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EFFECT OF THE 7E LEARNING MODEL ON ACADEMIC PERFORMANCE OF SENIOR SECONDARY SCHOOL STUDENTS IN MATHEMATICS IN ADAMAWA STATE, NIGERIA

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ABSTRACT

This study examined the effect of the 7E Learning Model on the academic performance of senior secondary school students in Mathematics in Adamawa State, Nigeria. A quasi-experimental pre-test–post-test non-equivalent control-group design was adopted. The population comprised 154,122 senior secondary school students in government-owned schools during the 2024/2025 academic session. Using multistage and purposive sampling procedures, two coeducational secondary schools and two intact SS II classes comprising 161 students were selected. The experimental group consisted of 88 students, while the control group had 73 students. Data were collected using the Students' Mathematics Performance Test, a 50-item multiple-choice instrument covering trigonometry and probability. The instrument was validated by three experts and yielded a reliability coefficient of 0.86 using Kuder–Richardson Formula 21. Mean and standard deviation were used to answer the research questions, while analysis of covariance was used to test the hypotheses at the 0.05 significance level, with pre-test scores as the covariate. The results showed a significant difference in favour of students taught using the 7E Learning Model, $F(1, 158) = 211.510$, $p < .001$, partial $\eta^2 = .572$. Gender had no significant effect on students' performance, $F(1, 85) = 1.623$, $p = .206$, partial $\eta^2 = .019$. The study concluded that the 7E Learning Model improved students' Mathematics performance. However, generalisation should be made cautiously because the sample was drawn from only two schools.

Keywords: 7E Model; Academic Performance; Mathematics; Gender; Adamawa State.

Introduction

Education develops knowledge, skills, reasoning, and the capacity to address practical problems. Mathematics contributes directly to these aims because it supports logical thought, analytical judgement, modelling, and decision-making across science, technology, engineering, economics, and everyday life. Students use mathematical ideas when they interpret information, plan resources, estimate quantities, and solve unfamiliar problems. Mathemsatics education therefore needs to move beyond memorisation and routine calculation towards teaching that helps students connect concepts, explain reasoning, and apply knowledge in new situations (Marujo & Casais, 2021; Okpala et al., 2018; Suleiman & Hammed, 2019).

Students' performance in mathematics has remained a concern in Nigeria and in Adamawa State. Records reported by the Adamawa State Ministry of Education show that the proportion of candidates who obtained credit passes or higher in West African Senior School Certificate Examination mathematics remained below 50 per cent from 2014 to 2023. The percentage of students scoring a credit pass or higher over the years are 6.5% in 2014, 7.1% in 2015, 8.9% in 2016, 8.8% in 2017, and 18.6% in 2018. However, there was an improvement in 2019 to 44.4% and in 2020 to 42.2%. The rate fell to 34.6% in 2021, then to 24.9% in 2022. There was a 35.6% performance recovery in 2023, though not substantial. A gender breakdown of the performance further reveals differences between male and female candidates. Among females, the percentage was 3.0% in 2014, 3.4% in 2015, 3.9% in 2016, and 3.8% in 2017. This rose to 7.1% in 2018, 18.2% in 2019, and reached the highest proportion of 19.3% in 2020. The figure then declined to 15.7% in 2021 and 11.2% in 2022, before increasing to 16.7% in 2023. For males, the proportion was 3.5% in 2014, 3.7% in 2015, 5.0% in 2016, and 5.1% in 2017. It subsequently increased to 11.5% in 2018 and reached its highest level of 26.2% in 2019. Thereafter, the percentages declined to 22.9% in 2020, 18.9% in 2021, and 13.7% in 2022, with a slight recovery to 18.9% in 2023. Overall, male candidates consistently recorded higher pass rates than female candidates, although the gap narrowed in some years. These results suggest that many students still struggle to meet the mathematics requirement for admission to higher education (Sadiq et al., 2020).

Student-centred instruction may help address this pattern. Such teaching engages students in questioning, discussion, collaborative problem-solving, and the application of ideas to practical tasks instead of limiting lessons to teacher explanation. The 7E learning model provides a structured form of student-centred instruction through seven stages: Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend. Eisenkraft (2003) developed the model by expanding the 5E learning model to give greater attention to prior knowledge and the transfer of learning. During Elicit and Engage, the teacher identifies what students already know and stimulates interest. Students then investigate ideas during Explore, articulate and refine their understanding during Explain, apply concepts during Elaborate, demonstrate understanding during Evaluate, and use learning in new settings during Extend.

