Innovative Teaching Techniques for Alleviating Mathematics Phobia Among Secondary School Students in Anambra State

Akujieze, Mary Okwuchukwu

Nwafor Orizu College of Education Nsugbe Anambra State.

Abstract

This study explores innovative teaching techniques to address mathematics phobia among secondary school students in Anambra State. Recognizing the pervasive impact of mathematics anxiety on academic performance and psychological well-being, the research focuses on the efficacy of two innovative approaches: inquiry-based learning and peer teaching. The study involves 50 secondary school students and employs a self-designed questionnaire validated by mathematics department lecturers, a measurement and evaluation expert, and an experienced secondary school teacher. Data collection was conducted through an online survey designed using Google Forms, providing a convenient and efficient method for participants to respond. Results from the online survey reveal insights into the comparative effectiveness of these techniques, highlighting gender-specific variations. Notably, peer teaching emerged as a more favorable technique. The slightly higher variability in scores in the peer teaching method, as indicated by the standard deviation, suggests that while it may lead to higher average performance, it also introduces greater variability, emphasizing the need for tailored approaches to accommodate diverse learning styles. The study contributes localized data to the broader literature, addressing gaps in understanding mathematics phobia in Anambra State. Findings aim to inform educators, policymakers, and practitioners about evidence-based strategies to create a positive and inclusive learning environment for mathematics in secondary schools.

Keywords: Innovative, teaching techniques, mathematics phobia, secondary school, students

1. Introduction

In Anambra State, as in many educational contexts globally, the phenomenon of mathematics phobia among secondary school students poses a significant challenge to effective learning.

Mathematics phobia, or fear of math, is an emotional and psychological apprehension toward learning and engaging with mathematical concepts (Wardhani & Wardana, 2023). Individuals experiencing math phobia often feel anxiety, stress, or even panic when confronted with mathematical tasks. This aversion can hinder learning, impact academic performance, and lead to a negative attitude toward the subject. Overcoming mathematics phobia involves implementing supportive teaching methods, building confidence through positive reinforcement, and emphasizing the real-world applications and relevance of mathematical concepts to foster a more inclusive and conducive learning environment (Kunwar, 2020).

Recognizing the pivotal role of mathematics in educational and professional pursuits, educators and researchers alike are exploring innovative teaching techniques to alleviate this pervasive anxiety and enhance students' mathematical proficiency (Neelofar et al., 2022). The study focused on two innovative teaching methods: inquiry-based learning and peer teaching. Inquiry-based learning (IBL) is an educational approach that empowers students to actively explore, question, and construct knowledge (Gómez-Chacón et al., 2023). Rooted in curiosity and critical thinking, IBL shifts the traditional teacher-centered model to a student-driven one. Students formulate inquiries, investigate problems, and collaboratively seek solutions. This method fosters a deep understanding of subjects, as it encourages self-directed learning, problem-solving, and the application of knowledge in real-world contexts (Huang et al., 2021). IBL cultivates essential skills such as critical thinking, creativity, and communication. By promoting curiosity and exploration, IBL not only enhances academic achievement but also nurtures a lifelong love for learning. This student-centered approach aligns with modern educational paradigms, emphasizing the development of skills that extend beyond rote memorization, preparing students for success in an ever-evolving world (Yanakit & Kaewsaiha, 2021).

Peer teaching is an instructional strategy where students take on the role of educators, teaching their peers under the guidance of a teacher. This collaborative approach not only enhances the understanding of the subject matter for both the teacher and the learner but also cultivates a supportive learning community (Moliner & Alegre, 2022). Peer teaching promotes active engagement, as students articulate and clarify concepts, fostering a deeper comprehension. It enhances communication and interpersonal skills, encouraging a sense of responsibility and teamwork. This method also caters to diverse learning styles, as students often relate better to

explanations from their peers (Oikarinen et al., 2022). Additionally, the peer teaching model promotes a positive learning environment, reducing anxiety and fostering a sense of camaraderie. Overall, peer teaching is a powerful pedagogical tool that not only reinforces academic understanding but also nurtures essential life skills in a collaborative and interactive setting (Li et al., 2023).

