DOI: 10.56773/bj.v4i1.59
E-ISSN: 2809-8528

Brillo Journal
Volume 4, Issue 1, December 2024, pp. 15-26

RELATIVE EFFECTIVENESS OF TEACHERS' QUESTIONING STRATEGIES IN ENHANCING STUDENTS' MATHEMATICS ACHIEVEMENT IN GWALE LOCAL GOVERNMENT AREA OF KANO-NIGERIA

Bashir Mohammed Ibrahim

Faculty of Education, Ahmadu Bello University, Zaria-Nigeria
Email: bashiribrahimmohd@gmail.com

Abstract

This study investigated the relative effectiveness of teachers' questioning strategies in enhancing students' Mathematics achievement in Gwale Local Government Area of Kano State, Nigeria. The study employed a quasi-experimental design. The population for this study consisted of 8,785 JSS II students. A sample of 135 JSS II students from three intact classes was purposively selected. A simple random sampling technique was used for the study. The instrument used for the pretest and posttest was the Mathematics Achievement Test (MAT), with a reliability coefficient of 0.78 calculated using Pearson's correlation coefficient (*r*). The collected data were analyzed using descriptive statistics, such as mean and standard deviation, to answer the research questions, and inferential statistics, including paired sample *t*-tests and analysis of variance (ANOVA), to test the hypotheses at a 0.05 level of significance. The findings revealed that divergent and convergent questioning strategies had a significant effect on enhancing students' Mathematics achievement. Additionally, the study found a significant difference between the divergent, convergent, and conventional methods. The researcher recommended that divergent and convergent questioning strategies be included in the Mathematics curriculum for teacher education programs.

Keywords: Academic achievement, Mathematics, Questioning strategy.

Abstrak

Penelitian ini menyelidiki efektivitas relatif dari strategi bertanya guru dalam meningkatkan prestasi Matematika siswa di Wilayah Pemerintah Lokal Gwale, Negara Bagian Kano, Nigeria. Penelitian ini menggunakan desain kuasi-eksperimental. Populasi dalam penelitian ini terdiri atas 8.785 siswa JSS II. Sampel sebanyak 135 siswa JSS II dari tiga kelas utuh dipilih secara purposif. Teknik pengambilan sampel acak sederhana digunakan dalam penelitian ini. Instrumen yang digunakan untuk pretest dan posttest adalah Tes Prestasi Matematika (MAT), dengan koefisien reliabilitas sebesar 0,78 yang dihitung menggunakan koefisien korelasi Pearson (r). Data yang dikumpulkan dianalisis menggunakan statistik deskriptif, seperti nilai rata-rata dan simpangan baku, untuk menjawab pertanyaan penelitian, serta statistik inferensial, termasuk uji-t sampel berpasangan dan analisis varians (ANOVA), untuk menguji hipotesis pada tingkat signifikansi 0,05. Temuan menunjukkan bahwa strategi bertanya divergen dan konvergen memiliki pengaruh signifikan dalam meningkatkan prestasi Matematika siswa. Selain itu, penelitian ini menemukan perbedaan signifikan antara metode divergen, konvergen, dan konvensional. Peneliti merekomendasikan agar strategi bertanya divergen dan konvergen dimasukkan ke dalam kurikulum Matematika untuk program pendidikan guru.

Kata kunci: *Matematika, Prestasi akademik, **S**trategi bertanya.*

How to Cite: Ibrahim, B. M. (2024). Relative Effectiveness of Teachers' Questioning Strategies in Enhancing Students' Mathematics Achievement in Gwale Local Government Area of Kano-Nigeria. *Brillo Journal*, *4*(1), 15-26.

INTRODUCTION

Academic achievement refers to the performance outcomes that indicate the level through which a learner has achieved specific objectives. It measures the extent to which students have achieved their stated educational objectives (Igbo et al., 2014). Narad and Abdullah (2016) asserted that the success of any educational institution is measured by the performance of its students in both academic and non-academic tests. Omaka and Osuafor (2020) explained that students' achievement deals with the extent students have gained from a particular course of instruction. Duru et al. (2024) expressed that in an endeavor to enhance students' achievement in mathematics, educational psychologists and mathematics educators have been actively involved in the search for variables, both personal and environmental, that could be manipulated to facilitate academic gains.