Previous studies have associated the 7E model with improved academic outcomes and stronger conceptual understanding in mathematics and related subjects (Adolphus et al., 2022; Cherono et al., 2021; Hussain et al., 2022; Sule et al., 2024). However, instructional outcomes can vary according to teacher preparation, available materials, student participation, and the topics taught. Research has provided limited evidence on the use of the 7E model among senior secondary school students in mathematics in Adamawa State. This study addressed that gap by comparing the academic performance of students taught through the 7E learning model with that of students taught through the conventional method and by examining whether performance in the 7E group differed by gender.

Statement of the Problem

Mathematics as a science and technology oriented subject, therefore should be taught in a way to foster conceptual thinking and development of critical faculties, and be transferable

from knowledge base to other contexts and life situations. Effective mathematics instructions should instill in the student motivation, confidence and skills to work and compete in a task oriented society as well as to prepare the student for real life experiences and additional academic endeavours. In spite of the above, students in most Nigerian secondary schools in general and in Adamawa State in particular continue to fail to meet the desirable standard of performance in mathematics. The rate of credits pass in Mathematics for West African Examination Certificate (WAEC) from 2014- 2023 is the evidence of students inability to perform well.

The mathematics currently being taught in many of our classrooms continues to use very conservative classroom instructional strategies that promote memorisation and a passive classroom style (Darsih, 2018). Failure to give much attention and efforts toward changing in how mathematical concept is being impart/be taught in the classroom may result in students being handicapped in applying mathematical concepts in answering most of real-world problems they could face. Also failure in mathematics performance could lead the student not to performing well in external examinations and having little interest in studying science disciplines in higher education institutions .

Confronting this challenge requires adopting student-centred instructional approaches, such as the 7E learning model, that actively involve students in the learning process. This student-centred approach emphasises engagement, exploration, explanation, elaboration, and evaluation, and includes additional phases to activate prior knowledge and extend learning. This study, therefore, evaluated the effect of the 7E learning model on senior secondary school students' academic performance in mathematics in Adamawa State. It also examined the moderating effect of gender on the dependent variables.

Purpose of the Study

The study investigated the effect of the 7E learning model on academic performance of senior secondary school students in mathematics in Adamawa State, Nigeria. It also examined whether academic performance among students taught through the model differed by gender.

Research Questions

The following research questions guide this study:

1. What are the pre-test and post-test mean scores of senior secondary students in mathematics taught using 7E and conventional methods?
2. What are the pre-test and post-test mean scores of male and female students taught mathematics using the 7E learning model?

Hypotheses

The following null hypotheses will be tested at a 0.05 level of significance in this study:

H01: There is no significant difference in the mean academic performance scores in mathematics of students taught using the 7E learning model and those taught using the conventional method.

H02: There is no significant difference in the mean academic performance scores of males and females taught using the 7E learning model in mathematics.

Theoretical Framework

The study was guided by Vygotsky's Social Constructivist Theory, introduced in 1978. The theory states that learning and cognitive development are strongly influenced by social interaction, cultural context, and language. Vygotsky proposed that learners do not develop in isolation but progress when they engage with others in meaningful activities. A central construct of the theory is the difference between what learners can do independently and what they can do with the assistance of a more knowledgeable other, such as a teacher, peer, or mentor is the Zone of Proximal Development (ZPD). Learning becomes most effective within this zone because learners are guided to stretch beyond their current abilities.

The relevance of Vygotsky's Social constructivist theory to this study lies in its strong alignment with the principles of the 7E learning model. The seven phases of the 7E model: Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend reflect the major features of scaffolding and the ZPD. For example, teachers reveal prior knowledge and misconceptions during the Elicit and Engage phases, which serve as entry points for scaffolding. In the Explore and Explain phases, students work collaboratively, test ideas, and receive guidance from peers and teachers. Aligning directly with the principles of social interaction and guided learning. In the Elaborate, Evaluate, and Extend phases, learners apply knowledge in new situations, reflect on their understanding, and transfer that knowledge to solve real-life problems. These stages correspond to the gradual release of responsibility described in Vygotsky's concept of scaffolding.

