



Effect of Think-Pair-Share Instructional Strategy on JSS2 Students Cognitive Engagement in Mathematics Classes

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Abstract

The study investigated the effect of think-pair-share instructional strategy on JSS2 students' cognitive engagement in Mathematics classes. Three research questions and corresponding hypothesis guided the study which adopted the pretest posttest quasi-experimental research design. The sample of the study was 93 JSS 2 students drawn using stage sampling procedure. One instrument titled: Students' Cognitive Engagement Questionnaire (SCEQ) developed by the researchers was used to collect data. The instrument was face validated by three experts. Mean and standard deviation were used to answer the research questions and ANCOVA to test the hypotheses at 0.05 level of significance. Results among others showed that the think-pair-share strategy had a significant effect on students' cognitive engagement in Mathematics classes than the lecture method. It was recommended among other that Mathematics teachers should use the think-pair-share instructional strategy in teaching Mathematics so as to enhance students' cognitive engagement in class.

Keywords: Think-pair-share, instructional strategy, students, cognitive engagement, Mathematics classes

Introduction

The world is fast changing into a technology driven economy and so also is teaching and learning. And for this reason, students are encouraged to take up courses in science and technology. Mathematics is key to the study of science and technology because it provides the needed foundation for the study of science and technology (Wambugu, 2019). To support in providing the needed foundation for the study of other subject, the Federal Republic of Nigeria (FRN, 2014) made it compulsory for students in primary and secondary schools. Consequently, students are expected to score at least a credit pass in the subject in their senior school certificate examinations. Also, the Joint Admission and Matriculation Board (JAMB, 2022) requires that students score at least a credit pass in the subject to be able to gain admission in most technology, engineering, physical sciences, management science among others. More so, most jobs in Nigeria require that the applicant has at least credit pass in the subject. Hence, those without credit pass in the subject may lose employment opportunities and or admissions into higher institutions. So, the importance of Mathematics to the student and the nation cannot be overemphasized. Unfortunately, research has shown that most students perform poorly in the subject. For instance, Zalmon and Wanu (2017) and Okeke (2021) stated that students in Nigeria have under achieved in Mathematics for many years. Researchers are quite concerned about the issue of low Mathematics student achievement in Nigeria

since it could have a severe impact on students, graduates, and even the nation's technological aspirations. A possible reason for such level of under achievement by students may be their level of cognitive engagement in the teaching and learning of Mathematics. Abla and Fraumeni (2019) defined student engagement as a student's readiness to learn as demonstrated by curiosity, participation, and the want to learn more. According to Mundelsee and Jurkowski (2021), student engagement is defined as the mental "investment" and the intellectual work required to learn, comprehend, and gain knowledge. As a result, it entails the time, energy, and resources pupils devote to learning. According to these criteria, active student readiness and willingness to participate in the teaching and learning of academic subjects, including Mathematics, could be interpreted as student engagement. Hence, it is described in this study as the level of participation and involvement of students in Mathematics classes.

According to research, there are three types of engagement in the classroom: cognitive engagement, behavioral engagement, and emotional engagement (Mundelsee & Jurkowski, 2021). While emotional engagement refers to the positive and negative sentiments a student has in response to the teacher, peers, and the educational environment, behavioral engagement relates to physical reactions to events (Gunuc & Kuzu, 2015). The aim of this study is

cognitive engagement since it captures students' thought processes and perception throughout learning. Burch, Heller, Burch, Freed, and Steed (2015) defined it as students' capacity to value learning and engage in self-regulated learning. According to research, students who are more cognitively engaged learn more than students who are less engaged over the course of their academic and professional careers (Finn & Zimmer, 2012). Employing teaching techniques that engage students should be given top importance in order to ensure that they are fully involved in the teaching and learning process.

Much of the teaching and learning of Mathematics in Nigeria primary and secondary schools has been done using the conventional method. Conventional approach in teaching and learning Mathematics sometimes make students passive and hence making them unable to understand the concepts of the material presented (Sihombing, Simamora & Dewi 2021). Therefore, the need to shift from this approach to such approaches that are students' centred and more engaging like the think-pair-share approach. Think-pair-share (TPS) is a collaborative learning strategy in which students collaborate to solve a problem or answer a question about an assigned task (Akanmu, 2019).

The strategy follows a three step approach. In the first step, the teacher possesses a question and allow the students time to think about the question or problem. Then with the help of the teacher, the students pair up in groups to discuss and brainstorm on their answers and solutions. This increases involvement, concentrates attention, and gets students interested in understanding the activities being presented. At the third stage, students share their answers or solutions to the problem with the whole class. At any point of learning, the learners will be actively involved in purposeful speaking and listening against the practice where the teacher and few learners dominate the teaching and learning process and making other students passive in class (Abiodun, Asanre, Ogundeji, Odupe & Rasaki, 2022).