Khair et al. (2012) investigated the level of students achievement in mathematics in Yemen. Their study uses a sample of 200 male students and 200 female students, chosen from eight government schools on the basis of diversified sampling techniques. The results showed that 35% of the students answered 50% or more of the test items correctly, while 80% of the students made errors in arithmetic problems, inequalities, equation solutions, division and addition of decimal fractions, and applications of the Pythagorean Theorem. Bichi et al. (2019) assessed students' academic achievement in the mathematics qualifying examination in senior secondary schools in Kano State, Nigeria. Their findings revealed that students' performance in the mathematics qualifying examination was slightly below average, as indicated by the mean scores of their academic performance.

In Nigeria, the Federal Government is quite aware of the important role of mathematical knowledge in other school subjects, hence, the subject is made a mandatory subject at the post-basic level of education (Federal Republic of Nigeria, 2014). Mathematical skills are needed in the study of sciences, technology, and humanities. Duru et al. (2024) described mathematics as a dynamic and elegant field of human activities, serving as a unifying force across various branches of science. Over the years, researchers have employed several teaching and assessment strategies to improve students' learning, especially in Mathematics subjects. For instance, the study of Ahmed et al. (2024) investigated the utilization of instructional materials and junior secondary students' academic achievement in geometrical shape. A significant difference in academic achievement was indicated by the results obtained from research question one and

hypothesis one. Given the low mathematics achievement of students, employing questioning strategies in Mathematics teaching can enhance students' understanding of the concepts. Thus, in the context of this study, achievement is the learning outcome after the students have been taught the concept of Mathematics using teachers' questioning strategy. It may also inform teachers and students about the effectiveness of the strategy when applied in teaching mathematics.

Questioning is considered to be a powerful and universal teaching strategy. Desai (2016) opined that designing strategic questions involves studying the topic at hand and developing the right kinds of questions in the appropriate order to elicit responses that already exist. Kira et al. (2013) explained that during instruction, teachers ask questions to determine whether students understand what has been taught to them. This strategy also allows the teachers to determine the level of success of their instructions. Marshall (2019) expressed that effective teachers are able to ignite curiosity and excitement through the thoughtful way in which they pose questions. All types of questioning strategies have a significant role in the classroom and should be used at different times to determine the level of students' understanding. Such strategies include divergent and convergent questioning strategies.

Divergent questions are open-ended questions and may have multiple answers (Dos et al., 2016). These questions are referred to as closed-ended questions, where students are not required to add ideas to an existing one. Convergent thinking is the process of finding the best solution to a problem, directed towards identifying one correct or optimal answer (Opara & Uma, 2020). Teachers may ask students to define, identify, or respond with "yes" or "no" answers. Therefore, there is a need for Mathematics teachers to adopt effective teaching strategies, such as questioning strategies, to address individual learners' needs. Enríquez et al. (2017) opined that the relationship between teaching strategies, mathematical tasks, and the teacher underscores the importance of using appropriate teaching strategies.

Statement of the problem

The exclusive use of conventional methods to assess students' learning outcomes has contributed to poor academic achievement in Mathematics, particularly in junior secondary schools. This issue has increasingly raised concerns among education stakeholders and the general public in Nigeria. One possible reason is the inability of

Mathematics teachers to employ effective teaching methods that enhance students' achievement. Researchers have identified factors such as study habits, teaching methods, and teacher qualifications as influencing students' achievement in Mathematics. Previous studies have assessed teachers' ability to use effective teaching strategies to evaluate students' learning outcomes but did not investigate the relative effectiveness of formative assessment strategies in improving students' academic achievement in junior secondary school classroom settings. Consequently, this study employed the most effective formative assessment strategies to explore how questioning strategies can enhance junior secondary school students' academic achievement in Mathematics.

Purpose of the study

The purpose of this study is to investigate the relative effectiveness of teachers' questioning strategies in enhancing students' Mathematics achievement in Gwale Local Government area of Kano State, Nigeria. Specifically, the objectives of the study were to determine the: (1) the relative effect of divergent questioning strategy on students' Mathematics achievement, (2) the relative effect of convergent questioning strategy on students' Mathematics achievement, (3) the difference in the mean achievement scores of students in Mathematics between divergent, convergent and conventional methods.

