting (Oldham, 2018) as an intervention to develop students' self-efficacy through Mastery Experience, Vicarious Experience, Social Persuasion, and Physiological State, as well as improve students' performance in geometry. The study was guided by five research questions which sought to find out the mean gain in response between the experimental and control groups. The data was analyzed using mean.

Results

The data collected from the pre-test and the post-test were used to compare the performance of the control and the experimental group before and after the grouping intervention. The results are presented in Tables 1 to 5.

Table 1: Results of the Mean Gain in Mastery Experience of the Experimental and the Control Group.

Group		**n**	$\underline{X}$	**SD**	**Mean-gain**
Experimental	Pre-test	43	1.94	0.34	
	Post-test	43	2.23	0.35	0.29
Control	Pre-test	31	1.61	0.32	
	Post-test	31	1.75	0.44	0.14

Key: N = Sample, $\underline{X}$= Mean, SD = Standard Deviation, Mean-gain = The difference between the pre-test and the post-test mean score of a group.

The result from Table 1 revealed that the experimental group had a pre-test mean score of 1.94, a standard deviation of 0.34 a post-test mean score of 2.23, a standard deviation of 0.35, and a mean gain of 0.29. while the control group had a pre-test mean score of 1.61, a standard deviation of 0.32, and a post-test mean score of 1.75, a standard deviation of 0.44 with a mean gain of 0.14. The mean gain of the experimental group is higher than that of the control group. This implies that groupings helped to improve the Mastery Experience of students in mathematics.

Table 2: Results of the Mean Gain in Vicarious Experience of the Experimental and the Control Group.

Group		n	$\underline{X}$	SD	Mean-gain
Experimental	Pre-test	43	2.14	0.41	
	Post-test	43	2.14	0.36	0.00
Control	Pre-test	31	1.84	0.40	
	Post-test	31	2.14	0.50	0.30

The result from Table 2 revealed that the experimental group had a pre-test mean score of 2.14, a standard deviation of 0.41, and a post-test mean score of 2.14, a standard deviation of 0.36 with a mean gain of 0.00. The control group had a pre-test mean score of 1.84, a standard deviation of 0.40, and a post-test mean score of 2.14, a standard deviation of 0.50 with a mean gain of 0.30. The mean gain of the control group is higher than the mean gain of the experimental group. This implies that grouping did not improve the Vicarious Experience of students in mathematics.

Table 3: Results of the Mean Gain in Social Persuasion of the Experimental and the Control Group.

Group		n	$\underline{X}$	SD	Mean-gain
Experimental	Pre-test	43	1.74	0.54	
	Post-test	43	2.15	0.37	0.41
Control	Pre-test	31	1.73	0.54	
	Post-test	31	2.00	0.51	0.27

The results from Table 3 revealed that the experimental group had a pre-test mean score of 1.74, a standard deviation of 0.54, and a post-test mean score of 2.15, a standard deviation of 0.37 with a mean gain of 0.41. The control group had a pre-test mean score of 1.73, a standard deviation of 0.54, and a post-test mean score of 2.00, a standard deviation of 0.51 with a mean gain of. 0.27. The mean gain of the experimental group is higher than the mean gain of the control group, hence it is concluded that grouping helped to improve students' Social Persuasion in mathematics.

Table 4: Results of the Mean Gain in the Physiological State of the Experimental and the Control Group.

Group		n	$\underline{X}$	SD	Mean- gain
Experimental	Pre-test	43	1.78	0.58	
	Post-test	43	2.30	0.39	0.52
Control	Pre-test	31	1.61	0.48	
	Post-test	31	1.98	0.65	0.37

The result from Table 4 revealed that the experimental group had a pre-test mean score of 1.78, standard deviation of 0.58, and post-test mean score of 2.30, standard deviation of 0.39, and mean gain of 0.52. The control group had a pre-test mean scores of 1.61, standard deviation of 0.48 and a post-test mean scores of 1.98, standard deviation of 0.65 with mean gain of. 0.37 The mean gain of the experimental group is higher than that of the control group, this implies that grouping helped to improve the Physiological State of students in mathematics.

Table 5: Results of the Mean Gain in Geometry Performance of the Experimental and the Control group.

Group		n	$\underline{X}$	SD	Mean-gain
Experimental	Pre-test	43	22.68	9.70	
	Post-test	43	50.67	12.68	27.99
Control	Pre-test	31	26.74	6.24	
	Post-test	31	31.48	4.58	5.06

The result from Table 5 revealed that the experimental group had a pre-test mean score of 22.68, a standard deviation of 9.70, and a post-test mean score of 50.67, a standard deviation of 12.68 with a mean gain of 27.99. The control group had a pre-test mean score of 26.74, a standard deviation of 6.24, and a post-test mean score of 31.48, a standard deviation of 4.58 with a mean gain of 27.99. 5.06. The mean gain of the experimental group is higher than the mean gain of the control group. This implies that grouping helped to improve the student's academic performance in geometry.