According to research, the think-pair-share technique can improve learning. In Ogun State, Nigeria, Abiodun et al. (2019) looked into the impact of the Think-Pair-Share method on students' performance in secondary school Mathematics. They discovered that the strategy has a significant impact on students' Mathematics achievement. More specifically, Akanmu (2019) looked at how think-pair-share affected senior school students' Mathematics performance in Ilorin, Nigeria and revealed that it enhances performance of students

taught set theory than the control group. When Ningsih (2019) looked at the usage of think pair sharing in Mathematics learning, Ningsih found that the outcomes were superior to those of students who used conventional learning.

These studies demonstrate how well the think-pair-share technique works to improve students' learning. Studies on the strategy's impact on students' learning engagement in Nigeria, however, are few and few between. This causes a gap in the literature, which the current study seeks to fill. Additionally, research is required to support recommendations and policies that might result in the usage of the think-pair-share strategy in the teaching of Mathematics. Therefore, more research is required to determine how the think-pair-share technique affects students' cognitive engagement in Mathematics classrooms.

Gender studies on students learning have yielded serious controversies all over the world. Fan, Umaru and Nseendi (2016) sees gender as a range of views used to define roles and responsibilities women and men are expected to play particular society. Hence, gender is a term constructed by a society based on their expectations of the activities men and women are expected to carry-out. However, a major point of concern is how these expectations affect the learning outcomes of men and women taught under the same circumstance.

The claimed discrepancies are supported by empirical research on how gender influences students' learning when they are exposed to the think-pair-share technique. Male students outperformed female students, according to Forgasz, Leder, and Vale's (2017) research. Furthermore, Oluyemo Musbahu, Kukwil, Anikweze, and Shaluko (2020) found that male students outperform female students in Mathematics. In contrast, Abiodun et al. (2022) found no evidence of a primary influence of gender on pupils' achievement in Mathematics. The results of Akanmu (2019), who used think-pair-share to teach set theory to Mathematics students likewise showed that there was no statistically significant difference between the performance of male and female students. These results provide support for the ambiguities over the impact of gender on pupils' academic achievement. The consequence is that answers to these issues are still elusive, necessitating additional investigation. Therefore, it is essential that this study examine the impact of the think-pair-share teaching technique on students' cognitive engagement in Mathematics classrooms while taking gender into account.

Research Questions

1. What is the mean cognitive engagement scores in Mathematics of students exposed to think-pair-share instructional strategy and those exposed to the lecture method?
2. What is the mean cognitive engagement scores in Mathematics of male and female students exposed to think-pair-share instructional strategy?
3. What is the interaction effect of strategy and gender on students' cognitive engagement in Mathematics?

Hypothesis

The following null hypotheses were tested at 0.05 level of significance in line with the research questions.

1. There is no significant difference in the mean cognitive engagement scores in Mathematics of students exposed to think-pair-share instructional strategy and those exposed to the lecture method
2. There is no significant difference in the mean cognitive engagement scores in Mathematics of male and female students exposed to think-pair-share instructional strategy
3. There is no significant interaction effect of strategy and gender on students' cognitive engagement in Mathematics.

Methods

The study adopted a pretest, posttest quasi-experimental research design. The study was conducted in Boki Local Government Area, Cross River State Nigeria. "The population of the study consist of all JSS 2 students in the 31 public secondary schools in the area for the 2022/2023 academic session. JSS 2 students were chosen because they are not an examination class and are still young enough to instill learning engagement in them. The sample of the study consist of 93 (48 males and 45 female) JSS 2 students in two intact classes drawn using stage sampling procedure. The intact classes were assigned one each to the experimental (think-pair-share) group and the control (lecture method) group. The experimental group had 49 (27 males and 22 females) students while the control group had 44 (21 males and 23 females) students. One instrument title: Students' Cognitive Engagement Questionnaire (SCEQ) developed by the researchers was used to collect data. The instrument had two sections A and B. Section A elicits information on students' gender and school code. Section B is a 20-

item questionnaire which elicits information on students' cognitive engagement. It is a 4 point scale with rating options of Very Well Engaged (VWE) = 4, Well Engaged (WE) = 3, Fairly Engaged (FE) = 2 and Poorly Engaged (PE) = 1. The questionnaire was scored by the research assistants. The instrument was faced validated by three experts, two of from Mathematics Education Unit and one from Measurement and Evaluation programme area, Department of Science Education, University of Nigeria, Nsukka. The SCEQ was trial tested on 20 JSS2 students in a school that was not part of the study. Cronbach alpha method was used to establish the reliability coefficient of the SCEQ because the items were scaled in multiple order. The reliability coefficient obtained was 0.89.

