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EFFECT OF 7 E'S INSTRUCTIONAL STRATEGY ON THE ACADEMIC ACHIEVEMENT IN MATHEMATICS AMONG SENIOR SECONDARY SCHOOL STUDENTS IN IJEBU ODE, OGUN STATE, NIGERIA

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ABSTRACT

The deployment of appropriate teaching methods tailored to specific learning objectives is essential for effective knowledge transmission in our secondary schools and in response to these challenges, educators are increasingly turning to innovative instructional strategies designed to promote active learning and deeper comprehension. Therefore, this research examines the impact of 7 Es instructional strategy on the achievement of the senior secondary school students in mathematics. The study was guided by pretest, posttest, and control group quasi experimental approaches. Eighty respondents were from two senior secondary education (SS1) in Ogun State's Ijebu Ode Local Government Area, Nigeria. Constituted part of the study sample. Three hypotheses were formulated and evaluated at the significance threshold of 0.05. A mathematics achievement test (MAT) and a teaching guide on the strategies were developed to guide the research. The MAT was validated and a reliability index of 0.82 was derived using the split half method. The results revealed that mathematics achievement among senior secondary school students was significantly impacted by 7 Es instructional strategy, Moreover, there was no discernible effect of gender on student children's mathematical ability, and the students' achievement in mathematics was not significantly impacted by the interplay between gender and approach. The study found that the application of the 7 Es instructional strategy significantly impacted the achievement in mathematics of Ogun state, Nigeria's senior secondary school students in Ijebu Ode. Therefore, it is suggested that this strategy should be integrated into the process of instruction and learning in secondary schools.

Keywords: Academic Achievement, Gender, Mathematics, Strategy, 7E instructional Strategy

INTRODUCTION

Mathematics education at the senior secondary level holds significant importance in shaping students' academic and professional trajectories. Therefore, achieving proficiency in mathematics is

crucial to facilitate the student with all requirements and skills that are needed by him for success in future academic and professional courses. (Adiguzel & Akpinar, 2014). Despite efforts to reform mathematics education, a considerable gap persists between how mathematics is taught in schools and its practical application in professional settings, as noted by Abiodun et al. (2024). Traditional teaching methods, such as teacher-centered approaches, dominate secondary school mathematics education in some developed countries as well as in the developing countries of the third world, focusing primarily on memorization and procedural learning. However, these methods often fail to effectively foster students' conceptual understanding and problem-solving abilities (Abiodun et al. 2022). Ogunfowote & Asanre (2019) suggested that employing appropriate teaching methods tailored to specific learning objectives is essential for effective knowledge transmission. In response to these challenges, educators are increasingly turning to innovative instructional strategies designed to promote active learning and deeper comprehension.

As highlighted by Asanre et al. (2022), it is imperative for teachers to employ effective teaching methods to stimulate and maintain students' academic performance. Therefore, there is a pressing need to transition from conventional teaching methods to more innovative, learner-centered approaches in the field of mathematics education. One such innovative approach is the 7 Es instructional strategy, which encompasses seven essential stages: Engage, Explore, Explain, Elaborate, Evaluate, Extend, and Elicit. After recognizing certain limitations, Eisenkraft (2003) added to 5E model the two additional phases and thus refining tactical scaffold that resulted in the 7E instructional model. This framework encourages educators to actively involve students in the learning process through practical applications, collaborative problem-solving, and reflective practices. By guiding students through a series of structured activities, the 7 Es framework aims to create meaningful learning experiences and enhance academic achievement in mathematics. Although the 7 Es instructional strategy has shown promise in various educational settings, further research is needed to assess its effectiveness in improving mathematics achievement among senior secondary school students.

According to Shuaibu et al. (2021), adopting the 7E instructional approach has been shown to enhance students' academic achievement in various subjects. Their research findings suggest that students can retain information over time, leading to improved performance in examinations. Additionally, Mateen et al. (2024) demonstrated that the 7E model of instruction, consisting of "Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend," has become widely recognized for its effectiveness in promoting active learning and student-centered teaching methods. This model emphasizes inquiry-based learning, encouraging students to actively participate in scientific investigations and discovery. Through hands-on experiences and critical thinking, students are able to explore and develop a deeper understanding of scientific concepts.