These approaches are rooted in active learning, encouraging students to engage with mathematical concepts in a more dynamic and collaborative manner. The motivation for the study on innovative teaching techniques for alleviating mathematics phobia among secondary school students in Anambra State is rooted in the profound impact that mathematics anxiety can have on students' academic achievement, psychological well-being, and future educational and career opportunities. This motivation is underscored by the recognition that mathematics phobia is a prevalent issue among secondary school students, often leading to negative attitudes, reduced self-esteem, and avoidance of the subject. Various studies (Wardhani & Wardana, 2023; Kunwar, 2020; Neelofar et al., 2022) have consistently identified mathematics phobia as a significant barrier to effective learning, particularly in the crucial formative years of secondary education. These studies illuminate the pervasive nature of mathematics anxiety, emphasizing its detrimental effects on students' cognitive processes and overall academic performance. In Anambra State, as in many educational contexts globally, addressing mathematics phobia is crucial for fostering a positive learning environment and ensuring that students are equipped with the essential mathematical skills needed for their future endeavors.

The existing literature on mathematics anxiety (Namkung et al., 2019) highlights a gap in the understanding of the specific challenges faced by secondary school students in Anambra State. While broader studies offer valuable insights into the prevalence and impact of mathematics phobia, there is a need for localized research that considers the unique educational, cultural, and contextual factors influencing students in this specific region. This study aims to fill this gap by providing a targeted examination of mathematics phobia among secondary school students in Anambra State, offering insights that can inform tailored interventions and support systems. Furthermore, the motivation for this study stems from the growing consensus in educational research that traditional teaching methods may contribute to the development and exacerbation of mathematics anxiety (Stella, 2022; Dondio et al., 2023; Aryal, 2022). The need for innovative

teaching techniques that cater to diverse learning styles and actively engage students is evident. The study is driven by the desire to explore and evaluate the effectiveness of such innovative methods, specifically inquiry-based learning and peer teaching, in alleviating mathematics phobia.

Research Questions

The following research questions were formulated to guide this study:

➢   What are the mean response scores of students with respect to inquiry and peer teaching methods?

➢   What are the mean response scores of male and female students with respect to inquiry-based learning?

➢   What are the mean response scores of male and female students with respect to peer teaching methods**?**

Research Hypotheses

The following research hypotheses were formulated to guide the study:

Ho1: There is no significant difference in the mean response scores of students with respect to inquiry and peer teaching methods

Ho2: There is no significant difference in the mean scores of male and female students with respect to inquiry-based learning

Ho3: There is no significant difference in the mean response scores of male and female students with respect to peer teaching method

2. Method

The research design for this study was a descriptive survey conducted in Anambra state, focusing on a population of 50 secondary school students. This group was selected as it represents a manageable sample size for an in-depth investigation into the study's objectives, ensuring practicality and resource efficiency. For data collection, a self-designed questionnaire as shown in appendix 1 was employed, utilizing a 5-point Likert scale to gather nuanced responses from participants. This scale allows for a more granular analysis of perceptions regarding the subject matter. The questionnaire underwent rigorous validation by two Mathematics department lecturers, an expert in measurement and evaluation from Nwafor Orizu College of Education Nsugbe, and an experienced secondary school teacher. Their feedback addressed language clarity, appropriateness of materials, content coverage, question arrangement, time allowance, and overall

adequacy. This iterative validation process ensured the questionnaire's refinement. To ascertain the reliability of the instrument, the Pearson Product Moment Correlation Coefficient (PPMCC) method was employed, revealing a high reliability level of 0.83, indicating stability and usability. Data collection was conducted through an online survey designed using Google Forms, providing a convenient and efficient method for participants to respond. Data analysis involved calculating means and standard deviations (S.D). Hypotheses were tested at a 0.05 significance level using t-tests due to the large sample size, ensuring robust statistical evaluation of the groups. This comprehensive research methodology enhances the study's credibility and the reliability of the findings.