Prior to the commencement of the study the researchers visited the sampled schools to seek the consent of the school principals to allow the students take part in the study. Upon granting of the permission, the researchers recruited two Mathematics teachers as research assistants. The criteria for recruiting the teachers was that the person must have at least five years working experience and must be teaching Mathematics at the junior secondary school level. The reason for using regular Mathematics teachers in their respective is to ensure that students are not aware that they are involved in an experiment. The experiment lasted for seven weeks. In the first week, the research assistant for the experimental group was trained for four days on the use of the think-pair-share instructional strategy while that of the control group was asked to use the lecture method. After the training sessions, two sets of lesson plans prepared for the two groups with same content, specific objectives, duration and evaluation, except that the lesson plan for the experimental group was prepared in line with the think-pair-share strategy were handed over to the research assistants. The SCEQ was also handed to the research assistants. On the fifth day of the first week, the students were taught by their respective teachers in a mock session and scored on their levels of cognitive engagement. The scores served as pretest scores. The actual teaching started in the second week through the seventh week using the normal school lesson periods which lasted for 40 minutes per lesson for four times in a week. The items on the SCEQ were reshuffled and used by the research assistants in their respective groups to score the students on their levels of cognitive engagement. These scores served as posttest scores. Data collected were analyzed using mean and standard deviations to answer the research questions

and ANCOVA to test the null hypotheses at 0.05 level of significance. **Results**

Table 1: Pretest and Post-test Mean Cognitive' Engagement Scores in Mathematics of students exposed to think-pair-share instructional strategy and those exposed to the lecture method

Groups	N	Pretest		Posttest		Mean Diff.
		\bar{X}	SD	\bar{X}	SD	
Think-pair-share	49	35.31	4.58	52.76	5.81	17.45
Lecture Method	44	33.02	6.40	43.68	3.63	10.66

The mean difference of 17.45 and 10.66 for think-pair-share strategy and the lecture method respectively shows that the think-pair-share strategy has positive effect on students' cognitive engagement in Mathematics classes.

Table 2: Analysis of Covariance (ANCOVA) of the Difference in the Mean students' Engagement Scores of students Taught Calculus using Activity-Based Learning and Those Taught using Lecture Method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared	Dec.
Corrected Model	2042.837 ^a	4	510.709	21.877	.000	.499	
Intercept	5776.603	1	5776.603	247.454	.000	.738	
Pretest	12.250	1	12.250	.525	.471	.006	
Method	1804.593	1	1804.593	77.304	.000	.468	S
Gender	73.687	1	73.687	3.157	.079	.035	NS
method * gender	35.424	1	35.424	1.517	.221	.017	NS
Error	2054.281	88	23.344				
Total	222517.000	93					
Corrected Total	4097.118	92					

a. R Squared = .499 (Adjusted R Squared = .476)

The result in table 2 shows that the effect of think-pair-share strategy on students' cognitive engagement in Mathematics classes was significant $F(1, 92) = 77.304$, $p < .05$, $\eta^2 p = .468$, thus the hypothesis is rejected.

This is because the exact probability value of 0.000 is less than 0.05 set as level of significance. The effect size of ($\eta^2 p = .468$) indicates that 46.8 percent changes in students' cognitive engagement in Mathematics classes is due to the use of think-pair-share instructional strategy. Thus, inference drawn is that think-pair-share instructional strategy has a significantly positive effect on students' cognitive engagement in Mathematics classes.

Table 3: Pretest and Post-test Mean Cognitive' Engagement Scores in Mathematics of male and female students exposed to think-pair-share instructional strategy

Gender	N	Pretest		Posttest		Mean Diff
		\bar{X}	SD	\bar{X}	SD	
Male	48	33.63	6.53	49.73	7.18	16.10
Female	45	34.87	4.39	47.11	5.86	12.24

Results in Table 3 shows that the mean difference for male and female students' cognitive engagement scores in Mathematics classes exposed to think-pair-share instructional strategy were 16.10 and 12.24 respectively. This shows that both male and female students improve their cognitive engagement in Mathematics classes, though the male were slightly better.

The result in Table 2 shows that the mean cognitive engagement scores in Mathematics of male and female students exposed to think-pair-share instructional strategy was not significant $F(1, 92) = 3.157$, $p > .05$, $\eta^2 p = .035$, thus the hypothesis was not rejected. This is because the exact probability value of 0.079 is greater than 0.05 set as level of significance. The effect size of ($\eta^2 p = .035$) indicates that 3.5 percent changes in students' cognitive engagement in Mathematics classes is due to gender. Thus, inference drawn is that there is no significant difference in the mean cognitive engagement scores in Mathematics of male and female students exposed to think-pair-share instructional strategy.

