



Improving Secondary School Students' Academic Performance and Interest in Trigonometry Using the 7Es Instructional Model in Rivers State, Nigeria

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Abstract

This study examined the impact of the 7E's Instructional Model on senior secondary school students' performance and interest in trigonometry in Rivers East Senatorial District, Rivers State, Nigeria. The study employed a quasi-experimental design involving pre-test and post-test measures with non-equivalent control groups, supported by a quantitative descriptive approach. Three research objectives, questions, and hypotheses guided the investigation. A total of 347 SS2 students (175 males and 172 females) participated, selected through a multistage sampling technique. Students in the experimental group were taught using the 7E's Instructional Model, while those in the control group received instruction through the Guided Discovery Method. Data were collected using the Trigonometry Performance Test (TPT) ($r = 0.79$) and Trigonometry Interest Scale (TIS) ($r = 0.83$). Data analysis involved mean, standard deviation, and Analysis of Covariance (ANCOVA). Findings indicated that students exposed to the 7E's model achieved significantly higher scores in trigonometry compared to those taught using guided discovery ($F(1,344) = 208.50, p < .05$). Similarly, the experimental group demonstrated a significantly higher level of interest ($F(1,344) = 249.85, p < .05$). No statistically significant gender difference was observed among students taught with the 7E's model ($F(1,172) = 0.113, p > .05$). The study concludes that the 7E's Instructional Model is an effective strategy for improving students' performance and interest in trigonometry and supports gender inclusiveness in mathematics classrooms.

Keywords: 7Es Instructional Model, Guided Discovery, Trigonometry, Performance, Interest, Gender

Introduction

Mathematics is fundamental in influencing scientific thinking and technological progress in modern society. Its significance reaches beyond the confines of the classroom and into practical uses in areas like engineering, economics, and information technology. As a crucial element of STEM education, mathematics is anticipated to provide learners with skills that are in harmony with global needs and twenty-first-century competencies (Ghazali & Yusuf, 2022; Asanre, 2024). Within this field, trigonometry holds a vital role due to its utility in addressing challenges related to angles, distances, and periodic relationships, in addition to enhancing logical reasoning and analytical thinking abilities (Bekene & Machaba, 2022). Even with its significance, the academic performance of students in trigonometry remains a troubling issue in numerous secondary schools. A significant portion of learners views the subject as abstract, challenging, and disconnected from everyday life (Ahmad et al., 2024). The difficulties linked to trigonometry often stem from its symbolic representations, conceptual requirements, and the mental processes needed for problem-solving. Students are anticipated to interpret both verbal and visual data, create mathematical connections, and utilize suitable trigonometric principles. Nevertheless, these expectations are not consistently met, leading to ongoing low performance and waning interest in the topic (Umar et al., 2019). A key factor contributing to this scenario is the persistent dependence on traditional teaching methods that focus on memorization and procedural knowledge rather than fostering conceptual understanding. Such strategies typically limit students' active engagement and hinder meaningful learning opportunities. As a result, learners cultivate negative attitudes toward mathematics, which subsequently impacts their motivation and involvement

(Rodríguez-Naveiras et al., 2023). When students regard mathematics as fundamentally challenging, they are less inclined to dedicate effort to their studies, thus perpetuating unsatisfactory academic results.

Research indicates that students attain superior results when they take an active role in their learning journey. Teaching strategies that encourage inquiry, teamwork, and critical thinking have been shown to improve both achievement and enthusiasm for mathematics (Hussain et al., 2021; Iqbal & Noreen, 2024). In this context, the 7E's Instructional Model serves as a structured, inquiry-based framework aimed at promoting active learning. This model, which evolved from earlier learning cycle methodologies, comprises seven stages: Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend, guiding learners through a systematic pathway of knowledge development (Eisenkraft, 2003). The 7E's model is rooted in constructivist learning theory, which posits that learners construct new knowledge based on their previous experiences and interactions with their educational environment (Sharma, 2018). Through thoughtfully crafted activities, this model motivates students to investigate concepts, reflect on their comprehension, and apply knowledge in relevant contexts. This organized methodology is especially beneficial for tackling abstract subjects like trigonometry, where students frequently need directed assistance to gain conceptual clarity. Empirical research has shown that the 7E's model improves students' academic performance, retention, and problem-solving skills across various disciplines (Shuaibu et al., 2021; Adolphus et al., 2022; Asanre et al., 2024).