The elicitation phase prompts learners to reflect on their past experiences within the learning context, while tasks in the engagement stage help teachers capture learners' interests and focus, preparing them for the learning process. Consequently, learners are motivated to connect prior knowledge with current learning situations, fostering a logical progression of ideas. In the exploration stage, the learning environment is characterized by various activities, including observing scientific processes, formulating hypotheses, identifying variables, recording data, organizing experimental procedures, creating graphical representations, and summarizing final outcomes for students. Here, teachers act as facilitators, posing questions, presenting models, offering feedback, and assessing comprehension levels. Moving to the explanation stage, tasks assist learners in articulating their understanding of related concepts, while teachers provide guiding principles for a deeper and clearer comprehension, introducing new scientific terminology and prompting students to apply these concepts in explaining outcomes. During the elaboration stage, activities support students in applying previously acquired knowledge to new situations, often with assistance and guidance provided through activities designed for the evaluation phase. In the evaluation stage, activities focus on assessing learning outcomes. Finally, the extension stage emphasizes the effective application and extension of acquired knowledge. (Hussain et al., 2021).

Cherono et al. (2021) conducted a study for the purpose of comparing the academic achievement of students, this study examined: the extent to which the 7E learning cycle model and conventional instructional method influenced students and the outcome was that the 7E learning cycle model had a more positive influence that holds promise for improving students' academic performance. Adolphus et al. (2022) endorsed the use of 7E instructional model to bolster teaching and learning practices, citing its ability to stimulate students' curiosity. They also suggested that teachers should receive training to enhance their proficiency in implementing the 7E instructional approach effectively. Additionally, Nilda (2021) observed that students tend to perform better when exposed to the 7E model's inquiry-based approach compared to traditional instructional methods. This finding suggests that students grasp subjects more easily when they actively engage in hands-on experiences and can relate the information learned to real-life events they encounter regularly.

Through the application of inquiry-based teaching methods, learners have demonstrated enhanced critical thinking abilities. It's strongly suggested that teachers prioritize the utilization of the 7E model's inquiry-based approach over conventional instructional methods. While implementing this approach may require additional effort, it ultimately leads to improved academic achievement for learners. This assertion is supported by Jack et al. (2024), who found that the use of the 7E instructional strategy offers a superior approach for students to learn and enhance their academic performance. Therefore, teachers are encouraged to adopt the 7Es instructional strategy to foster greater achievement among students. This approach not only promotes gender-friendly classrooms but also facilitates peer interaction and cultivates advanced critical thinking skills.

Abdullahi et al. (2020) concluded that students' attitudes were more positively influenced when utilizing the 7E teaching style as opposed to when employing conventional teacher-centered techniques. Hence, the 7E instructional strategy not just significantly enhanced academic success of the students, but moreover positively impacted their attitudes toward learning. Similarly, Francis et al. (2015) demonstrated that within the context of the study it was concluded that, the use of the 7E learning cycle model and case-based learning was more advantageous in enhancing senior secondary school students' achievement in and attitude towards chemistry than the conventional teaching approaches.

Khaled (2016) asserted that the 7 E's learning cycle proves to be more effective than traditional methods in achieving both quickly and slowly understanding of mathematical ideas. Furthermore, matching-samples t-test analysis revealed an advantageous longitudinal impact of the 7 E's learning cycle to retention among Preparatory Year students at KSU, which contrasts with the conventional method's inefficiency. In a similar vein, Cherono et al. (2021) recommended the adoption of constructivist methods, such that the 7E learning cycle model, are used in biology education. Their study highlighted a statistically significant difference in mean scores between students instructed using the traditional teaching techniques and the 7E learning cycle model, underscoring the potential for the 7E learning cycle model to enhance students' academic achievement. Echoing these sentiments, Kevin et al. (2022) emphasized the paramount importance of effective approaches such as the 7E learning cycle model in studies on science education. They stressed the objective of enabling students to understand and create fundamental systems of the world and beyond through this approach.