Research questions

The following research questions were raised to guide the study: (RQ1) What is the relative effect of divergent questioning strategy on students' Mathematics achievement?; (RQ2) What is the relative effect of convergent questioning strategy on students' Mathematics achievement?; (RQ3) To what extent do mean achievement scores of students in Mathematics differ between divergent, convergent, and conventional methods?

Hypotheses

The following hypotheses were tested at 0.05 level of significance: ($H_0$1) There is no significant effect of divergent questioning strategy on students' Mathematics achievement; ($H_0$2) There is no significant effect of convergent questioning strategy on students' Mathematics achievement; ($H_0$3) There is no significant difference in the mean achievement scores of students in Mathematics between divergent, convergent and

conventional methods.

RESEARCH METHODS

The study employed a quasi-experimental design. It applied pretest, posttest, and control group design. There were two experimental groups and one control group. The diagram for the design is shown in Figure 1.

Groups		Pretest		Treatment		Posttest
Experimental group 1	→	O_1	→	X_1	→	O_2
Experimental group 2	→	O_1	→	X_1	→	O_2
Control group	→	O_1	→	X_0	→	O_2

Figure 1. Diagram of three groups (pretest, posttest, and control group)

Key: Experimental group 1 = $O_1\ X_1\ O_2$ representing divergent questioning strategy; Experimental group 2 = $O_1\ X_1\ O_2$ representing convergent questioning strategy; Control group = $O_1\ X_0\ O_3$ representing conventional method (no experimental treatment).

The population of the study consisted of 8,785 JSS II Mathematics students from public junior secondary schools in Gwale Local Government Area of Kano State, Nigeria. Three (3) intact classes were selected from three (3) schools using a purposive sampling technique. In each of the three schools selected, forty-five (45) students were randomly chosen as the study sample using a simple random sampling technique, making a total sample size of 135 Mathematics students. Two schools were assigned as experimental groups: Group 1 (divergent questioning) and Group 2 (convergent questioning), while the third school served as the control group (conventional method).

The instrument used was a 40-item test titled "Mathematics Achievement Test (MAT)," which was designed by the researcher to collect data. The instrument was validated by three experts in the field of Measurement and Evaluation from Ahmadu Bello University, Zaria, Nigeria. Following validation, a pilot test was conducted with thirty (30) JSS II Mathematics students from another school that was not part of the study to estimate the reliability of the test instrument. A reliability coefficient of 0.78 was obtained using Pearson's correlation in the test-retest method, confirming that the instrument was reliable.

The researcher administered the forty (40) test items to experimental groups 1 and 2, and the control group as a pretest, with the assistance of a research assistant. Experimental

group 1 was exposed to training on the divergent questioning strategy, while experimental group 2 received training on the convergent questioning strategy for three weeks. The control group, however, was not given any treatment and continued with the conventional method as usual. After three weeks of treatment, the same test items were administered as a posttest to both the experimental and control groups. Data collected from the pretest and posttest were used for data analysis. Three research questions were answered in line with the hypotheses tested using means and standard deviations, while paired sample *t*-tests and one-way analysis of variance (ANOVA) were used to test the hypotheses at the 0.05 level of significance. All analyses were carried out using SPSS version 20 statistical software.

RESULTS AND DISCUSSION

The research results of the pretest and posttest are presented in this section according to the research questions stated along with the corresponding hypotheses formulated as follows. Table 1 displays the results of the study based on addressed RQ1 and $H_0$1.

Table 1. Paired sample *t*-test analysis of the effect of divergent questioning strategy

Test	N	Mean	SD	*df*	*t*-cal	*p*-value	Decision
Pretest	45	23.62	2.070	44	-9.306	0.000	Significant
Posttest	45	26.36	2.681				

Note: N=Number of sample, SD=Standard Deviation, *df*=degree of freedom.