Table 4: Pretest and Post-test Mean interaction effect of strategy and gender on students' cognitive engagement in Mathematics

Instructional Methods	Gender	N	Pretest		Posttest		Mean Diff.
			\bar{X}	SD	\bar{X}	SD	
Think-pair-share	Male	27	34.93	5.48	54.15	5.96	19.22
	Female	22	35.77	3.22	51.05	5.26	15.28
Lecture Method	Male	21	31.95	7.48	44.05	3.85	12.10
	Female	23	34.00	5.20	43.35	3.47	9.35

Result in Table 4 shows that the male and female students exposed to think-pair-share instructional strategy had mean difference of 19.22 and 15.28 respectively. This means that the both male and female students improved in their cognitive engagement in Mathematics classes but the males improved slightly higher than the female students. More so, male and female students exposed to lecture method had mean difference of 12.10 and 9.35 respectively. This means that both male and female students improved in their cognitive engagement in Mathematics classes but the males were slightly better than the female students.

The result in Table 2 shows that the interaction effect of strategy and gender on students' cognitive engagement in Mathematics was not significant $F(1, 92) = 1.517, p > .05, \eta^2 p = .017$, thus the hypothesis was not rejected.

This is because the exact probability value of 0.221 is greater than 0.05 set as level of significance. The effect size of ($\eta^2 p = .017$) indicates that 1.7 percent changes in students' cognitive engagement in Mathematics classes is due to the interaction effect of strategy and gender. Thus, inference drawn is that there is no significant interaction effect of strategy and gender on students' cognitive engagement in Mathematics.

Discussion

The findings of the study revealed that the think-pair-share strategy has positive effect on students' cognitive engagement in Mathematics classes. Furthermore, the effect of think-pair-share strategy on students' cognitive engagement in Mathematics classes was significant. This implies that the think-pair strategy is effective in enhancing students' cognitive engagement in Mathematics classes more than the lecture method. A possible reason is because the strategy is a collaborative strategy that engages students actively into the teaching and learning process. The finding validates previous findings by Ningsih (2019) who reported that Mathematics learning outcomes of students using think pair share were better than the Mathematics learning outcomes of students who use conventional learning. The findings could be so because students in the think

pair group collaborated together to ponder on the solutions and answers to questions posed by the teachers. This gives each student the opportunity to bring forth their ideas for discussion. More so, the students share their ideas with the whole class thereby enhancing their cognitive engagement in the teaching and learning process.

Additionally, one of the findings revealed that male students slightly improved in their cognitive engagement than their female counterparts when exposed to think-pair-share strategy though the difference was statistically not significant. This implies difference in the cognitive engagement scores of male and female students could be due to chance rather than the effect of strategy. This finding is in line with those of Akanmu (2019) and Abiodun et al. (2022) who in their separate studies revealed that there is no significant main effect of gender on the achievement of the students in Mathematics. This could be so because the students were taught using the same strategies and by the same teachers. Expectedly, their levels of cognitive engagement should be not differ significantly.

Lastly, the findings of the study revealed that both male and female students exposed to the think-pair-share and lecture method improved in their cognitive engagement in Mathematics classes. However, there was no significant interaction effect of method and gender on students' cognitive engagement in Mathematics classes. This means that the methods used did not exhibit gender bias. The findings supports previous findings by Mohammed, Atagana and Edawoke (2014) who reported that no significant difference exists in the engagement of male and female students. The implication is that though the cognitive engagement scores of male and female students in both the experimental group improved, the improvement was due to teaching and not gender bias. This could be so because when students have a similar level of cognitive engagement and are taught by the same teachers under the same circumstance, their scores are expected to be the same.

Conclusion

Based on the findings of the study, it was concluded that the think-pair-share instructional strategy is more effective in improving students' cognitive engagement than the lecture method, which was statistically significant. Furthermore, it was concluded that gender was not significant in improvement students' cognitive engagement in Mathematics. And that the interaction effect of strategy and gender on students' cognitive engagement was not significant. In conclusion, the study provided findings on the effectiveness of think-pair-share instructional strategy on students' cognitive engagement in Mathematics classes.

Recommendations

Based on the findings of the study, the researchers made the following recommendations

1. Mathematics teachers should use the think-pair-share instructional strategy in teaching Mathematics so as to enhance students' cognitive engagement in class.
2. Government and school administrators should organize training workshops for Mathematics teachers on the use of think-pair-share instructional strategy in teaching Mathematics

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