Methodology

The design of the study is a quasi-experimental pre-test, post-test, non-equivalent control group design. The study area is Adamawa State. The population of the study is 154,122 senior secondary students in the government-owned secondary schools in Adamawa State. The sample for this study comprises 161 Senior Secondary II students drawn from two coeducational government senior secondary schools in Adamawa State, using intact classes. The experimental group consisted of 88 students, comprising 51 males and 37 females, while the control group consisted of 73 students, comprising 39 males and 34 females. One education zone was randomly selected from the five education zones in Adamawa State, resulting in the selection of Gombi Education Zone. Two Local Government Areas, Hong and Gombi, were selected from the zone using multi-stage sampling technique. Subsequently, two coeducational government senior secondary schools were selected from each of the two LGAs using purposive sampling. The purposive selection was guided by specific criteria: the schools must have consistently presented candidates for WAEC examinations over five years and must have qualified Mathematics teachers with an educational background in Mathematics education and at least two years of teaching experience. Students' Mathematics Performance Test (SMPT) was adapted for data collection. The SMPT consists of 50 multiple-choice items with five options: A, B, C, D and E. Items in the test were adapted from WAEC and NECO past question papers covering two topics: Trigonometry and Probability. The Students' Mathematics Performance Test (SMPT) underwent face, content and construct validation by three experts. The instruments were administered to the students; the SMPT scores were analysed using the Kuder-Richardson formula 21 (K-R-21) which yielded a reliability index of 0.86. Permission to conduct the study was obtained from the relevant school authorities, and informed consent was obtained from the participants before data collection. The collected data were analysed; research questions were answered using mean and standard deviation, and hypotheses were tested using Analysis of Covariance (ANCOVA) at a 0.05 level of significance, with pre-test scores as covariates. Before conducting ANCOVA, the assumption of homogeneity of regression slopes was examined by testing the interaction between the pre-test scores and the treatment groups. The interaction effect was not statistically significant, $F(1, 157) = 0.61$, $p = 0.437$, indicating that the assumption was satisfied and that ANCOVA was appropriate for the analysis. The decision criterion was that the null hypothesis would be rejected if the p-value was less than 0.05; otherwise, it would not be rejected.

Presentation of Results

Table 1: Independent-Samples t-Test of Pre-test Scores

Group	n	M	SD	t	df	P
Experimental	88	24.71	4.15	1.87	159	.063
Control	73	23.49	4.08	-	-	-

[M = pre-test mean. The test used the pooled-variance estimate derived from the reported group means, standard deviations, and sample sizes.]

An independent-samples t-test compared the groups' pre-test scores before the treatment. The difference between the experimental group (M = 24.71, SD = 4.15) and the control group (M = 23.49, SD = 4.08) was not statistically significant, t(159) = 1.87, p = .063. The result indicates that the two groups had comparable initial performance on the Students' Mathematics Performance Test.

Research Question 1: What are the pre-test and post-test mean scores of senior secondary students in mathematics taught using 7E and conventional methods?

Table 2: Pre-Test and Post-Test Mean Scores Difference in the Performance of Students Taught Using 7E Learning Model and Conventional Method in Adamawa State, Nigeria

Group	n	Pre-test Mean	SD	Post-test Mean	SD	Mean Difference
Experimental	88	24.71	4.15	37.02	6.17	11.42
Control	73	23.49	4.08	25.60	5.38	

[Mean Difference = Experimal Group Post-test – Control Group Post-test = 11.42]

Table 2 presents the mean performance scores of students before and after being taught using the 7E Learning Model and the conventional method. The experimental group had a pre-treatment mean score of 24.71 (SD = 4.15) and a post-treatment mean of 37.02 (SD = 6.17). The control group had a pre-treatment mean of 23.49 (SD = 4.08) and a post-treatment mean of 25.60 (SD = 5.38), with a mean difference of 11.42. This shows that the 7E Learning Model produced a stronger positive effect on students' academic performance in Mathematics than the conventional method.

Research Question 2: What are the pre-test and post-test mean scores of male and female students taught mathematics using the 7E learning model?

Table 3: Pre-Test and Post-Test Mean Scores Difference in the Performance of Male and Female Students Taught Using 7E Learning Model in Adamawa State, Nigeria

Gender	N	Pre-test Mean	SD	Post-test Mean	SD	Mean Difference
Male	51	25.11	4.27	34.13	5.42	1.55
Female	37	23.52	4.06	32.58	4.70	

[Mean Difference = Male Post-test – Female Post-test = 1.55]

The mean performance scores of male and female students before and after being taught using the 7E Learning Model. The male students had a pre-treatment mean score of 25.11 (SD = 4.27) and a post-treatment mean of 34.13 (SD = 5.42). The female students had a pre-treatment mean of 23.52 (SD = 4.06) and a post-treatment mean of 32.58 (SD = 4.70), with a mean difference of 1.55. This shows that both male and female students improved in their Mathematics performance after being exposed to the 7E Learning Model, with male students showing a slightly higher post-test mean than female students.

Hypothesis One

H0₁: There is no significant difference in the mean academic performance scores in mathematics of students taught using the 7E learning model and those taught using the conventional method.

