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Effects of Guided Inquiry and Cooperative Learning Strategies on Junior Secondary School Students' Achievement in Mathematics

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Abstract

The study investigated the effects of guided inquiry strategy and cooperative learning strategy on mathematics performance among junior secondary school students. It also examined the influence of gender on the performance of students exposed to these instructional strategies. Adopting a pre-test post-test control group quasi-experimental design, the sample consisted of 110 Junior Secondary School II students randomly selected from three schools in Ijebu-Ode, Ogun State, Nigeria, with one school serving as the experimental group and the other as the control group. The experimental group received instruction using guided inquiry and cooperative learning strategies, while the control group

received conventional instruction. Results showed that the experimental group outperformed the control group. Additionally, there was a significant influence on the performance of both male and female students exposed to the experimental strategies, although no significant interaction effect of treatment and gender was found on mathematics achievement. The study concludes that both guided inquiry and cooperative learning strategies have a positive impact on the achievement of junior secondary school students in Ijebu-Ode. Recommendations include promoting the interchangeable use of both strategies to enhance the learning environment and improve academic achievement in mathematics classes.

Keywords: Mathematics, Achievement, Cooperative Learning Strategy, Gender, Guided Inquiry Strategy, Instructional Strategies

Introduction

Mathematics serves as a vital tool across various domains worldwide, including natural sciences, engineering, medicine, and social sciences, enabling the resolution of life's complex problems. It unveils the unseen, facilitating solutions to seemingly impossible challenges. Through establishing connections between concepts, mathematics emerges as a fundamental subject, essential for the advancement of any science-oriented discipline (Fajemidagba *et al.*, 2012). Furthermore, without the support of mathematics and its contributions to elevating scientific methodologies and frameworks to societal standards, scientific progress would stagnate (Asanre, et al. 2022).

As a consequence of this recognition, the Federal Government of Nigeria, through the curriculum planning body of the Federal Ministry, opted to designate Mathematics as a compulsory subject. In Nigeria's pursuit of technological advancement, Mathematics has been integrated into the primary and secondary school curriculum by the Federal Ministry of Education. Furthermore, a nation's advancement and prosperity hinge upon the extent of its scientific and technological progress, which can only be achieved through a robust Mathematics education. Such education equips citizens to function effectively in both pure and applied sciences, fostering national development. Competence in Mathematics is crucial for nurturing an informed citizenry and cultivating highly skilled professionals demanded by industry, technology, and science sectors. Without this foundation, a nation in the contemporary world cannot thrive or attain economic self-reliance (Adesina & Akinbobola, 2005).

Mathematics permeates every aspect of our lives, making it an integral part of our daily activities. However, many students often find themselves struggling and disengaged during mathematics classes, especially when they encounter difficulty in memorizing or recalling concepts taught. The root cause of this challenge can vary, but it is often linked to the teaching methods employed to convey these topics (Udeinya & Okabiah, 1991). The poor performance of students in mathematics is frequently attributed to ineffective teaching methodologies, which diminishes their motivation to learn. As stated by Adeyemi (2018), achievement encompasses the fulfillment of goals and indicates a student's present academic standing. Assessing a student's achievement serves the purpose of assisting both the teacher and fellow students in assessing the level of comprehension of a specific concept. When it

comes to mathematics, educators should pay close attention to instances of low achievement.

There is a growing recognition among stakeholders in mathematics education that traditional teaching approaches have not yielded optimal results. Effective teaching requires adept mathematics instructors to employ a variety of methods and techniques. According to Abiodun *et al.*, (2022), the predominant strategy employed in secondary schools in Nigeria and elsewhere for teaching mathematics is teacher-centered. The combination of Mathematics teachers' limited utilization of student-centered teaching approaches, along with the inherently abstract nature of Mathematics, contributes to many students performing below the expected level in the subject.

Therefore, it is imperative to explore the impact of employing guided inquiry techniques and cooperative learning strategies as teaching methodologies that could enhance the academic achievement of secondary school students in mathematics, recognizing that effective implementation of these strategies requires active engagement and effort from learners, as they facilitates the encoding and retrieval of learning (Duada, 2022). Guided inquiry fosters students' ability to pose questions, analyze evidence, and select optimal problem-solving approaches (Lee, 2012). Utilizing guided inquiry may mitigate time wastage and alleviate students' frustration and anxiety associated with encountering difficulties.