Asanre et al. (2022) argued that gender differences in mathematics learning are complex and cannot be attributed solely to gender, as various factors such as socioeconomic status, ethnicity, school environment, and teacher mindset also play significant roles. They also highlight the gender-related challenges within the Nigerian educational system that need to be addressed. In recent years, educators have expressed diverse opinions regarding gender and academic success, particularly in mathematics. While some believe that male students outperform female students, others contend that this belief is not universally applicable. This finding corroborated by Author (2024), who reported that gender differences

in academic performance in mathematics have been controversial and have generated considerable interest in educational research over the years. Furthermore, Akilu et al. (2023) conducted an investigation at how gender affects academic performance in genetics adopting the 7 Es instructional learning model. Their findings indicated that students' gender had no discernible influence on their academic performance. Consequently, they recommend that teachers giving priority to teaching genetics using the 7 Es paradigm, irrespective of the gender differences.

It is evident that student mathematics achievement, particularly in senior secondary schools in Ijebu Ode, has been consistently poor, impacting their capacity to use mathematical ideas in practical contexts. Considering that out of the 37 states in Nigeria, including the FCT, the 2022 WAEC results in mathematics for Ogun State revealed a decline in performance compared to previous years, statistics given by WAEC show that out of 1.6 million candidates who sat for examination in 2022, 76.36% had credit in five subjects including English and mathematics, yet students had a decline of 5% in their performance compared to the previous year, which was 2021 when the performance was 81.1%. Despite various research efforts, there remains a lack of comprehensive research on the efficiency of innovative learning strategies, particularly the 7E instructional model, among students in Ijebu Ode secondary schools. Therefore, this research sought to determine how the 7E educational approach affected the mathematics performance of senior secondary school pupils in Ogun State's Ijebu Ode Local Government Area. By examining the effectiveness of this instructional approach, this study seeks to provide valuable insights into enhancing mathematics education and improving student outcomes in the region.

OBJECTIVES OF THE STUDY

The purpose of this research study, therefore is to assess the impact of the 7 Es instructional model on the mathematics achievement of senior secondary school students in the chosen local government area of Ogun State. Specifically, this study intended to:

1. The impact of the 7 Es instructional model on students' mathematics achievement in senior secondary school.
2. The impact of gender on students in senior secondary school mathematics achievement was examined.
3. The impact of the teaching approach and gender interaction on the mathematical achievement of senior secondary school students was investigated.

STATEMENT OF HYPOTHESES:

For the purpose of this investigation, the 0.05 level of significance was used to evaluate the following hypotheses:

1. Students in senior secondary schools do not significantly benefit from the 7E teaching paradigm in terms of their mathematical achievement.
2. Students in senior secondary schools do not significantly differ in their mathematical achievement based on their gender.
3. The teaching style and gender did not significantly interact to affect the mathematical achievement of senior secondary school students.

METHODOLOGY AND TOOLS

In this research, a pretest, posttest, control group quasi experimental design was used in studying the effects of the 7 E instructional model in enhancing mathematics achievement among senior secondary school students in the Ijebu-Ode Local Government Area of Ogun State Nigeria. Abiodun et al (2024) submitted that a quasi experimental study applies independent variables to a specific sample to

observe their impact on the dependent variable. The population of interest encompassed all public senior secondary schools in the area. The sample consisted of 80 participants, specifically forty senior secondary School one (SSS1) students from intact classes selected from two public senior secondary schools. A guide detailing the 7E instructional model was developed to differentiate the teaching procedure from conventional methods. To assess students' academic achievement in mathematics, a self-constructed mathematics achievement test (MAT) was administered. Importantly, the MAT consisted of 30 items all of which had a letter label ranging from A to D with only one correct answer and three distracter options. The items were drawn to cover the following areas in mathematics: word problems leading to mathematics equations (12 questions), simultaneous equations involving indices (8 questions) and quadratic equations (10 questions), which are topics to which the student was exposed. It was developed to cover students' knowledge, comprehension and application levels, and underwent revalidation by a senior colleague and secondary schoolteachers within the local government to guarantee content and face legitimacy. The reliability of the MAT instrument was determined to be satisfactory, with a coefficient of 0.70, obtained through administration to a separate sample not included in the main study. Ethical considerations were upheld throughout the research process. Informed consent was obtained from all participants, and confidentiality was maintained to ensure the integrity of the study. Both descriptive (mean and standard deviation) and quantitative statistics were used to analyze the gathered data to demonstrate the population and level of achievement in terms of gender and inferential statistics of analysis of covariance (ANCOVA), allowing for the examination of potential differences in mathematics achievement between the experimental and control groups while controlling for pretest scores as covariates.

