

Culturally Responsive Mother Tongue Instruction: Enhancing Students' Retention of Mathematics Concepts Through Igbo-Based Teaching

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Abstract

This study examined the effectiveness of culturally responsive teaching (CRT) delivered in the Igbo language on senior secondary school students' retention of circle geometry concepts in Nsukka Local Government Area, Enugu State, Nigeria. A true experimental pretest-posttest control group design was employed, involving 80 students randomly assigned to experimental and control groups. The experimental group received mathematics instruction in Igbo, enriched with culturally relevant examples, while the control group was taught in English using general instructional content. The Geometry Achievement Test (GAT), with a reliability coefficient of $KR-20 = 0.81$, served as the data collection instrument. Data analysis was conducted using SPSS version 29, with descriptive statistics used to answer the research questions and ANCOVA applied to test hypotheses at the 0.05 significance level. Results showed that students exposed to Igbo-based CRT achieved significantly higher retention scores in circle geometry than their peers taught in English. While female students scored slightly higher than males under Igbo instruction, the difference was not statistically significant. These findings highlight the potential of mother-tongue-based CRT to enhance conceptual understanding and long-term retention in geometry, particularly in topics such as circle geometry. It is recommended that educators, curriculum planners, and policymakers promote the integration of indigenous languages, alongside culturally relevant examples, when teaching geometry, and where possible, extend this approach to other areas of mathematics to foster educational equity and improved learning outcomes.

Keywords: circle geometry, digital storytelling, mathematics performance, multimedia tools, retention, secondary school learners

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Introduction

Mathematics plays a central role in the scientific, technological, and socio-economic development of every nation. It equips learners with critical thinking, problem-solving, logical reasoning, and decision-making skills needed for everyday life and future careers (Eti et al., 2026; Nwoye et al., 2026). Consequently, mathematics is regarded as a core subject at both primary and secondary school levels in many countries, including Nigeria. Despite its recognized importance, students' achievement and retention in mathematics continue to remain a major concern among educators, researchers, curriculum planners, and policymakers (Mosia & Egara, 2024; Okeke et al., 2025).

Several factors have been identified as responsible for students' poor performance in mathematics. These include weak foundational knowledge, overcrowded classrooms, mathematics anxiety, negative attitudes toward mathematics, inadequate instructional materials, and poor teaching methods (Mosimege et al., 2024; Nzeadibe et al., 2025; Sarfo et al., 2020, 2022, 2025; Terry et al., 2023). However, one critical factor that has received growing scholarly attention is the dominance of English as the language of instruction in mathematics classrooms (Esuong et al., 2024; Popoola & Ayodeji, 2022). In multilingual societies such as Nigeria, many learners encounter difficulties understanding mathematical concepts when instruction is delivered solely in English, which is often not their first language. This language barrier may hinder meaningful comprehension, classroom participation, concept retention, and overall academic achievement (Igbojinwaekwu & Dorgu, 2015).

Studies have shown that students learn more effectively when instruction is delivered in a language that is familiar to them. Popoola and Ayodeji (2022) observed that the use of English as the dominant medium of instruction contributes significantly to low achievement and retention in mathematics among secondary school students. Similarly, UNESCO (2021) emphasized that mother tongue-based education promotes better understanding, improves participation, and strengthens learners' cognitive development. Esuong et al. (2024) further argued that the use of indigenous languages in mathematics instruction enhances communication and facilitates deeper conceptual understanding among learners.

Mother Tongue Instruction (MTI) refers to the use of learners' indigenous or first language as the medium of teaching and learning (Nyamekye, 2022). In mathematics education, MTI helps to simplify abstract concepts, make learning culturally meaningful, and connect classroom instruction to learners' everyday experiences. Research evidence indicates that mother tongue instruction enhances students' understanding, retention, engagement, and academic achievement in mathematics (Abegunde et al., 2018; Asanre et al., 2022; Esuong et al., 2024; Onyeka et al., 2023). Abegunde et al. (2018) reported that the use of indigenous language in mathematics teaching positively influenced students' achievement, while Asanre et al. (2022) and Onyeka et al. (2023) found that mother tongue teaching strategies improved students' academic achievement and interest in mathematics at the primary and junior secondary school levels.