In contrast, the Guided Discovery Method, despite being student-centered, offers less structured support throughout the learning journey. While it promotes independent exploration, the lack of clearly outlined instructional phases can hinder its effectiveness, particularly when addressing intricate and abstract concepts. Research has demonstrated that although guided discovery can enhance critical thinking and engagement, its effectiveness largely hinges on the amount of support extended to learners (Savery, 2015;). In circumstances where such support is insufficient, students may find it challenging to attain a meaningful understanding (Rodríguez-Naveiras et al., 2023). Another crucial factor that affects achievement in mathematics is students' interest. Interest boosts attention, motivation, and persistence, all of which are vital for effective learning (Toli & Kallery, 2021). When learners show enthusiasm for a subject, they are more inclined to engage actively and tackle the challenges posed by difficult concepts. Research has indicated that interest is a significant predictor of students' academic success in mathematics (Ahmad et al., 2024). Consequently, instructional strategies that foster curiosity and maintain engagement are essential for enhancing learning outcomes in trigonometry.

Gender-related disparities in mathematics achievement have also gained significant focus in educational research. While some studies indicate differences in performance between male and female students, others contend that these discrepancies are shaped by contextual and instructional factors rather than innate ability (Iroko et al., 2024). Recent research suggests that learner-centered instructional methods, such as the 7E's model, can create equitable learning opportunities for both male and female students, thus fostering gender equity in the classroom (Akilu & Umar, 2023; Asanre et al., 2024). Although the 7E's Instructional Model has been extensively utilized in science education, its implementation in trigonometry instruction is still limited. Considering the abstract nature of trigonometry and the challenges tied to its teaching, there is a pressing need to examine the efficacy of structured, inquiry-based approaches in enhancing students' performance and interest. This study, therefore, aims to explore the impact of the 7E's Instructional Model on students' learning outcomes in trigonometry among senior secondary school students in Rivers East Senatorial District, Rivers State.

Statement of the Problem

Trigonometry continues to pose significant challenges for numerous secondary school students in Nigeria, with persistently low achievement linked to inadequate conceptual understanding and difficulties in applying mathematical principles (Abiodun et al., 2022). This issue has been associated with the prevalence of teacher-centered instructional methods, which prioritize rote learning and restrict students' active participation, consequently leading to poor performance and diminished interest in mathematics (Rodríguez-Naveiras et al., 2023). While learner-centered approaches, such as the 7E's Instructional Model, have been shown to improve understanding and engagement (Iqbal & Noreen, 2024), their use in teaching trigonometry is still limited. Simultaneously, students' interest remains a pivotal factor influencing achievement, as low interest diminishes participation and learning outcomes (Ahmad et al., 2024). Additionally, the matter of gender differences in mathematics achievement remains unresolved, although recent studies propose that the 7E's model may foster a gender-inclusive learning atmosphere (Akilu & Umar, 2023; Asanre et al., 2024). Despite these insights, there is insufficient empirical evidence on the effectiveness of the 7E's Instructional Model in improving students'

performance and interest in trigonometry within the Nigerian context. This study therefore seeks to address this gap by examining the effect of the 7E's Instructional Model on students' learning outcomes in trigonometry.

Purpose of the Study

The main purpose of this study is to examine the effect of the 7E's Instructional Model on senior secondary school students' academic performance and interest in trigonometry in Rivers East Senatorial District, Rivers State, Nigeria, in comparison with the Guided Discovery Method. The study specifically seeks to:

1. Determine the difference in the academic performance of students taught trigonometry using the 7E's Instructional Model and those taught using the Guided Discovery Method.
2. Examine the difference in the level of interest of students exposed to the 7E's Instructional Model and those taught using the Guided Discovery Method.
3. Assess the difference in the academic performance of male and female students taught trigonometry using the 7E's Instructional Model.

Research Questions

The following research questions were formulated to guide the study:

1. What difference exists in the academic performance of students taught trigonometry using the 7E's Instructional Model and those taught using the Guided Discovery Method?
2. What difference exists in the level of interest of students taught trigonometry using the 7E's Instructional Model and those taught using the Guided Discovery Method?
3. What difference exists in the academic performance of male and female students taught trigonometry using the 7E's Instructional Model?

Hypotheses

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

1. There is no statistically significant difference in the mean academic performance scores of students taught trigonometry using the 7E's Instructional Model and those taught using the Guided Discovery Method.
2. There is no statistically significant difference in the mean interest scores of students taught trigonometry using the 7E's Instructional Model and those taught using the Guided Discovery Method.
3. There is no statistically significant difference in the academic performance of male and female students taught trigonometry using the 7E's Instructional Model.

