



Effect of Round-Robin Instructional Strategy on Achievement in ... Gabi, S. S., Et. al. (2026)

Effect of Round-Robin Instructional Strategy on Achievement in Circle Geometry Concept among Secondary School Mathematics Students in Keffi, Nasarawa State, Nigeria

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Abstract

This study investigated the impact of the Round-Robin Instructional Strategy (RRIS) on the circle-geometry achievement of Senior Secondary School II students in Keffi, Nasarawa State, Nigeria. A quasi-experimental design incorporating pre-test, post-test, non-equivalent, non-randomised control groups was employed. The accessible population consisted of 1,027 students—1,612 males and 415 females—drawn from seven public co-educational Senior Secondary Schools within the Keffi Area Educational Quality Evaluation Office. A sample of 91 students (49 males; 42 females) was purposively selected from two schools. Data were obtained using the Circle Geometry Achievement Test (CGAT), a 40-item, four-option multiple-choice instrument validated by three subject-matter experts (two in Mathematics Education and one in Measurement and Evaluation), yielding a logical validity index of 0.79. Internal consistency was established at 0.82 using the Kuder-Richardson Formula 21 (KR-21). Two research questions were answered using descriptive statistics (mean and standard deviation), and two null hypotheses were tested using Analysis of Covariance (ANCOVA) at $\alpha = 0.05$. Results revealed that students in the RRIS group significantly outperformed their counterparts taught through the conventional method. A statistically significant gender difference in achievement was also observed within the RRIS group, suggesting that the strategy's effectiveness may not be uniformly distributed across gender. It is recommended that mathematics teachers embrace activity-oriented approaches such as RRIS, while simultaneously attending to gender-responsive instructional design to ensure equitable learning outcomes.

Keywords: Round-Robin Strategy, Academic Achievement, Gender, Circle Geometry, Quasi-Experiment

Introduction

Mathematics occupies a foundational position in human intellectual development, cultivating logical reasoning, analytical precision, and creative problem-solving. Its compulsory status across primary and secondary school curricula worldwide testifies to its centrality in preparing individuals for productive participation in society. Malik (2017) characterised mathematics as the universal language undergirding scientific inquiry and technological progress, asserting that its mastery is inseparable from meaningful engagement with modern life. Within the Nigerian curriculum, mathematics is treated as a core subject at both levels of basic and secondary schooling, encompassing branches such as arithmetic, algebra, trigonometry, calculus, and geometry—the last of which constitutes the focal concern of the present study. Geometry, and circle geometry in particular, occupies a distinctive and structurally important place within the senior secondary school curriculum. It serves as an integrative domain that draws together several foundational Euclidean concepts and, when mastered, sharpens students' capacity for logical deduction and mathematical argumentation (Ityazau, 2019). Despite its conceptual richness, circle geometry has persistently been identified as one of the most cognitively demanding areas of the curriculum. Hissan and Ntow (2021) and Dogwi (2014) documented the difficulties students experience in internalising circle theorems, a challenge that manifests directly in poor performance outcomes. Indeed, the WAEC Chief Examiner's report (2021) explicitly cited inadequate comprehension of geometric concepts as a primary contributor to underperformance in the national mathematics examination. Salami and Popoola (2016) further linked this conceptual weakness to the broader pattern of low mathematics achievement that has characterised Nigerian secondary school education.

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Students' academic achievement—defined broadly as the measurable knowledge and skills acquired within a given instructional period (Barowski, 2021)—has long been a central preoccupation of educational research in Nigeria. The chronic underachievement observed in public mathematics examinations has attracted sustained scholarly attention, with Ndukwe (2018), Adebayo (2010), Nwankwo (2012), and Anibueze (2017) converging on the view that pedagogically inappropriate and insufficiently engaging instructional strategies are principal culprits. The conventional, teacher-centred model of instruction—in which the teacher functions as the sole knowledge source while students adopt a largely passive, receptive role—has been widely criticised for suppressing student interaction, limiting collaborative enquiry, and failing to stimulate the active cognitive engagement necessary for deep mathematical understanding (Ikide & Edit, 2013). Against this background, the Round-Robin Instructional Strategy (RRIS) has attracted growing interest as an alternative pedagogical framework. Rooted in the principles of structured brainstorming and collaborative discourse, RRIS situates students in small groups around a shared task, ensuring that every participant contributes to the discussion in a systematic, turn-based manner. Unlike whole-class brainstorming, which tends to amplify the voices of the most confident learners while marginalising others, RRIS guarantees equal participation and generates multiple concurrent lines of inquiry. Cox (2020) positioned brainstorming-based strategies as powerful instruments for fostering critical thinking and authentic student engagement. Janneke, Frans, and Beishuizen (2015) reinforced this view by demonstrating that learning gains are most pronounced in socially rich environments characterised by interaction, negotiation, and collaborative knowledge construction—conditions that RRIS is specifically designed to create. Gender remains a contested and consequential variable in mathematics education research. Studies examining gender differences in geometry achievement have produced inconsistent findings. While Oloda (2017) reported male superiority in mathematics achievement, Olasehinde and Olatoye (2014) and Ajai and Imoke (2015) found no statistically significant gender gap, and Unodiaku (2015) and Anibueze (2017) reported female students outperforming their male counterparts. This body of conflicting evidence underscores the need for continued investigation, particularly with respect to how specific instructional strategies interact with gender to shape mathematics achievement. The present study contributes to this discourse by examining whether RRIS produces differential achievement outcomes for male and female students in circle geometry.