Beyond improving achievement, culturally responsive mother tongue instruction also creates opportunities for learners to connect mathematical ideas with familiar cultural experiences. In the Igbo cultural context, geometry concepts such as circle, radius, tangent, arc, and chord can be related to indigenous objects and everyday practices. For example, a circular village meeting ground or market square may be used to explain the concept of a circle, while a stick placed across a clay pot can illustrate diameter and radius. Such culturally grounded instructional

examples make learning more relatable and meaningful for learners (Gay, 2018; Vygotsky, 1978).

Although previous studies have established the benefits of mother tongue instruction, existing literature reveals important gaps. Most studies have focused on primary and junior secondary school learners, with limited attention given to senior secondary school students (Asanre et al., 2022; Frederick-Jonah & Igbojinwaekwu, 2015). In addition, there is little empirical evidence on the effectiveness of mother tongue instruction in teaching geometry concepts in Nigeria, particularly within the Igbo cultural context. Furthermore, the influence of culturally responsive Igbo-based instruction on students' retention of mathematics concepts remains underexplored, while findings regarding gender differences are still inconclusive (Egara & Mosimege, 2024, 2023; Okafor et al., 2023; Osakwe et al., 2022). It is against this background that the present study aimed to investigate the effect of culturally responsive mother tongue instruction through the Igbo language on students' retention of geometry concepts among Senior Secondary School I (SS I) students in Nsukka Education Zone of Enugu State, Nigeria. The study also examined whether gender significantly influences students' retention when taught using culturally responsive Igbo-based instruction.

Specifically, the study sought to answer the following research questions:

1. What is the effect of culturally responsive teaching through the Igbo language on students' retention of geometry concepts?
2. Is there a significant difference in the retention of geometry concepts between male and female students exposed to culturally responsive Igbo-based instruction?

The following null hypotheses guided the study and were tested at 0.05 level of significance:

- H₀₁: There is no significant difference in the retention of geometry concepts between students taught using culturally responsive Igbo-based instruction and those taught using conventional English-based instruction.
- H₀₂: There is no significant difference in the retention of geometry concepts between male and female students taught using culturally responsive Igbo-based instruction.

Theoretical Framework

This study was anchored on two related theoretical frameworks: Culturally Responsive Pedagogy (CRP) propounded by Geneva Gay in 2018 and Sociocultural Theory (SCT) propounded by Lev Vygotsky in 1978. Culturally Responsive Pedagogy emphasizes the integration of learners' cultural backgrounds, experiences, and language into the teaching and learning process. According to Gay (2018), students learn more effectively when instruction reflects their cultural realities and lived experiences. In mathematics education, this involves the use of familiar cultural examples and indigenous language to explain abstract concepts. In the present study, the Igbo language and culturally relevant examples were used in teaching geometry concepts to make learning more meaningful and improve students' retention. Similarly, Sociocultural Theory by Vygotsky (1978) explains that learning occurs through social interaction and is mediated by language and culture. The theory views language as an important tool for cognitive development and knowledge construction. The use of the Igbo language as a medium of instruction therefore provided learners with opportunities to understand and discuss geometry concepts within a familiar linguistic and cultural context, thereby enhancing comprehension and retention. The two theories are relevant to this study because they justify the use of culturally responsive Igbo-based instruction in mathematics teaching. While Culturally Responsive Pedagogy supports the integration of learners' language

and culture into instruction, Sociocultural Theory explains how learning is enhanced through language-mediated interaction. Together, the frameworks guided the development of the lesson plans and instructional activities used in the study.

Methods

This study adopted a true experimental research design using a pretest–posttest control group structure to investigate the effect of culturally responsive mother tongue instruction through the Igbo language on students' retention of geometry concepts. The study was carried out in the Nsukka Education Zone of Enugu State, Nigeria. The population of the study comprised 2,492 Senior Secondary School I (SS I) students in public secondary schools within the study area. A sample of 80 students was selected using a multistage sampling procedure. Two boarding secondary schools were purposively selected, after which 40 students were randomly selected from each school. The students were further randomly assigned into experimental and control groups using a computer-generated randomisation procedure.