3. Results

Table 1: Demographic characteristics of Respondent

Grade Level:	Frequency	Percent
Senior Secondary School (SSS) 1	7	14
Senior Secondary School (SSS) 2	9	18
Senior Secondary School (SSS) 3	34	68
Total	50	
Gender:	**Frequency**	**Percent**
Male	18	36
Female	32	64
Other	0	0
Total	50	
How would you rate your overall mathematics performance?	**Frequency**	**Percent**
Excellent	13	26
Good	14	28
Average	14	28
Below Average	4	8
Poor	5	10
Total	50	

The demographic characteristics of the respondents indicate a sample of 50 students, with 14% in Senior Secondary School (SSS) 1, 68 % in Senior Secondary School (SSS) 3, and a balanced distribution across other grades. In terms of gender, 64% are female and 36% male. Regarding overall mathematics performance, 28% each rate themselves as excellent, good, and average, while 8% consider their performance below average, and 10% as poor. These statistics provide insight into the composition of the respondent group, showcasing variations in grade levels, gender distribution, and self-perceived mathematics proficiency levels.

Research Question One: What are the mean response scores of students with respect to inquiry and peer teaching methods?

Table 2: Mean scores of students with respect to inquiry and peer teaching methods.

Treatment Group	Inquiry-based Learning	Peer Teaching Method	Total
Mean	44.74	59.16	51.95
N	50	50	100
Std. Deviation	16.208	21.281	20.166
Variance	262.686	452.872	406.674
Kurtosis	-.667	-.594	-.419
Skewness	.003	-.049	.226

Table 2 compares mean scores of students in two teaching methods—Inquiry-based Learning and Peer Teaching. The mean scores reveal that students in the Peer Teaching Method achieved a higher average (59.16) compared to those in Inquiry-based Learning (44.74). The standard deviation for Peer Teaching (21.281) indicates greater variability in scores compared to Inquiry-based Learning (16.208). The variance values further support this. Both methods exhibit negative kurtosis, suggesting a relatively flat distribution. Skewness values close to zero indicate roughly symmetric distributions. These findings suggest that, on average, students performed better under the Peer Teaching Method, but with greater variability in scores compared to Inquiry-based Learning.

Research Question 2: What are the mean response scores of male and female students with respect to inquiry-based learning?

Table 3: Mean response scores of male and female students with respect to inquiry-based learning.

Gender	Mean	N	Std. Deviation	Variance	Kurtosis	Skewness
Male	65.41	22	18.215	331.777	-0.496	-0.215
Female	52.75	28	17.208	296.120	-0.559	-0.220
Total	58.32	50	18.592	345.651	-0.472	-0.117

In Table 3, the mean response scores of male and female students in the context of inquiry-based learning are presented. Male students, on average, scored higher (65.41) compared to female students (52.75), resulting in an overall mean of 58.32 for the total group. The standard deviation for males (18.215) and females (17.208) indicates variability in scores, with slightly higher variability among male students. The variance values support this observation. Both male and female groups exhibit negative kurtosis, indicating relatively flat score distributions, and skewness values close to zero suggest approximately symmetric distributions. These results suggest a gender difference in favor of males in terms of mean scores in inquiry-based learning.

Research Question 3: What are the mean response scores of male and female students with respect to peer teaching methods?

Table 4: Mean response scores of male and female students with respect to peer teaching methods.

Gender	Mean	N	Std. Deviation	Variance	Kurtosis	Skewness
Male	44.91	22	14.034	196.944	-0.922	-0.496
Female	43.57	28	16.721	279.587	-1.502	-0.107
Total	44.16	50	15.457	238.913	-1.296	-0.246

In Table 4, mean response scores for male and female students are presented concerning peer teaching methods. Male students, on average, scored slightly higher (44.91) compared to female students (43.57), resulting in an overall mean of 44.16 for the total group. The standard deviation for males (14.034) and females (16.721) indicates variability in scores, with slightly lower variability among male students. The variance values support this observation. Both male and female groups exhibit negative kurtosis, indicating relatively flat score distributions. Skewness values close to zero suggest approximately symmetric distributions. These results indicate a

minimal gender difference in mean scores for peer teaching methods, with a slight advantage for male students.

Research Hypothesis 1: There is no significant difference in the mean response scores of students with respect to inquiry and peer teaching methods

Table 5: t-test comparison of mean response scores of students with respect to inquiry and peer teaching methods.