Statement of the Problem

Sustained underachievement in Mathematics among Nigerian secondary school students represents a well-documented yet inadequately resolved challenge. Geometry, and circle geometry specifically, is among the most demanding conceptual territories within the senior secondary curriculum, with students frequently struggling to apply theorems accurately in examination contexts. The WAEC Chief Examiner's report (2021) confirmed that deficiencies in geometric reasoning directly depress overall mathematics scores. Despite growing evidence that collaborative and activity-based learning approaches can meaningfully improve outcomes in a range of subjects, the teaching of circle geometry has largely remained tethered to passive, teacher-directed instructional models that restrict student interaction and inhibit co-constructed understanding. An additional and unresolved dimension of this problem concerns gender: existing research has produced contradictory findings regarding whether male and female students differ systematically in their mathematics achievement, and whether specific instructional interventions narrow or widen any such gap. This study therefore addresses the following central question: What is the effect of the Round-Robin Instructional Strategy on the circle-geometry achievement of Senior Secondary School students in Keffi, Nasarawa State, Nigeria?

Objectives of the Study

The study was designed to:

1. determine the effect of the Round-Robin Instructional Strategy on students' achievement in circle geometry
2. compare the influence of gender on students' achievement in circle geometry when taught using the Round-Robin Instructional Strategy.

Research Questions

The following research questions guided the study:

1. What are the mean achievement scores of students taught circle geometry using the Round-Robin Instructional Strategy compared with those taught using the conventional method?
2. What are the mean achievement scores of male and female students taught circle geometry using the Round-Robin Instructional Strategy?

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Research Hypotheses

The following null hypotheses were formulated and tested at $\alpha = 0.05$:

- H₀₁: There is no statistically significant difference in the mean achievement scores of students taught circle geometry using the Round-Robin Instructional Strategy and those taught using the conventional method.
- H₀₂: There is no statistically significant difference in the mean achievement scores of male and female students taught circle geometry using the Round-Robin Instructional Strategy.

Methodology

The study adopted a quasi-experimental design with pre-test, post-test, non-equivalent, non-randomised control groups. This design was selected because it permits causal inference regarding the effect of a treatment while accommodating the practical constraints of intact classroom groups, which preclude full randomisation. The target population comprised 1,027 Senior Secondary School II students (612 male; 415 female) enrolled in the seven public co-educational senior secondary schools under the jurisdiction of the Keffi Area Educational Quality Evaluation Office, Nasarawa State. Using simple random sampling, two schools were selected, yielding a final sample of 91 students: 49 male and 42 female. One school was assigned to the experimental condition (RRIS; $n = 46$) and the other to the control condition (conventional method; $n = 45$). Data were collected using the Circle Geometry Achievement Test (CGAT), a researcher-developed instrument comprising 40 four-option multiple-choice items covering the following content areas: properties of a circle; the angle at the centre and the angle at the circumference; the angle in a semicircle; angles in the same segment; cyclic quadrilaterals; and tangents to a circle. The CGAT was reviewed by three independent validators—two specialists in Mathematics Education (National Open University, Abuja) and one in Measurement and Evaluation (Nasarawa State University, Keffi)—whose ratings produced a logical validity index of 0.79, affirming the instrument's content appropriateness. Reliability was determined through a pilot administration, with internal consistency computed using the Kuder-Richardson Formula 21 (KR-21), yielding a coefficient of 0.82, which is considered acceptable for achievement testing. A pre-test was administered to all participants before the commencement of instruction to establish baseline equivalence between groups. The experimental group received instruction on the designated circle-geometry topics through the Round-Robin Instructional Strategy over the treatment period, while the control group was taught the same content using the conventional teacher-centred method. A post-test was administered on conclusion of the treatment to measure achievement gains. Research questions were answered using descriptive statistics (means and standard deviations). The null hypotheses were tested using Analysis of Covariance (ANCOVA) at the 0.05 level of significance, with pre-test scores entered as the covariate to statistically control for baseline differences between groups and to enhance the statistical power of the design given the absence of random assignment.