The results from Table 1 indicated that the pretest mean score for the divergent questioning strategy (experimental group 1) was 23.62, with a standard deviation (SD) of 2.070, while the posttest mean score was 26.36, with an SD of 2.681. The posttest mean score was higher than the pretest mean score, implying that the divergent questioning strategy is effective in enhancing students' Mathematics achievement. Table 1 also revealed that the *t*-value of -9.306 and the corresponding *p*-value of 0.000 were obtained. Since the *p*-value of 0.000 is less than the 0.05 level of significance, it indicates that the divergent questioning strategy had a significant effect on enhancing students' Mathematics achievement. Based on this, the hypothesis, which stated that there is no significant effect of divergent questioning strategy on students' Mathematics achievement, was rejected.

The findings from Table 1 provide a clear indication of the effectiveness of the

divergent questioning strategy. To further explore the effects of other strategies, Table 2 presents the results related to the second research question (RQ2) and hypothesis ($H_0$2).

Table 2. Paired sample *t*-test analysis of the effect of convergent questioning strategy

Test	N	Mean	SD	*df*	*t*-cal	*p*-value	Decision
Pretest	45	22.58	2.369	44	-7.528	0.000	Significant
Posttest	45	25.96	2.412				

Note: N=Number of sample, SD=Standard Deviation, *df*=degree of freedom.

The results from Table 2 indicated that the pretest mean score for the convergent questioning strategy (experimental group 2) was 22.58, with a standard deviation (SD) of 2.369, while the posttest mean score was 25.96, with an SD of 2.412. The posttest mean score was higher than the pretest mean score, implying that the convergent questioning strategy is effective in enhancing students' Mathematics achievement. Table 2 also revealed that the *t*-value of -7.528 and the corresponding *p*-value of 0.000 were obtained. Since the *p*-value of 0.000 is less than the 0.05 level of significance, it indicates that the convergent questioning strategy had a significant effect on enhancing students' Mathematics achievement. Based on this, the hypothesis, which stated that there is no significant effect of convergent questioning strategy on students' Mathematics achievement, was rejected.

The results from Table 2 highlight the effectiveness of the convergent questioning strategy in improving students' Mathematics achievement. Moving forward, Table 3 addresses the findings related to the third research question (RQ3) and hypothesis ($H_0$3).

Table 3. One-way ANOVA on the difference between divergent, convergent, and conventional methods

Groups	N	Mean	SD	*F*	*p*-value.	Decision
Divergent	45	26.36	2.681	17.891	0.000	Significant
Convergent	45	25.96	2.412			
Conventional	45	23.47	2.341			

Note: N=Number of sample, SD=Standard Deviation.

The analysis in Table 3 indicated that the posttest mean scores for the divergent, convergent, and conventional strategies were 26.36, 25.96, and 23.47, with standard deviations (SD) of 2.681, 2.412, and 2.341, respectively. The posttest mean scores for divergent and convergent questioning strategies were higher than the posttest mean score for the conventional method. This implies that divergent and convergent questioning

strategies were more effective in enhancing students' Mathematics achievement compared to the conventional method. Table 3 also revealed that the *F*-value of 17.891 and the corresponding *p*-value of 0.000 were obtained. Since the *p*-value of 0.000 is less than the 0.05 level of significance, it indicates that a significant difference exists between the divergent, convergent, and conventional strategies. Based on this, the hypothesis stating that there is no significant difference in the mean achievement scores of students in Mathematics between the divergent, convergent, and conventional methods was rejected. Furthermore, Scheffe's Post Hoc test was performed to identify where the differences exist.

The last Table 4 presents Scheffe's Post Hoc analysis which further reveals that the difference exists between the three variables measured.

Table 4. Scheffe Post Hoc analysis on the difference between divergent, convergent, and conventional strategies

Strategies (I)	Strategies (J)	Mean Difference (I-J)	Std. Error	*p*-value.
Divergent	Convergent	.400	.523	.747
	Conventional	2.889*	.523	.000
Convergent	Divergent	-.400	.523	.747
	Conventional	2.489*	.523	.000
Conventional	Divergent	-2.889*	.523	.000
	Convergent	-2.489*	.523	.000

Note: *=The mean difference is significant at the 0.05 level.

Table 4 revealed that a significant difference exists between the divergent and conventional strategies. Additionally, the table further shows that a significant difference exists between the convergent and conventional strategies. This indicates that the direction of significance moves from the conventional method to the divergent and convergent questioning strategies.