Methodology

This study employed a quasi-experimental approach utilizing a pre-test and post-test non-equivalent control group design, supported by a quantitative descriptive framework. The choice of this design was informed by the need to work with intact classes without disrupting the normal school schedule, thereby preserving the natural classroom setting. The study was conducted in Rivers East Senatorial District of Rivers State, Nigeria. The target population comprised all students enrolled in public senior secondary schools within the district. The district consists of eight Local Government Areas and a total of one hundred and forty public senior secondary schools, with an estimated student population of 33,866 according to records from the Rivers State Senior Secondary Schools Board (2024/2025 academic session). A multistage sampling procedure was employed to obtain the sample for the study. Initially, the district was organized into clusters based on geographical similarities. From these clusters, two were selected through a simple random sampling technique. Subsequently, one Local Government Area was chosen from each selected cluster using a random selection process. At the next stage, two schools were selected from each of the chosen Local Government Areas based on accessibility considerations, resulting in four participating schools. The study focused on Senior Secondary Two (SS2) students, who were purposively selected because trigonometry is a key component of their curriculum at this level. Finally, intact classes were randomly assigned to either the experimental or control group, yielding a total of eight classes. The sample consisted of 347 students, including 175 males and 172 females.

Two instruments were utilized for data collection. The first instrument, the Trigonometry Performance Test (TPT), was designed to assess students' understanding of selected trigonometric concepts. The test consisted of 25 multiple-choice items with four response options each, covering areas such as trigonometric ratios, identities, equations, angles of elevation and depression, as well as sine and cosine rules. The same instrument was administered before and after the instructional intervention to measure changes in students' performance. Each

correct response was awarded four marks, resulting in a maximum obtainable score of 100. The second instrument, the Trigonometry Interest Scale (TIS), was used to evaluate students' level of interest in trigonometry. The instrument was adapted and modified from an existing mathematics interest inventory developed by Wong and Wong(2019) to suit the objectives of the study. It consisted of statements structured on a four-point Likert scale ranging from Strongly Agree to Strongly Disagree. The scale included both positively and negatively worded items, with the negatively framed items reverse scored during analysis to ensure consistency in interpretation. To ensure the validity of the instruments, they were reviewed by experts in mathematics education who examined their content relevance, clarity, and alignment with the study objectives. Their suggestions were incorporated into the final versions of the instruments. Reliability of the TPT was established using the test-retest method, where the instrument was administered twice to a similar group of students at a two-week interval. The resulting scores were correlated using the Pearson Product Moment Correlation Coefficient, yielding a reliability index of 0.79. The reliability of the TIS was determined using Cronbach's alpha, which produced a coefficient of 0.83, indicating acceptable internal consistency.

The instructional intervention involved teaching trigonometry concepts using two different approaches. Students in the experimental group were taught using the 7E's Instructional Model, while those in the control group were taught using the Guided Discovery Method. The teaching process lasted for four weeks, during which lesson plans specifically designed for each instructional strategy were implemented. Prior to the intervention, both groups were administered the TPT and TIS as pre-tests to establish baseline equivalence. At the end of the treatment period, the same instruments were administered as post-tests to measure changes in performance and interest. Data collected from the study were analyzed using both descriptive and inferential statistical techniques. Mean and standard deviation were used to answer the research questions, while Analysis of Covariance (ANCOVA) was employed to test the hypotheses at the 0.05 level of significance. The use of ANCOVA was considered appropriate as it allowed for the adjustment of initial differences between groups by controlling for pre-test scores. In this analysis, pre-test scores served as the covariate, while post-test scores were treated as the dependent variable.

Table 1: Distribution of Schools and Students by Treatment Group

Groups	No. of Schools in the selected LGA	Gender		
		Male	Female	Total
7E Instruction Strategy	2	86	89	175
Guided Discovery Method	2	87	85	172
Total	4	202	196	347

Source: Field Survey, 2025

Results

Research Question 1: What difference exists in the academic performance of students taught trigonometry using the 7E's Instructional Model and those taught using the Guided Discovery Method?

Table 2: Mean Performance Scores of Students Taught Trigonometry using the 7E's Instructional Model and Guided Discovery Method

Method	N	Pre-Test		Post-Test		Mean Gain
		Mean	SD	Mean	SD	
7E's Instructional Approach	175	42.80	10.45	60.87	10.03	18.07
Guided Discovery Methods	172	45.50	10.68	52.51	8.46	7.01
Mean Difference		2.7		8.36		11.06

Source: Field Study, 2025

Table 2 indicates that although the guided discovery group had a higher pre-test mean score ($M = 45.50$, $SD = 10.68$) than the 7E group ($M = 42.80$, $SD = 10.45$), the trend reversed at post-test. Students taught using the 7E Instructional Model recorded a higher mean score ($M = 60.87$, $SD = 10.03$) compared to those taught using the Guided Discovery Method ($M = 52.51$, $SD = 8.46$). The mean gain further shows greater improvement among

students in the 7E group (18.07) than those in the guided discovery group (7.01). This suggests that the 7E Instructional Model was more effective in enhancing students' academic performance in trigonometry.