RESULTS

The descriptive statistics

Table 1: Students' mean achievement scores and standard deviation who were Exposed to Experimental and Control Strategies Based on Their Gender.

Strategy	Gender	Mean	Std. Deviation	N
7E's Instructional Model	Male	28.63	5.976	16
	Female	27.17	5.592	24
	Total	27.75	5.719	40
Conventional	Male	21.84	2.688	25
	Female	21.00	3.443	15
	Total	21.53	2.978	40

Table 1 shows the mean mathematical achievement scores of students who were exposed to the 7 Es instructional model and those who encountered the traditional teaching method according to their gender. The male students exposed to 7 Es Instructional model possessed a standard deviation of 5.976 and a mean achievement score of 28.63 while the male students exposed to the traditional teaching approach had a standard deviation of 2.688 and a mean achievement score of 21.84. Similarly, the mean achievement score of female students exposed to the 7 Es Instructional Model was 27.17 with a standard deviation of 5.592, whereas the mean achievement score of female students exposed to the conventional style of teaching was 21.00 with a standard deviation of 3.443.

TESTING OF THE HYPOTHESES

Hypothesis one: Students in senior secondary schools do not significantly benefit from the 7E teaching paradigm in terms of their mathematical achievement.

Table 2: Synopsis of the Analysis of Covariance of Mathematics Students' Achievement by Strategy and Gender

Source	Sum of Squares	Df	Mean Square	F	Sig	Partial Eta Squared
Corrected Model	1377.548 ^a	4	344.387	25.349	.000	.575
Intercept	724.944	1	724.944	53.360	.000	.416
Achievement	575.504	1	575.504	42.360	.000	.361
Strategy	295.841	1	295.841	21.776	.000	.225
Gender	.682	1	.682	.050	.823	.001
strategy * gender	5.744	1	5.744	.423	.518	.006
Error	1018.940	75	13.586			
Total	50957.000	80				
Corrected Total	2396.488	79				

* Indicates a significant F at the .05 level, R squared = .575 (adjusted R squared = .552)

The results in Table 2 show the effect of strategy (i.e. 7E's Instructional Model used as treatment in the study) on the students' success in mathematics. A significant difference was seen ($F_{(1, 75)} = 21.776$, $P < 0.05$) in the data. This result suggests that the mean achievement scores of the students exposed to the two types of instructional methodologies differ significantly from one another. Hence, the null hypothesis, according to which the 7E teaching paradigm has no discernible effect on senior secondary school students' mathematics achievement, is rejected and it is concluded demonstrates the 7E educational approach significantly affects senior secondary school students' mathematics achievement. Table 2 demonstrates further that 22.5% of the variation in the students' mathematical achievement was explained by the used approach.

Hypothesis two: Students in senior secondary schools do not significantly differ in their mathematical achievement based on their gender

Table 2's gender effect data indicate that gender had no discernible impact on students' mathematics ability ($F_{(1, 75)} = 0.050$, $P > 0.05$). This finding suggests that there was little difference in the mean accomplishment scores between male and female students following their exposure to the two study methodologies. Hence, the null hypothesis, according to which gender has no discernible impact on senior secondary school students' mathematics proficiency, is upheld and it is concluded that senior secondary school students' achievement in mathematics is not much impacted by their gender. The results in Table 2 further show found the variation in the students' achievement in mathematics scores was 1.0% explained by gender as a variable.