Discussion of findings

The discussion of findings in this study was done based on the results obtained from three research questions stated and hypotheses formulated and tested.

Firstly, the findings of this study showed that the posttest mean score for the divergent questioning strategy was higher than the pretest mean score. It also revealed that the divergent questioning strategy had a significant effect on enhancing students'

Mathematics achievement. This finding is in line with the findings of Opara and Uma (2020), who revealed that the divergent questioning strategy has a significant effect on students' achievement in Social Studies. This result supports a similar study conducted by Ibrahim (2022), who found that the peer assessment strategy significantly affected the academic achievement of students in Mathematics.

Secondly, the findings of this study showed that the posttest mean score for the convergent questioning strategy was higher than the pretest mean score. It also revealed that the convergent questioning strategy had a significant effect on enhancing students' Mathematics achievement. This finding agrees with the findings of Opara and Uma (2020), which revealed that the convergent questioning strategy has a significant effect on students' achievement in Social Studies. This result supports previous findings by Ifeanacho and Osuagwu (2016), who discovered that using the convergent instructional method significantly increased the academic achievement of students. Additionally, the results from Sodangi et al. (2020) showed that respondents agreed their teachers' classroom questioning techniques had a positive impact on their learning outcomes in Mathematics.

Thirdly, the results from this study indicated that the posttest mean scores for the divergent and convergent questioning strategies were higher than the posttest mean score for the conventional method. It also revealed that a significant difference exists between the divergent, convergent, and conventional teaching strategies. Scheffe's Post Hoc test was conducted to determine where the differences exist, and it indicated that significant differences were found between divergent and conventional strategies, as well as between convergent and conventional strategies.

Additionally, Lemo (2014) criticized the conventional method, reporting that the traditional approach, which uses a one-way, teacher-centered method of communication, leads to students asking few or no questions. This contributed to the low achievement of students in Mathematics. The findings of the present study are also consistent with a study conducted by James and Folorunso (2012) in Nigeria, which emphasized that assessment methods significantly affect students' learning and improve their performance in Mathematics. Furthermore, in a study conducted by Ibrahim and Maude (2022), it was recommended that more facilities to enhance students' performance in Mathematics for the West African Examinations Council (WAEC) and National Examinations Council

(NECO) should be provided by the state government for both coeducational and single-sex schools in Kano State.

CONCLUSION

Based on the findings, it can be concluded that divergent and convergent questioning strategies had significant effects in enhancing students' mathematics achievement. Using divergent and convergent questioning strategies as formative assessment methods while teaching mathematics in junior secondary schools improved students' academic achievement in mathematics. Therefore, divergent and convergent questioning strategies are more effective for improving students' learning in mathematics than the conventional method. Additionally, the divergent questioning strategy proved to be a better teaching strategy, followed by the convergent questioning strategy, compared to the conventional method.

The researcher recommends that: (1) divergent and convergent questioning strategies should be included in the Mathematics curriculum for teacher education programs; (2) mathematics teachers should adopt both divergent and convergent questioning strategies alongside traditional assessment techniques when assessing the academic achievement of junior secondary school students in mathematics; (3) the government and stakeholders should organize seminars or workshops to train junior secondary school mathematics teachers on the importance of using questioning techniques in their instruction to improve students' academic achievement.

REFERENCES

Ahmed, M. U., Aliyu, A. Z., & Liman, A. M. (2024). Utilization of Instructional Materials and Junior Secondary Students' Academic Achievement in Geometrical-Shape. *Brillo Journal, 3*(2), 102-112. https://doi.org/10.56773/bj.v3i2.54

Bichi, A. A., Suleiman, A. H. & Ali, H. (2019). Students' achievement in mathematics: Analysing the influence of gender and school nature. *Contemporary Educational Researches Journal, 9*(3), 50-56. https://doi.org/10.18844/cerj.v9i3.4293

Desai, F. (2016, August 31). Five questions to consider during strategic planning section. *Forbers*. https://www.forbes.com/sites/falgunidesai/2016/08/31/five-questions-to-consider-during-strategic-planning-sessions/

Dos, B., Bay, E., Aslansoy, C., Tiryaki, B., Cetin, N., & Duman, C. (2016). An analysis of teachers' questioning strategies. *Educational Research and Reviews, 11*(22), 2065-2078. https://doi.org/10.5897/ERR2016.3014