Presentation of Results

Research Question 1: What are the mean achievement scores of students taught circle geometry using RRIS compared with those taught using the conventional method?

Table 1: Pre-test and Post-test Mean Achievement Scores and Standard Deviations by Instructional Group

Instructional Strategy	N	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD
Round-Robin Strategy	46	11.78	2.149	23.39	1.639
Conventional Method	45	13.02	1.889	19.47	1.878
Total	91				

Table 1 presents the descriptive statistics for both groups. Students in the Round-Robin group recorded a pre-test mean of 11.78 (SD = 2.149), which increased to a post-test mean of 23.39 (SD = 1.639)—a gain of approximately 11.61 points. Students in the conventional method group began with a slightly higher pre-test mean of 13.02 (SD = 1.889) but attained a markedly lower post-test mean of 19.47 (SD = 1.878), representing a gain of 6.45 points. These descriptive patterns suggest a larger achievement gain for students exposed to RRIS.

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Hypothesis 1: There is no statistically significant difference in the mean achievement scores of students taught using RRIS and those taught using the conventional method.

Table 2: ANCOVA Summary for Mean Achievement Scores of Experimental and Control Groups

Source	Type III SS	df	Mean Square	F	Sig.
Corrected Model	357.073a	2	178.537	58.307	.000
Intercept	901.395	1	901.395	294.383	.000
Pre-test (Covariate)	6.702	1	6.702	2.189	.143
Instructional Strategy	347.698	1	347.698	113.553	.000
Error	269.454	88	3.062		
Total	42498.000	91			
Corrected Total	626.527	90			

a. $R^2 = .570$ (Adjusted $R^2 = .560$)

The ANCOVA results presented in Table 2 indicate that, after statistically controlling for pre-test performance, the effect of instructional strategy on post-test achievement was statistically significant: $F(1, 88) = 113.553$, $p = .000 < .05$. The corrected model accounted for 57.0% of the variance in post-test scores ($R^2 = .570$; Adjusted $R^2 = .560$). The pre-test covariate was not a significant predictor ($F = 2.189$, $p = .143$), confirming that post-test differences were attributable to the instructional treatment rather than pre-existing achievement differences. Accordingly, the null hypothesis H_{01} was rejected. Students taught through RRIS achieved significantly higher post-test scores than those taught through the conventional method.

Research Question 2: What are the mean achievement scores of male and female students taught circle geometry using RRIS?

Table 3: Pre-test and Post-test Mean Achievement Scores and Standard Deviations by Gender within the Round-Robin Group

Gender	N	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD
Male	26	11.50	2.005	23.81	1.357
Female	20	12.15	2.323	22.85	1.843
Total	46				

Table 3 presents gender-disaggregated descriptive statistics for the RRIS group. Male students entered the study with a pre-test mean of 11.50 ($SD = 2.005$) and achieved a post-test mean of 23.81 ($SD = 1.357$), a gain of 12.31 points. Female students recorded a pre-test mean of 12.15 ($SD = 2.323$) and a post-test mean of 22.85 ($SD = 1.843$), representing a gain of 10.70 points. Although both groups showed substantial improvement, male students achieved a marginally higher post-test mean.

Hypothesis 2: There is no statistically significant difference in the mean achievement scores of male and female students taught using RRIS.