Hypothesis three: The teaching style and gender did not significantly interact to affect the mathematical achievement of senior secondary school students. There is no discernible interaction impact between treatment approach and gender on students' math success scores, according to the results of the two-way interaction effect of treatment strategy and gender in Table 2 ($F_{(2, 75)} = .423$, $P > 0.05$). This result suggests that there is no significant difference in the groups' mean mathematics achievement scores at the two treatment approach levels in the study between the two student gender levels (male and female). Therefore, the null hypothesis, which states that gender and approach do not significantly interact to affect senior secondary school students' mathematical success, is supported and it is concluded that the impact of approach and gender on the mathematical achievement of senior secondary school students is not statistically significant. The lack of interaction between strategy and gender is shown in the figure below.

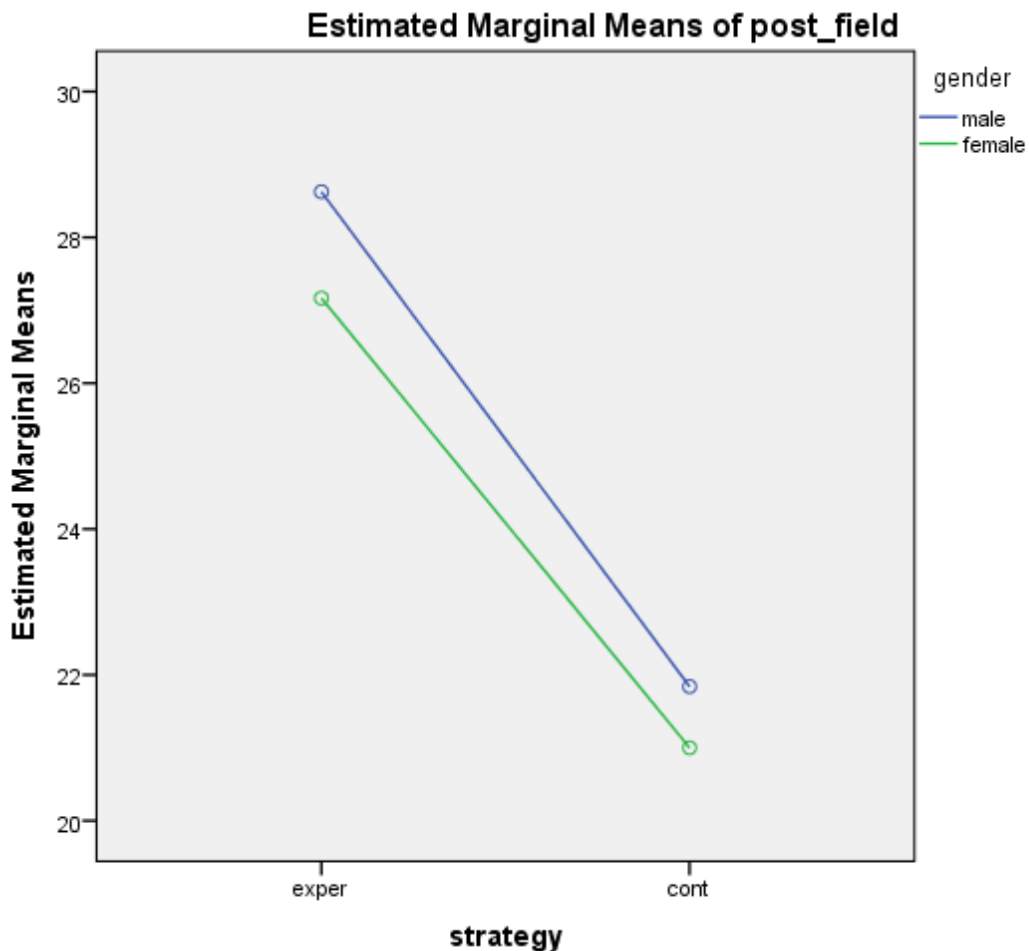


Figure 1: Interaction effect of strategy and gender

DISCUSSION OF RESULTS

In comparison to the control group, which had a mean achievement score of 21.84 with a standard deviation of 2.688, the results showed that the mean male achievement score increased following instruction, to 28.63 with a standard deviation of 5.976. Additionally, comparing the female group's mean achievement score to the control groups, which was 21.00 with a standard deviation of 3.443, the female group's score was higher at 27.17 with a standard deviation of 5.592. This finding shows the effectiveness and efficiency of using the strategy in the teaching of learners. Table 1 illustrates the possible impact of the 7 Es teaching technique on the academic achievement of Ijebu Ode senior school students in Ogun state, Nigeria. This corresponds with the filing of Abiodun et al (2024) that the use of a student-centered teaching method during the excellent mathematical accomplishment of senior secondary school students was caused by the teaching and learning process. Cherono et al. (2021) highlighted that the 7E Learning Cycle Model has the ability to improve the academic achievement of learners, as evidenced by the statistically significant difference in mean scores between students taught using the model and those taught using conventional instructional methods. Table 1 also, demonstrates that male students fared better in this field of study than female students. However, on a slit interval when comparing the mean achievement score, this outcome is not in line with the report of Asanre (2023) who noted that gender implications for mathematics success among students, show that female students

outperform male students in mathematics, which may be due to the type of student-centered strategy used, the degree to which students have adjusted and the genders' degree of concentration.

Table 2, shows that method significantly affects senior secondary school students' mathematics achievement, specifically the 7 Es instructional model was shown to be an effective strategy for boosting the students' academic performance in mathematics. This supported the results of Obodo (2017) and recommendations made in the Examiner report from the West African Examination Council (WAEC) from 2018 shows that teaching of mathematics should be student-centered and not dogmatic. This conclusion is consistent with Cheronon et al.'s (2021) finding that the 7E learning cycle model has a statistically significant impact on the