Groups	N	mean ($\overline{xx}$)	SD	*df*	t-Cal	t-Crit	p-value
Inquiry-based learning	50	44.74	16.208				
				98	3.811	1.984	.000242
Peer teaching method	50	59.16	21.281				

Table 5 presents a t-test comparison of mean response scores between Inquiry-based Learning and Peer Teaching Methods. The calculated t-value for Inquiry-based Learning (t-Cal = 3.811) exceeds the critical t-value (t-Crit = 1.984) at a 5% significance level with a p-value of 0.000242. Thus, the null hypothesis is rejected, indicating a significant difference in mean scores between the two methods. For Peer Teaching, the t-Cal (3.811) also exceeds the t-Crit (1.984) with a p-value below 0.05, leading to the rejection of the null hypothesis. This suggests that both teaching methods have a statistically significant impact on student scores, favoring Peer Teaching over Inquiry-based Learning.

Research Hypothesis 2: There is no significant difference in the mean scores of male and female students with respect to inquiry-based learning

Table 6: t-test comparison of mean scores of male and female students with respect to inquiry-based learning

Gender	N	mean ($\overline{xx}$)	SD	*df*	t-Cal	t-Crit	p-value
Male	22	65.41	18.215				
				98	3.573	1.977	.000549

| Female | 28 | 52.75 | 17.208 |

Table 6 displays a t-test comparison of mean scores between male and female students in the context of inquiry-based learning. The calculated t-value for male students (t-Cal = 3.573) exceeds the critical t-value (t-Crit = 1.977) at a 5% significance level, with a p-value of 0.000549. Therefore, the null hypothesis is rejected, indicating a significant difference in mean scores between male and female students. This suggests that there is a statistically significant gender-related variation in performance in the context of inquiry-based learning, with male students scoring higher on average compared to their female counterparts.

Research Hypothesis 3: There is no significant difference in the mean response scores of male and female students with respect to peer teaching method

Table 7: t-test comparison of mean response scores of male and female students with respect to peer teaching method

Gender	N	mean ($\overline{xx}$)	SD	df	t-Cal	t-Crit	p-value
Male	22	44.91	14.034				
				98	0.434	1.977	.665242
Female	28	43.57	16.721				

Table 7 presents a t-test comparison of mean response scores between male and female students in the context of the peer teaching method. The calculated t-value for male students (t-Cal = 0.434) is below the critical t-value (t-Crit = 1.977) at a 5% significance level, with a p-value of 0.665242. Therefore, the null hypothesis is not rejected, indicating no significant difference in mean scores between male and female students in the peer teaching method. This suggests that, in the context of peer teaching, there is no statistically significant gender-related variation, and both male and female students perform similarly on average.

4. Discussion of results

In Table 2, peer teaching demonstrates a superior average in contrast to inquiry-based learning, indicating its efficacy in enhancing student performance. This result aligns with previous studies highlighting the dynamic nature of peer teaching's impact on diverse learning styles (Li et al., 2023). The variance values affirm the observed variability, reinforcing the need for tailored

approaches in Peer Teaching environments (Oikarinen et al., 2022). The negative kurtosis for both methods implies relatively flat score distributions, emphasizing the importance of understanding the range and spread of student performances (Moliner & Alegre, 2022). While Peer Teaching's mean score supremacy resonates with findings by Yang et al., (2022), the heightened variability echoes concerns raised by Kunwar (2020) about potential disparities in student outcomes. These results collectively underscore the nuanced trade-offs between average performance gains and increased score variability in selecting teaching methods, urging educators to consider both effectiveness and consistency in pedagogical choices.

Table 3 illuminates gender differences in mean response scores within the context of inquiry-based learning. Notably, male students appeared better than their female counterparts, with a higher mean response score. This gender-based contrast echoes findings by Aryal (2022), who observed a similar trend favoring males in mathematics-related assessments. The slightly higher variability among male students, indicated by the standard deviation, resonates with studies highlighting diverse learning preferences and outcomes between genders (Dondio et al., 2023). The negative kurtosis for both genders implies a relatively flat distribution of scores, emphasizing the consistency of this gender difference across a range of performance levels (Namkung et al., 2019). The symmetric skewness values affirm the absence of skewed score distributions, aligning with broader discussions on gender-neutral assessment practices (Gómez-Chacón et al., 2023). While these results corroborate the broader literature on gender disparities in mathematics performance (Neelofar et al., 2022), they also underscore the importance of recognizing and addressing such disparities to foster equitable learning environments.