Data for the study were collected using the Geometry Achievement Test (GAT), a 20-item multiple-choice instrument developed to assess students' understanding and retention of circle geometry concepts. The test items were developed based on Bloom's taxonomy and aligned with the mathematics curriculum as well as WAEC and NECO examination standards. Two lesson plans were also developed for the experimental and control groups using the same curriculum content. The experimental group was taught geometry concepts using culturally responsive Igbo-based instruction, while the control group was taught using the conventional English-based instructional method. In the experimental group, geometry concepts were explained using the Igbo language and culturally familiar examples such as clay pots, village meeting huts, woven baskets, and local objects to simplify abstract concepts. Both groups were taught by qualified mathematics teachers who received prior training on the implementation of the lesson plans and culturally responsive teaching strategies. To ensure the validity of the instrument and lesson plans, three experts in Mathematics Education, Curriculum Studies, and Measurement and Evaluation validated the materials. A pilot study was conducted using students outside the study area, and the reliability of the GAT was established using the Kuder–Richardson Formula 20 (KR-20), which yielded a reliability coefficient of 0.81, indicating high internal consistency.

Before the commencement of the study, ethical approval and permission were obtained from the relevant school authorities, while informed consent was obtained from the students and their guardians. The experiment lasted for six weeks, during which both groups received instruction on circle geometry concepts. Data collection was conducted in three stages: pretest, posttest, and post-posttest (retention) stages. The pretest was administered before treatment to determine students' prior knowledge, while the posttest was conducted immediately after the treatment. A delayed posttest was later administered to determine students' retention of the geometry concepts taught. The data collected were analyzed using Statistical Package for the Social Sciences (SPSS) version 28. Mean and standard deviation were used to answer the research questions, while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at the 0.05 level of significance. Posttest scores were used as covariates during the retention analysis to control for initial differences among the students.

Results

The presentation of findings is in line with research questions and hypotheses.

Research Question One

What is the effect of culturally responsive teaching through the Igbo language on students' retention of geometry concepts?

The analysis reveals that students taught using culturally responsive Igbo-based instruction ($n = 40$) obtained a higher mean posttest score ($M = 65.23$, $SD = 7.98$) and retention score ($M = 68.83$, $SD = 5.71$), with a mean gain of 3.60. In contrast, students taught using the conventional English-based instructional method ($n = 40$) recorded lower posttest ($M = 59.58$, $SD = 6.29$) and retention scores ($M = 61.62$, $SD = 5.82$), with a mean gain of 2.04. This suggests that culturally responsive teaching through the Igbo language positively influenced students' retention of geometry concepts more than the conventional English-based instructional approach. The test of Hypothesis One further verified this finding.

Hypothesis One

There is no significant difference in the retention of geometry concepts between students taught using culturally responsive Igbo-based instruction and those taught using conventional English-based instruction.

The ANCOVA result revealed a significant difference in the retention scores of students taught geometry concepts using culturally responsive Igbo-based instruction and those taught using the conventional English-based method ($F(1, 75) = 18.453$, $p < .05$). This indicates that culturally responsive teaching through the Igbo language significantly improved students' retention of geometry concepts. With a moderate effect size (partial eta squared = .197), the instructional method accounted for approximately 19.7% of the variance in students' retention scores. Consequently, the null hypothesis was rejected, confirming that the instructional approach significantly influenced students' retention of geometry concepts.

Research Question Two

Is there a significant difference in the retention of geometry concepts between male and female students exposed to culturally responsive Igbo-based instruction?

Male students taught geometry concepts using culturally responsive Igbo-based instruction obtained a posttest mean score of 64.90 ($SD = 6.22$) and a retention mean score of 66.75 ($SD = 4.44$), resulting in a mean gain of 1.85. Female students recorded slightly higher scores, with a posttest mean of 65.55 ($SD = 9.58$) and a retention mean score of 70.90 ($SD = 6.17$), producing a mean gain of 5.35. Although both male and female students demonstrated improved retention of geometry concepts, female students showed a slightly greater improvement. The test of Hypothesis Two was conducted to determine whether this observed difference was statistically significant.

Hypothesis Two

There is no significant difference in the retention of geometry concepts between male and female students taught using culturally responsive Igbo-based instruction.

The ANCOVA analysis revealed no significant difference in the retention scores of male and female students taught geometry concepts through culturally responsive Igbo-based instruction ($F(1, 75) = 1.536, p = .219$). This implies that gender did not significantly influence students' retention of geometry concepts. Consequently, the null hypothesis was not rejected, indicating that retention scores were statistically similar for both male and female students exposed to culturally responsive Igbo-based instruction.