Table 4: ANCOVA Summary for Gender Differences in Achievement within the Round-Robin Group

Source	Type III SS	df	Mean Square	F	Sig.	Partial η^2
Corrected Model	24.702a	2	12.351	5.518	.007	.204
Intercept	573.344	1	573.344	256.132	.000	.856
Pre-test (Covariate)	14.334	1	14.334	6.404	.015	.130
Gender	14.113	1	14.113	6.305	.016	.128
Error	96.254	43	2.238			

Source	Type III SS	df	Mean Square	F	Sig.	Partial η^2
Total	25290.000	46				
Corrected Total	120.957	45				

$$R^2 = .204 \text{ (Adjusted } R^2 = .167)$$

Table 4 presents the ANCOVA results for the gender comparison within the RRIS group. After adjusting for pre-test scores, the effect of gender was statistically significant: the corrected model accounted for 20.4% of the variance in post-test scores ($R^2 = .204$ (Adjusted $R^2 = .167$)). $F(1, 43) = 6.305$, $p = .016 < .05$, with a partial eta-squared of .128, indicating a medium effect size. The pre-test covariate was also significant ($F = 6.404$, $p = .015$), suggesting that initial ability contributed meaningfully to post-test outcomes. On the basis of these results, the null hypothesis H_{02} was rejected. A statistically significant gender difference in achievement existed within the RRIS group, with male students outperforming female students in circle geometry.

Discussion of Findings

The primary finding of this study is that students instructed through the Round-Robin Instructional Strategy significantly outperformed those taught via the conventional method in circle geometry. Round-Robin Instructional Strategy is both statistically robust and educationally meaningful. This outcome aligns with a growing body of empirical evidence supporting the superiority of collaborative and activity-oriented approaches over traditional didactic instruction. Onukwube and Ebele (2022), Iroko and Olaoye (2022), and Kayode, Yahaya, Francis, and Taiye (2024) similarly reported significantly higher achievement among students exposed to RRIS across diverse subject areas including Mathematics, Chemistry, Biology, Physics, and Basic Science, pointing to the cross-disciplinary generalisability of the strategy. The theoretical basis for these gains is well established. RRIS operationalises core tenets of Vygotsky's (1978) sociocultural theory of learning: by situating knowledge construction within structured peer interaction, it activates the zone of proximal development and ensures that learning is co-constructed through dialogue, negotiation, and collaborative problem-solving. The systematic, turn-based structure of RRIS removes the participation inequities characteristic of conventional whole-class instruction, ensuring that every learner is both a contributor and a beneficiary of the group's intellectual work. The resulting learning environment—characterised by heightened engagement, shared responsibility, and active cognitive processing—appears to be especially well suited to the conceptual demands of circle geometry. The second finding; a statistically significant gender difference in achievement within the RRIS group, favouring male students, merits careful consideration. This result diverges from Folaranmi (2016), who found no significant gender effect under comparable instructional conditions, and is in tension with studies reporting either female superiority or gender parity (Ajai & Imoke, 2015; Olasehinde & Olatoye, 2014; Unodiaku, 2015; Anibueze, 2017). While the magnitude of the gender difference (partial $\eta^2 = .128$) is modest relative to the overall treatment effect, it nonetheless signals that RRIS, as currently implemented, may not distribute its benefits equitably across gender lines. Possible explanations include differential socialisation into collaborative discourse, gendered patterns of assertiveness within group settings, or topic-specific confidence effects in geometric reasoning. These mechanisms warrant systematic investigation before definitive conclusions can be drawn.

Conclusion

This study provides compelling evidence that the Round-Robin Instructional Strategy constitutes a pedagogically superior alternative to conventional methods for teaching circle geometry at the senior secondary school level in Keffi, Nasarawa State. By embedding instruction within a structured collaborative framework, RRIS generates achievement gains that considerably exceed those produced by teacher-centred approaches. At the same time, the observed gender differential within the RRIS group introduces an important caveat: while the strategy raises achievement broadly, its benefits may not be distributed equally across all student groups without deliberate gender-responsive adaptation. Mathematics Teachers are therefore encouraged to adopt RRIS while remaining attentive to the gendered dynamics of collaborative learning environments.

Recommendations

The following recommendations are advanced on the basis of the study's findings:



1. Mathematics teachers at the senior secondary level should systematically incorporate the Round-Robin Instructional Strategy into their pedagogical repertoire, particularly for topics in circle geometry that have historically posed comprehension difficulties for students.
2. Teachers implementing RRIS should attend to gender dynamics within group settings by designing explicit participation structures, rotating leadership roles, and providing targeted support to ensure that female students derive comparable benefits from collaborative activities.
3. Educational authorities and curriculum developers in Nasarawa State should incorporate training in collaborative and activity-based instructional strategies—including RRIS—into pre-service and in-service teacher development programmes.
4. Further quasi-experimental research should be conducted across varied geographic and demographic contexts to establish the generalisability of these findings and to investigate the mechanisms underlying the observed gender difference in achievement.

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