Discussion of Results

The research was motivated by the poor performance of students in mathematics, where low mathematics self-efficacy was found to be one of the leading causes (Onyeka & Arokoyu, 2018). Grouping was found in the literature to be a way of improving mathematics self-efficacy (Benton, 2014: Muchiri & Njenga, 2020). It is because of this that this study used grouping to improve the mathematics self-efficacy of students. The Mastery Experience of the students in the experimental group was at 1.94 before the intervention but it increased to 2.23 after the intervention while those in the control group was 1.61 before the intervention and 1.75 after the intervention. The study revealed that there is a difference in the Mastery Experience of students taught mathematics using grouping and those taught without grouping. The result shows an improvement in the Mastery Experience of those taught with grouping.

Comparing this finding with previous studies shows that this finding is in line with the findings of Gao (2019) who investigated the sources of mathematics self-efficacy in students and found that students develop their mathematics self-efficacy from Mastery Experience. It is also in line with the finding of Saunder-Wyndham (2020) who investigated the effect of cooperative learning on students' self-efficacy and found that self-efficacy improved through all the sources as a result of cooperative learning. The finding is also consistent with the study of Melissa and Kulacki (2023) who found that group work significantly develops students' self-efficacy through Mastery Experience. The finding is also in consonance with the findings of Yang and Harijanto (2022) who found that the group project-based learning method developed self-efficacy in students. Other studies such as Habibullah, Puspitarani, and Prasetyo (2020), Zakariya (2022) also found grouping as an effective intervention that increases students' mathematics self-efficacy. However, the finding contradicts that of Ontas and Tekindal (2015) which surprisingly found that grouping does not significantly increase the self-efficacy of students generally.

The experimental group had a Vicarious Experience mean score of 2.14 before the intervention and still 2.14 after the intervention while the control group had 1.84 before and 2.14 after the intervention. No difference was found in students' Vicarious Experience of those taught using grouping. This indicates that grouping did not seem to improve the Vicarious Experience of students. This finding aligns with the study of Ontas and Tekindal (2015) which found group work to be statistically insignificant in developing self-efficacy. It is also in line with the study of Getachew and Birhane (2016) which found the intervention

not to have any significant effect on the self-efficacy of students. It is also consistent with the study of Nhan and Nhan (2019) which found that group discussion is not a significant means of improving self-efficacy. It is also in line with the study of Mertes (2015) which found group counselling as a means of developing self-efficacy in students to be statistically insignificant. Interestingly, the findings disagree with that of Saunder-Wyndham (2020) which found that grouping increases Vicarious Experience in students.

The study found a difference in the students' Social Persuasion, the experimental group improved more in their Social Persuasion compared to the control group. The Social Persuasion mean score of the experimental group was 1.74 before the intervention and 2.15 after the intervention while the control group had 1.73 before the intervention and 2.00 after the intervention. This aligns with the findings of Widajati, Setyosari, Degeng, Sumarmi, and Mustaji (2020) who found group investigation to be effective in developing self-efficacy in students through Social Persuasion. It is also in line with the study of Johnson (2023) who found group discussion methods to be effective in developing students' self-efficacy through Social Persuasion. It is also consistent with the findings of Melissa and Kulacki (2023) who found grouping as a means by which students inspire one another through Social Persuasion to develop self-efficacy.

A difference was also found between the experimental group and the control group in their Physiological State. The experimental group had a Physiological State mean score of 1.78 before the intervention and 2.30 after the intervention while the control group had 1.61 before and 1.98 after the intervention. This indicates that grouping improves the Physiological State of students. The finding is consistent with the finding of Zakariya, Nilsen, Goodchild and Bjorkestol (2020) who investigated self-efficacy and approaches to learning and found that grouping develops self-efficacy through a Physiological State. The finding is also consistent with the finding of Ozcan, Kontas, and Unisen (2021) who investigated the sources of mathematics self-efficacy in gifted and non-gifted students and found that the two groups of students develop self-efficacy from Physiological State. Sinanan (2022) found that mathematics self-efficacy is improved through the four sources of mathematics self-efficacy, including the Physiological States. A similar finding was by Olarewaju and Awofala (2023).

Similarly, a difference was found in the performance of students taught geometry using grouping and those taught without grouping. The experimental group had a pre-test mean score of 22.68 and a post-test mean score of 50.67 while the control group had a pre-

test mean score of 26.74 and a post-test mean score of 31.48 all of them out of 100 marks. This shows that grouping improved the performance of students in geometry. This finding is in line with the findings of Hayati and Surya (2017), Oni (2018), Akanmu (2019), and Oh (2019).

Conclusion and Recommendation

The study investigated the role of grouping on senior secondary school students' mathematics self-efficacy and performance in geometry. The study concluded that grouping is a means of improving students' mathematics self-efficacy and the performance of students in geometry. The study recommends that teachers should incorporate grouping into normal classroom teaching to improve students' mathematics self-efficacy and performance in mathematics.

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