Mathematics learning through a Guided Inquiry model involves various stages, beginning with the first inquiry phase where the teacher introduces a problem either formulated by learners or sourced from a textbook. Subsequently, students engage in activities aimed at discovering solutions to the problem while receiving intensive guidance from the teacher (Meidawati, 2014). According to Asanre *et al.*, (2022), this teaching strategy enables students to progress systematically through several steps, including problem identification, definition, hypothesis formulation, data collection, result verification, generalization, and conclusion drawing. Inquiry-based mathematics learning follows an inductive approach, commencing with observation to grasp a concept. This method offers students genuine and interactive experiences, fostering their autonomy in problem-solving, decision-making, and skill acquisition (Duada, 2022). Asanre *et al.*, (2022) suggested that employing this strategy enhances students' performance in both theoretical understanding and practical application. Moreover, the technique facilitates the development of more advanced mental abilities among students, including the formulation of hypotheses, experimental planning, information synthesis, and the cultivation of scientific attitudes.

Cooperative learning, a practice with roots dating back to 1889, gained recognition slowly and was largely overlooked by educators until the mid-1960s (Johnson & Johnson, 2011). Today, however, it is widely employed in schools and universities worldwide, spanning various age groups. This approach involves small teams comprised of students with diverse abilities engaging in a range of learning activities to enhance their comprehension of a subject. Each team member assumes responsibility not only for their own learning but also for facilitating their teammates' learning, fostering an environment of collective achievement. Extensively documented in educational research, cooperative

learning has proven to be a successful pedagogical method for enhancing students' academic performance. The cooperative learning paradigm sets high expectations, promoting the belief that students can grasp course content effectively by actively participating in their learning process (Duada, 2022).

Cooperative learning involves instructional techniques where the teacher arranges students into small groups, encouraging them to collaborate in learning academic content. Asanre *et al.*, (2018) highlighted its positive impact on students' academic performance, especially in science-focused subjects. According to Duada (2022), working in small groups can enhance student engagement and enable teachers to introduce more rigorous and thought-provoking content into the curriculum. However, critics of cooperative learning have raised concerns about its feasibility in large class settings, which are predominant in many Nigerian classrooms. While many teachers acknowledge the benefits of cooperative learning in principle, they often cite the challenge of implementing it effectively due to the large number of students.

In his article, Zhang (2010) contends that cooperative learning not only enhances productivity and academic success rates but also fosters increased communication among learners. Similarly, Zakaria *et al.* (2010) argue that while integrating cooperative learning into mathematics instruction may pose initial challenges, it is ultimately manageable. Moreover, in today's interconnected world, cooperative learning can transcend geographical boundaries, allowing students from different countries to collaborate using technology. To effectively implement cooperative learning, teachers must prepare additional materials for lessons, introduce students to cooperative learning techniques, and equip them with the necessary skills to complete tasks within their assigned groups. This approach aligns with the guided principle in the guided inquiry strategy and underscores the shared objectives of both strategies, ultimately aiming to enhance student achievement in secondary mathematics.

The influence of learner characteristics, such as gender, on mathematics achievement is a significant aspect of educational research. As reported by Asanre *et al.* (2021), despite ongoing efforts to address the underrepresentation of women in advanced mathematics, gender-related concerns regarding achievement and aptitude persist. Gender, delineated into male and female classifications, holds importance in educational contexts. Gender issues within education pertain to the perceived or real differences between boys and girls, including their relative achievements and opportunities (Mankumari & Ajay, 2017). Abungu et al. (2014) found notable differences in mathematics achievement between males and females exposed to an activity-based teaching approach.

The challenge of comprehending mathematics is evident in the low performance of students in both internal and external examinations. This poor performance has been linked to the ineffective use of teaching methods, particularly traditional approaches. However, the current study aims to investigate the impact of guided inquiry and cooperative learning strategies on students' mathematics achievement in junior secondary schools in Ijebu Ode, Ogun State, Nigeria.

Objectives of the Study

The primary aim of this study is to examine the effects of guided inquiry and cooperative learning strategies on the academic achievement of junior secondary school students in Mathematics. The specific objectives are as follows:

i. To assess the primary impact of treatment (strategies) on students' achievement in Mathematics.
ii. To explore the influence of gender on students' achievement in Mathematics.
iii. To investigate the interaction effect between the strategies and gender on students' achievement in Mathematics.

Statement of Hypotheses

The following hypotheses are tested at 0.05 level of significance:

i. There is no significant main effect of treatment (strategy) on students' achievement in Mathematics.
ii. There is no significant main influence of gender on students' achievement in Mathematics.
iii. There is no significant interaction effect of treatment and gender on students' achievement in Mathematics.