Research Question 2: What difference exists in the level of interest of students taught trigonometry using the 7E's Instructional Model and those taught using the Guided Discovery Method?

Table 3: Mean Interest Scores of Students in 7E's Instructional Model and Guided Discovery Method

Method	N	Pre-Interest		Post-Interest		Mean Gain
		Mean	SD	Mean	SD	
7E's Instructional Model	175	2.09	0.15	3.13	0.45	1.04
Guided Discovery method	172	2.11	0.23	2.49	0.35	0.38
Mean Difference		0.02		0.64		0.66

Source: Field Study, 2025

Table 3 shows that both groups had comparable interest levels at the pre-test stage (7E: $M = 2.09$, $SD = 0.15$; Guided Discovery: $M = 2.11$, $SD = 0.23$). However, at post-test, students taught using the 7E Instructional Model recorded a higher mean interest score ($M = 3.13$, $SD = 0.45$) than those taught using the Guided Discovery Method ($M = 2.49$, $SD = 0.35$). The mean gain further indicates a greater improvement in interest among the 7E group (1.04) compared to the guided discovery group (0.38). This suggests that the 7E Instructional Model was more effective in enhancing students' interest in trigonometry.

Research Question 3: What difference exists in the academic performance of male and female students taught trigonometry using the 7E's Instructional Model?

Table 4: Mean Performance Scores of Male and Female Students Taught Using 7E's Instructional Model

Gender	N	Pre-Interest		Post-Interest		Mean Gain
		Mean	SD	Mean	SD	
Male	86	46.19	10.04	63.33	10.86	17.14
Female	89	39.53	9.83	58.49	8.57	18.96
Mean Difference		6.66		4.84		1.82

Source: Field Study, 2025

Table 4 shows that male students recorded higher mean scores than female students at both pre-test ($M = 46.19$, $SD = 10.04$) and post-test ($M = 63.33$, $SD = 10.86$), compared to female students (pre-test: $M = 39.53$, $SD = 9.83$; post-test: $M = 58.49$, $SD = 8.57$). However, female students demonstrated a slightly higher mean gain (18.96) than male students (17.14). This indicates that although male students had higher overall scores, female students showed greater improvement following the instructional intervention.

Hypothesis 1: There is no statistically significant difference in the mean academic performance scores of students taught trigonometry using the 7E's Instructional Model and those taught using the Guided Discovery Method

Table 5: ANCOVA Analysis on the Academic Performance of Students taught Trigonometry using 7E's Instructional Model and Guided Discovery Method.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	21617.060 ^a	2	10808.530	261.989	.000	.604
Intercept	15360.744	1	15360.744	372.331	.000	.520
Pre_TPT	15559.023	1	15559.023	377.137	.000	.523
Method	8601.866	1	8601.866	208.502	.000	.377
Error	14191.931	344	41.256			
Total	1152408.000	347				
Corrected Total	35808.991	346				

a. R Squared = .604 (Adjusted R Squared = .601)

The ANCOVA result shows that the instructional method had a statistically significant effect on students' academic performance ($F(1,344) = 208.50, p < .05$). Since the significance value is less than 0.05, the null hypothesis is rejected. This indicates that students taught using the 7E's Instructional Model performed significantly better than those taught using the guided discovery method.

Hypothesis 2: There is no statistically significant difference in the mean interest scores of students taught trigonometry using the 7E's Instructional Model and those taught using the Guided Discovery Method.

Table 6: ANCOVA Summary of the difference in the mean interest scores of students taught Trigonometry using 7E's Instructional Model and those taught using the Guided Discovery Method.

Source	Type III Sum of		Mean Square	F	Sig.	Partial Eta Squared
	Squares	Df				
Corrected Model	41.092 ^a	2	20.546	136.327	.000	.442
Intercept	6.035	1	6.035	40.045	.000	.104
Pre_TIS	5.329	1	5.329	35.360	.000	.093
Method	37.654	1	37.654	249.845	.000	.421
Error	51.845	344	.151			
Total	2842.952	347				
Corrected Total	92.936	346				

a. R Squared = .442 (Adjusted R Squared = .439)

The results indicate a significant effect of instructional method on students' interest in trigonometry ($F(1,344) = 249.85, p < .05$). The null hypothesis is therefore rejected, implying that the 7E's Instructional Model significantly enhanced students' interest compared to the guided discovery method.