academic achievement of students. Similarly, Francis et al. (2015) and Abdullahi et al. (2020) both concluded that 7E instructional strategy not only significantly enhanced students' academic achievement but also positively impacted their attitudes toward learning. The findings further indicated that senior secondary school students' achievement in mathematics was not significantly impacted by their gender. The results of Abiodun et al. (2022), Asanre et al. (2022) and Asanre et al. (2024) are consistent with this conclusion, that gender does not impact student's scholastic achievement in mathematics, as the quality and efficacy of instructional techniques are paramount. The results showed that there was no discernible interaction between gender and approach on the mathematical success of senior secondary school students. This finding corroborates the findings of Akilu et al. (2023) they used the 7 Es instructional learning style to conduct research on the impact of gender on academic success in genetics. Their results suggested that students' academic performance was not significantly impacted by their gender. Consequently, they recommend that teachers give priority to using the 7 Es model for teaching genetics, irrespective of gender differences. This shows that the instructional strategy is not gender sensitive as it significantly increases the achievement of both genders. Hence, Shuaibu et al. (2021) and Mateen et al. (2024) emphasize that adopting the 7E instructional approach has been shown to enhance students' academic achievement in various subjects.

CONCLUSION AND RECOMMENDATION This research looked at how senior secondary school students in Ijebu Ode, Ogun State, Nigeria, performed in mathematics while they were taught using the 7 Es teaching technique. According to the established objectives, three hypotheses were constructed and put to the test using the mean, standard deviation and ANCOVA at the 0.05 significance level. The numerical evaluation of the gathered information from the respondents, demonstrated that students who were taught the technique outperformed those who were taught the traditional way in terms of mean achievement scores for both male and female students, which clearly indicates that the teacher-centered approach to education is less effective and efficient than the student-centered approach. Additionally, the findings showed that the 7 Es instructional strategy had a noteworthy impact on mathematics achievement in the targeted sample, while both gender and the strategy-gender relationship had no discernible impact because the performance of the participants showed little difference in terms of gender. The outcome of this study may have been influenced by the hunger of the student for the student-centered approach rather than the traditional approach, which provides room for rote learning and cramming of mathematics concepts instead of eliciting on their experience, engaging in tasks, exploring, explaining the concept, elaborating on the process, evaluating it and extending the solution, thereby applying it to their environment. Therefore, this study concludes that the 7 Es instructional strategy enhances students' achievement in mathematics, particularly for students enrolled in senior secondary schools in Ijebu Ode, Ogun State, Nigeria. It is advised that educators be motivated to integrate the application of this strategy into their teaching and learning process to alienate students, misconceptions about the challenge of mathematics in the classroom.

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