Methodology

This study employed a pretest-posttest, control group quasi-experimental design. The population of interest comprised all public junior secondary schools in Ijebu-Ode Local Government, Ogun State. A sample of one hundred and ten (110) junior secondary school students was selected from three intact classes. Purposive Sampling Technique was utilized to choose the schools based on specific criteria. The regular Mathematics teachers of the sampled schools served as research assistants. Data collection was facilitated through the Mathematics Achievement Test (MAT), which consisted of 25 multiple-choice items with five options per item, along with a teaching guide on the strategies. The MAT instrument was adapted from past questions papers of the Junior Secondary School Certificate Examination (JSSCE) and was validated by two experts in the field of Mathematics. A pretest was administered to both the control and experimental groups before the treatment, with the question papers retrieved from the research subjects. The same items from the pretest were reorganized and used as the posttest. Following the pretest, the treatment was implemented over several weeks, after which the posttest was administered to both the control and experimental groups. The scripts were then marked and scored, and the collected data were analyzed using inferential statistics, specifically Analysis of Covariance (ANCOVA), at a significance level of 0.05.

Results

Research Hypothesis One

There is no significant main effect of treatment (strategy) on students' achievement in Mathematics.

Table 1: Two-way analysis of Covariate (ANCOVA) of students' achievement scores on treatment, gender and interaction.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5932.223	4	332.128	40.651	.000
Intercept	347.324	1	347.324	54.703	.000
Covariate	345.21	1	345.21	104.005	.000
Strategy	.660	1	.660	33.60	.000
Gender	.8712	1	.8712	1.01	.000
Strategy * Gender	102.34	1	102.34	26.34	.080
Error	238.11	105	342.325		
Total	20134.238	110			
Corrected Total	546.45	109			

R-Squared = .602 (Adjusted R Squared =.567)

The ANCOVA of students' achievement scores presented on Table 1 revealed that the effect of Guided Inquiry Strategy and Cooperative Learning Strategy on Performance of students in Mathematics at 0.05 level of significant. The F- value of 33.60 for treatment is significant at 0.000 which is less than 0.05 alpha level and thus the null hypothesis was rejected. We then conclude that there is a significant main effect of treatment (strategy) on students' achievement in Mathematics. This implies a significant difference in the mean achievement scores of students taught using Guided Inquiry Strategy and Cooperative Learning Strategy and those taught using conventional method as an instructional guide.

Research Hypothesis Two

There is no significant main effect of gender on students' achievement in Mathematics.

The F- value of 1.01 for gender difference is significant at 0.00 which is less than 0.05 alpha level and thus the null hypothesis was rejected and we then conclude that there is significant main effect of gender on students' achievement in Mathematics.

Research Hypothesis Three

There is no significant interaction effect of treatment and gender on students' achievement in Mathematics.

From Table 3, the F- value of 26.34 for treatment and gender difference interaction is significant at 0.080 which is greater than 0.05 alpha level and thus the null hypothesis was accepted and we then conclude that there is no significant interaction effect of treatments and gender on students' achievement in Mathematics.

Discussion

The study unveiled a significant main effect of treatment (strategy) on students' Mathematics achievement, indicating that the intervention, which emphasized student-centered learning and encouraged exploration and collaboration, led to improved academic performance. This finding aligns with previous research by Abiodun *et al.* (2024) and Asanre *et al.* (2022), who

also found that instructional strategies positively impact students' mathematical achievement. Additionally, the results demonstrated a significant main effect of gender on students' Mathematics achievement. This contrasts with the findings of Abiodun *et al.* (2022), who suggested that gender does not significantly influence academic achievement in secondary school mathematics. However, the current study suggests that the quality and effectiveness of instructional techniques matter more than gender in teaching and learning mathematics. Moreover, there was no significant interaction effect of treatments and gender on students' Mathematics achievement. This is consistent with previous research by Asanre *et al.* (2021) and Asanre *et al.* (2022), who concluded that the relationship between gender and instructional approach does not affect students' academic progress in mathematics at the senior secondary level.

Conclusion

In conclusion, both the guided inquiry strategy and cooperative learning strategy demonstrate effectiveness in enhancing the acquisition of mathematics skills and competencies compared to the traditional approach. These strategies transform the learning process into active and interactive experiences, enabling individual learners to engage with the content and interact with their peers. The incorporation of social interactions into learning tasks appears to foster greater learning engagement. Moreover, guided inquiry is shown to be non-gender biased, as evidenced by the non-significant gender-related differences in performance. This lack of gender disparity can be attributed to the learner-centered nature of guided inquiry, which promotes active learning over passive learning methods.

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