Hypothesis 3: There is no statistically significant difference in the academic performance of male and female students taught trigonometry using the 7E's Instructional Model

Table 7: ANCOVA Analysis of differences in the academic performance of male and female students taught Trigonometry using 7E's Instructional Model.

Source	Type III Sum of		Mean Square	F	Sig.	Partial Eta Squared
	Squares	Df				
Corrected Model	8626.847 ^a	2	4313.423	83.538	.000	.493
Intercept	9199.487	1	9199.487	178.166	.000	.509
Pre_TPT	7606.001	1	7606.001	147.305	.000	.461
Gender	5.845	1	5.845	.113	.737	.001
Error	8881.130	172	51.634			
Total	665880.000	175				
Corrected Total	17507.977	174				

a. R Squared = .493 (Adjusted R Squared = .487)

The analysis reveals that gender did not have a statistically significant effect on students' academic performance ($F(1,172) = 0.113, p > .05$). Therefore, the null hypothesis is retained, indicating that both male and female students benefited similarly from the 7E's Instructional Model.

Discussion of Findings

The findings of this study revealed that the 7E's Instructional Model significantly improved students' academic performance in trigonometry when compared to the guided discovery method. This outcome can be attributed to the structured and sequential nature of the 7E's model, which actively engages learners in the process of knowledge construction. By guiding students through stages that promote exploration, explanation, and application, the model enhances conceptual understanding and facilitates meaningful learning. This supports the view that instructional strategies grounded in inquiry and active participation are more effective in improving students' achievement in mathematics (Hussain et al., 2021; Iqbal & Noreen, 2024).

The observed improvement in students' interest further reinforces the effectiveness of the 7E's model. The higher level of engagement recorded among students exposed to this approach may be linked to its interactive and student-centered characteristics. When learners are actively involved in the learning process, they are more likely to develop curiosity and sustained interest in the subject matter. This finding aligns with previous studies which emphasize that interest plays a crucial role in enhancing students' motivation and overall academic success (Ahmad et al., 2024). The ability of the 7E's model to integrate both cognitive and affective aspects of learning makes it particularly suitable for subjects such as trigonometry, which students often perceive as abstract. In addition, the study found no significant difference in the performance of male and female students taught using the 7E's Instructional Model. This suggests that the model provides an equitable learning environment where all students have equal opportunities to succeed. The absence of gender disparity may be attributed to the inclusive nature of the instructional process, which encourages participation, collaboration, and equal engagement among learners. This outcome supports earlier findings that emphasize the potential of learner-centered instructional strategies to reduce gender-related differences in academic achievement (Akilu & Umar, 2023; Asanre et al., 2024).

The results of this study highlight the importance of adopting structured, inquiry-based instructional approaches in the teaching of mathematics. The 7E's Instructional Model not only enhances students' understanding of trigonometric concepts but also fosters positive attitudes toward learning. Its effectiveness in improving both performance and interest underscores its relevance as an innovative teaching strategy capable of addressing persistent challenges in mathematics education.

Conclusion

This study examined the effect of the 7E's Instructional Model on students' performance and interest in trigonometry. The findings revealed that students taught using the 7E's model achieved significantly higher performance and demonstrated greater interest compared to those taught using the Guided Discovery Method. The model was also found to be gender-inclusive, as no significant difference was observed between male and female students' performance. Importantly, the results indicate that the 7E's Instructional Model is an effective learner-centered approach for improving both academic achievement and interest in trigonometry, making it suitable for addressing persistent learning challenges in mathematics.

Recommendations

In line with the findings of this study, the following recommendations are made:

1. Mathematics teachers should adopt the 7E's Instructional Model as a regular teaching strategy, particularly when teaching abstract concepts such as trigonometry, in order to improve students' understanding and engagement.
2. Teacher training institutions and professional development programmes should incorporate training on the effective use of inquiry-based instructional models, including the 7E's framework, to equip teachers with the necessary pedagogical skills.
3. Curriculum planners and education stakeholders should integrate learner-centered instructional approaches into mathematics curricula to promote active learning and improve overall student outcomes.
4. School administrators should support the implementation of innovative teaching strategies by providing necessary instructional resources and creating an enabling classroom environment.

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