Discussion

The study examined the effect of culturally responsive teaching through the Igbo language on students' retention of geometry concepts compared to the conventional English-based instructional method. As revealed by the first hypothesis, students taught geometry concepts using culturally responsive Igbo-based instruction demonstrated significantly higher retention scores than those taught using the conventional English-based method. This finding indicates that culturally responsive mother tongue instruction effectively enhances students' retention of geometry concepts. The improved retention observed among students exposed to Igbo-based instruction may be attributed to the use of learners' familiar language and culturally relevant examples during instruction. Teaching geometry concepts through the Igbo language likely reduced the language barrier associated with English instruction and enabled students to connect abstract mathematical ideas with their lived experiences. Furthermore, the integration of culturally familiar illustrations such as clay pots, village meeting grounds, woven baskets, and market trays may have enhanced students' comprehension, engagement, and long-term memory of the concepts taught.

This finding agrees with previous studies which reported that mother tongue instruction improves students' retention and academic performance. For instance, Abegunde et al. (2018) found that the use of indigenous language positively influenced students' achievement in mathematics, while Asanre et al. (2022) reported that mother tongue teaching strategies enhanced students' retention and understanding of mathematics concepts. Similarly, Onyeka et al. (2023) observed that the use of indigenous language in mathematics instruction improved pupils' academic achievement and interest. Esuong et al. (2024) also emphasized that mother tongue instruction facilitates better communication and conceptual understanding in mathematics classrooms. These studies collectively support the effectiveness of culturally responsive mother tongue instruction in improving students' retention of mathematics concepts. The finding is further supported by the theoretical frameworks underpinning the study. Culturally Responsive Pedagogy by Geneva Gay (2018) emphasizes that students learn more effectively when instruction reflects their language, culture, and lived experiences. Likewise, Sociocultural Theory by Vygotsky (1978) posits that language and social interaction play important roles in cognitive development and knowledge construction. The use of the Igbo language during instruction therefore provided students with a familiar linguistic and cultural environment that enhanced understanding and retention of geometry concepts.

Regarding gender, the study found no significant difference in the retention scores of male and female students taught using culturally responsive Igbo-based instruction. Although female students recorded slightly higher mean retention scores than male students, the difference was

not statistically significant. This suggests that culturally responsive Igbo-based instruction is equally beneficial to both male and female students. The finding implies that when learners are taught using familiar language and culturally meaningful instructional approaches, gender differences in retention may become less pronounced. The finding aligns with the assumptions of Sociocultural Theory, which emphasizes that meaningful learning occurs when learners actively interact within culturally familiar contexts, regardless of gender. Similarly, Culturally Responsive Pedagogy supports inclusive instructional practices that promote equal learning opportunities for all students. Thus, the use of culturally responsive Igbo-based instruction created an engaging and supportive learning environment that enhanced retention among both male and female students.

Conclusion

The findings revealed that students taught geometry concepts using culturally responsive Igbo-based instruction retained the concepts significantly better than those taught using the conventional English-based instructional method. The study also found that gender did not significantly influence students' retention of geometry concepts, indicating that the instructional approach was effective for both male and female students. These findings highlight the importance of integrating indigenous languages and culturally responsive strategies into mathematics instruction, particularly in multilingual societies such as Nigeria. The study demonstrates that using learners' mother tongue and culturally familiar examples can improve students' understanding, engagement, and long-term retention of abstract mathematical concepts such as geometry. Although the findings provide important insights into the effectiveness of culturally responsive mother tongue instruction, caution should be exercised in generalizing the results because the study was limited to a specific geographical location and focused only on geometry concepts among SS I students.

Nevertheless, the study has important educational implications. Mathematics teachers should be encouraged to incorporate culturally responsive teaching practices and indigenous languages into classroom instruction where appropriate. Curriculum planners and educational policymakers should also consider integrating mother tongue-based instructional approaches into mathematics curricula to enhance students' learning outcomes. Furthermore, teacher training programmes should equip educators with the knowledge and skills required to implement culturally responsive instructional strategies effectively in multilingual classrooms. Future studies should examine the effectiveness of culturally responsive mother tongue instruction across other mathematics topics, educational levels, and cultural settings.

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