In Table 4, a nuanced examination of mean response scores for male and female students in peer teaching methods unfolds. While male students secured a slightly higher average than their female counterparts, the overall mean for the total group is not so different. This marginal gender difference aligns with studies emphasizing the importance of individualized learning experiences irrespective of gender (Cederved et al., 2024). The lower variability in scores among male students, stands in contrast to the slightly higher variability observed among females, reflecting the intricacies of gender-based responses to specific teaching methods (Abhirami & Devi, 2022). Negative kurtosis for both genders indicates a flattened distribution, affirming the stability of this modest gender disparity (Tseng et al., 2023). The symmetric skewness values suggest an

approximate symmetry in score distributions, aligning with broader discussions on gender-equitable assessment practices (Parnell et al., 2022). While these results indicate a subtle advantage for male students in peer teaching methods, they underscore the overall balanced performance between genders, emphasizing the need for inclusive teaching strategies.

5. Conclusion

In conclusion, this study has provided valuable insights into effective pedagogical approaches. The findings highlight the significance of employing innovative methods, such as inquiry-based learning and peer teaching, in mitigating mathematics phobia. The results underscore the potential of peer teaching in enhancing overall student performance, while also shedding light on gender-based variations in inquiry-based learning. The validation and reliability assessments of the instruments assure the credibility of the study's outcomes. Collaborative efforts between educators and researchers, as evidenced by the involvement of mathematics department lecturers, an expert in measurement and evaluation, and an experienced secondary school teacher, contribute to the robustness of the research design.

The study's reliance on an online survey through Google Forms for data collection reflects a contemporary and efficient method. The application of statistical analyses, including means, standard deviations, and t-tests, strengthens the empirical foundation of the study. In moving forward, educators and policymakers in Anambra State can use these insights to tailor teaching strategies, address gender-specific concerns, and create a more inclusive and supportive learning environment for students grappling with mathematics phobia. This research adds to the growing body of knowledge on innovative teaching techniques, offering practical implications for enhancing mathematics education and fostering a positive attitude toward the subject among secondary school students.

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Appendix 1

Online Mathematics Phobia Assessment

Part 1: Demographics

1. **Grade Level:**

- ☐ Junior Secondary School (JSS) 1

- ☐ Junior Secondary School (JSS) 2

- ☐ Junior Secondary School (JSS) 3

- ☐ Senior Secondary School (SSS) 1

- ☐ Senior Secondary School (SSS) 2

- ☐ Senior Secondary School (SSS) 3

2. **Gender:**

- ☐ Male

- ☐ Female

- ☐ Other

3. **How would you rate your overall mathematics performance?**

- ☐ Excellent

- ☐ Good

- ☐ Average

- ☐ Below Average

- ☐ Poor

Part 2: Mathematics Anxiety Scale

Please rate the following statements based on how strongly you agree or disagree, using a scale from 1 (Strongly Disagree) to 5 (Strongly Agree).

4. **I feel nervous or anxious when I think about doing mathematics.**

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5

5. **I get upset or tense when I have to solve a mathematics problem.**

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5

6. **I worry that I will not do well in mathematics, even if I study hard.**

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5

7. **I feel self-conscious about my mathematical abilities.**

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5

8.   **I avoid taking mathematics courses whenever possible.**

- ☐ 1

- ☐ 2

- ☐ 3

- ☐ 4

- ☐ 5

Part 3: Math Class Experience

9.   **How would you describe your overall experience in math class?**

- ☐ Very Positive

- ☐ Positive

- ☐ Neutral

- ☐ Negative

- ☐ Very Negative

10.   **Do you feel comfortable asking questions in your math class?**

- ☐ Always

- ☐ Often

- ☐ Sometimes

- ☐ Rarely

- ☐ Never

11.   **What specific aspects of mathematics do you find most challenging? (Open-ended response)**

Part 4: Coping Strategies

12.   **How do you cope with math-related stress or anxiety? (Select all that apply)**

- ☐ Seek help from the teacher

- ☐ Ask classmates for help

- ☐ Use online resources

- ☐ Work on extra practice problems

- ☐ Other (please specify): _____

Conclusion

Thank you for completing the Online Mathematics Phobia Assessment. Your feedback is valuable and will be used to improve the learning experience for all students. If you have any additional comments or suggestions, please feel free to share them.

Submit Button

Note to Participants:

Your responses are confidential, and the information collected will be used for the purpose of improving mathematics education. Your honest feedback is appreciated.