Duru, D. C., Obasi, C. V., & Oguoma, C. (2024). Predictive Analysis: Academic Resilience as a Determinant of Mathematics Achievement among Senior Secondary

School Students in Nigeria. *Brillo Journal, 3*(2), 72-82. https://doi.org/10.56773/bj.v3i2.48

Enríquez, J. A. V., Pereira de Oliveira, A. M., & Valencia, H. G. (2017). What Mathematic Teachers Say about the Teaching Strategies in the Implementation of Tasks. *English Language Teaching, 11*(1), 65-79. https://doi.org/10.5539/elt.v11n1p65

Federal Republic of Nigeria. (2014). *National policy on education* (6th Edition). NERDC Press.

Ibrahim, B. M. (2022). Effects of Peer-assessment Strategy on Students' Academic Achievement in Mathematics in Senior Secondary Schools of Nasarawa Local Government Area, Kano State, Nigeria, *International Journal of Research in Education and Sustainable Development, 2*(10), 15-25.

Ibrahim, B. M., & Maude, L. K. (2022). Comparative Analysis of Students' Performance in WAEC and NECO English Language and General Mathematics Examinations of Senior Secondary Schools in Kano State, Nigeria (2015-2019). *African Journal of Science, Technology and Mathematics Education (AJSTME), 8*(1), 480-487.

Ifeanacho, A. O., & Osuagwu, C. T. (2016). Effect of convergent and divergent methods of teaching on students' Mathematics achievement in senior secondary schools in Umuahia education zone. *ASSEREN Journal of Educational Research and Development (AJERD) 3*, 79-87.

Igbo, J. N., Okafor, N., & Eze, R. (2014). Effect of Peer tutoring on the mathematics achievement of learning disabled children. *Bulgarian Journal of Science and Education Policy (BJSEP), 10*(1).

James, A. O., & Folorunso, A. M. (2012). Effect of Feedback and Remediation on Students' Achievement in Junior Secondary School Mathematics. *International Education Studies, 5*(5), 153-162. https://doi.org/10.5539/ies.v5n5p153

Khair, T. M. A., Khairani, A. Z., & Elrofai, T. A. (2012). Level of Students' Achievement in Mathematics at the End of Elementary Education in Yemen. *US-China Education Review, A*(6), 588-593.

Kira, E., Komba, S., Kafanabo, E., & Tilya, F. (2013). Teachers' Questioning Techniques in Advanced Level Chemistry Lessons: A Tanzanian Perspective. *Australian Journal of Teacher Education, 38*(12), 66-79. https://doi.org/10.14221/ajte.2013v38n12.7

Lemo, O. O. (2014). *Development of self-instructional manual for automobile technology craftsman in South Western, Nigeria* [Unpublished PhD thesis]. University of Nigeria, Nsukka

Marshall, J. (2019). *Rise to the challenge: Designing rigorous learning that maximizes student success*. ASCD.

Narad, A., & Abdullah, B. (2016). Academic Performance of Senior Secondary School Students: Influence of Parental Encouragement and School Environment. *Rupkatha Journal on Interdisciplinary Studies in Humanities, 8*(2), 12-19. https://doi.org/10.21659/rupkatha.v8n2.02s

Omaka, N. T., & Osuafor, A. M. (2020). Effect of Peer Assessment Technique on Secondary School Students' Achievement in Biology in Awka Education Zone. *South Eastern Journal of Research and Sustainable Development (SEJRSD), 3*(1), 57-77.

Opara, I. M., & Uma, A. A. (2020). Effects of teachers' questioning strategies on students' achievement in Social Studies in Obio-Akpor Local Government Area of

Rivers State, Nigeria. *Advances in Social Sciences Research Journal, 7*(3), 211-219. http://dx.doi.org/10.14738/assrj.73.7913.

Sodangi, U., Musa, R., & Suleiman, B. (2020). An investigation of the effects of teachers' classroom questioning techniques on the performance of senior secondary school students in Mathematics, Zamfara State, Nigeria. *The Eurasia Proceedings of Educational and Social Sciences, 17*, 67-74.