Table 4: Summary of ANCOVA of Significant Difference in the Performance of Students Taught Mathematics Using the 7E Learning Model and Conventional Method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	9251.744[a]	2	4625.872	185.328	0.000	0.701
Intercept	1436.521	1	1436.521	57.548	0.000	0.267
pre-test	1634.728	1	1634.728	65.476	0.112	0.293
Teaching Methods	5279.493	1	5279.493	211.510	0.000	0.572
Error	3943.828	158	24.961			
Total	161890.000	161				
Corrected Total	13195.572	160				

[a]R Squared = 0.701 (Adjusted R Squared = 0.697)

A significant difference in the academic performance of students taught Mathematics using the 7E Learning Model compared to those taught using the Conventional Method. The teaching method significantly improved student performance, as shown by an F-value of F(1,158)=211.50 and a p-value of 0.000, which is less than the 0.05 level of significance. This result implies that the 7E Learning Model enhanced students' performance in Mathematics more effectively than the Conventional Method. The partial eta squared of 0.572 indicates that the teaching method accounts for 57.2% of the variance in student performance. Therefore, the null hypothesis was rejected.

Hypothesis Two

H02: There is no significant difference in the mean academic performance scores of males and females taught using the 7E learning model in mathematics.

Table 5: Summary of ANCOVA of Significant Difference in the Performance of Male and Female Students Taught Mathematics Using 7E Learning Model and Conventional Method in Adamawa State, Nigeria

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	412.726[a]	2	206.363	7.292	0.001	0.146
Intercept	241.385	1	241.385	8.530	0.004	0.091
pre-test	364.227	1	364.227	12.873	0.001	0.132
Gender	45.922	1	45.922	1.623	0.206	0.019
Error	2405.478	85	28.300			
Total	113829.00	88				
Corrected Total	2818.204	87				

[a]R Squared = 0.146 (Adjusted R Squared = 0.126)

The ANCOVA results indicate that the effect of gender on students' academic performance was not statistically significant, $F(1,85) = 1.623$, $p = 0.206$, partial $\eta^2 = 0.019$. Since the p-value is greater than 0.05, the null hypothesis was not rejected. This implies that there is no significant performance difference between male and female students taught Mathematics using the 7E Learning Model. Gender accounted for only 1.9% of the variance in students' academic performance.

Discussion of Findings

The study found that students taught mathematics through the 7E learning model performed significantly better than students taught through the conventional method. This finding agrees with Cherono et al. (2021), Nilda (2021), Jack and Ogunleye (2024), and Sule et al. (2024), who reported improved academic outcomes when instruction actively involved learners in investigation, explanation, and application. The result also supports the social constructivist account adopted for the study because the model gives students repeated opportunities to connect prior knowledge with new ideas, discuss solutions with peers, receive guidance, and apply concepts beyond the first example. The content taught in this study, trigonometry and probability, requires students to interpret relationships and justify procedures instead of relying only on memorised steps. The Elicit and Engage stages may have helped teachers identify gaps in prerequisite knowledge before introducing new tasks. Explore and Explain may then have allowed students to test ideas and make their reasoning explicit, while Elaborate and Extend may have supported transfer to unfamiliar questions. These linked activities offer a plausible explanation for the substantial difference between the two teaching groups. However, Hussain et al. (2022) showed that the model does not produce the same advantage for every task, so teachers need suitable preparation, materials, and time to implement each stage carefully.

The study also found no statistically significant difference between the performance of male and female students taught through the 7E learning model. This is similar to the result of Sule et al. (2024) and Asanre et al. (2024). It suggests that a structured, participatory approach can provide comparable opportunities for male and female students to question, explore, explain, and apply mathematical ideas. The result does not mean that the groups obtained identical scores; it means that the observed difference was too small to reach statistical significance after adjustment for pre-test performance. The finding differs from Oribhabor (2020) and Oluyemo et al. (2020), who reported gender differences in mathematics performance. Differences across studies may reflect variation in students' age, the mathematical topics assessed, sample composition, teacher preparation, and the fidelity with which an instructional model was implemented. The Adamawa result may also reflect the way the 7E sequence distributes participation across several stages, giving students more than one route through which to demonstrate understanding. Further research should examine these possible explanations directly instead of attributing differences to gender alone.

CONCLUSION

The findings concluded that the 7E Learning Model is an effective instructional model for improving senior secondary school students' performance in Mathematics in Adamawa State, Nigeria. It is also found that students taught using the 7E Learning Model performed better than those taught using the conventional teaching method, indicating that the structured and student-centred phases of the model enhance students' understanding of mathematics. Furthermore, it was also confirmed that there is no significant difference in learning achievement between male and female students. So it can be proven that learning through the 7E Learning Model is good for both male and female students.

Recommendations

The following recommendations are made based on the findings;

1. Mathematics teachers in senior secondary schools are recommended to adopt the 7E Learning Model in the classroom. It was found that using this model has a positive effect of students' academic achievement in Mathematics. This model is effective in making students learn in more interactive and meaningful way by using seven stages: Elicit, Engage, Explore, Explain, Elaborate, Evaluate and Extend.
2. Teachers have responsibility to ensure equal opportunities for all students regardless of gender, as gender was not a significant factor in how students performed in mathematics.

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