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Impact of the Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend (7E) Learning Model on Senior Secondary School Students' Mathematics Achievement

T. O. Abiodun[1], Akorede Asanre[2], Chinaka Taurayi[2]*

[1]Tai Solarin University Education, Nigeria
[2]University of Zululand, South Africa
[*]Correspondence: E-mail: abiodunto@tasued.edu.ng

ABSTRACT

This study investigated the effect of the Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend (7E) instructional model on the academic achievement of senior secondary school students in mathematics in Ijebu Ode, Ogun State, Nigeria. A pre- and post-test quasi-experimental design was adopted, guided by two research questions and two null hypotheses. The sample comprised 107 students from two mathematics classes, purposively selected from two public secondary schools, with 52 assigned to the experimental group (7E model) and 55 to the control group (discussion method). Data were collected using a 50-item mathematics achievement test, with a reliability coefficient of 0.87 (Kuder-Richardson 20). Descriptive statistics (mean and standard deviation) and independent sample t-tests at the 0.05 significance level were used for analysis. Results revealed a significant improvement in mathematics achievement for students taught using the 7E model compared to those taught using the discussion method. However, no significant gender difference was found in achievement among students exposed to the 7E model. It is recommended that mathematics teachers adopt the 7E instructional model to enhance learning outcomes.

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1. INTRODUCTION

One of the reasons mathematics is still taught as a core subject in both primary and secondary schools is that it is considered a vital and integral part of science education, and its importance is needed in everyday life. Mathematics is known as the queen of all sciences because it plays a major role in technological advancement and is used in many aspects of daily life, including banking, medicine, internet technology, scientific discoveries, and even the planning of tasks (Ajibola, 2014). Since mathematics is taught as a general subject and is a prerequisite for graduation for all science students in tertiary education. The Federal Government of Nigeria in 2014 made it a core subject that all secondary school students must offer at both junior and senior secondary school certificate levels. Without a credit pass in mathematics at the senior secondary school level, no student in Nigeria can access tertiary education at the tertiary level. Despite this focus, secondary school students' performance in mathematics appears to have remained quite low. There is ample evidence of subpar math performance. Students' poor performance in mathematics is a result of their failure to acquire the knowledge and abilities necessary to contribute successfully in the scientific, cultural, and political spheres in the future (Abdullahi, 2021). For instance, the annual report in mathematics from the West African Examination Council (WAEC) Chief Examiners in 2019-2024 showed that secondary school students performed poorly in mathematics.

Numerous factors, such as instructional methods, motivation, and attitude, are linked to students' subpar performance in mathematics (Abiodun *et al*., 2022). The use of teaching methods that are thought to be ineffective is frequently associated with students' poor performance in mathematics (Barakaev *et al*., 2020). As a result, teachers need to be aware of instructional strategies that will improve student performance. Traditional ways of learning mathematics relied on the teacher-centred approach, where teachers would normally provide input and students would largely absorb and recall the knowledge. On the other hand, contemporary approaches to mathematics education promote the process of sharing and integrating ideas from others. One of the best ways to impart knowledge to students is through traditional teaching methods like lecturing or using a chalkboard, yet there is no assurance that they will remember it. The outdated approach to teaching mathematics, which is ineffective and a primary factor in students' poor performance in the subject, is still in use (Abiodun *et al*., 2022). The common instructional strategy appears to be the conventional method, which is characterized by a preponderance of teachers' tasks with little or no active involvement of students in the process, creating misconceptions (Ajibola, 2014). Lessons that require practice are primarily taught through teacher demonstration, so students' participation is limited to listening, answering, asking questions, and writing notes as the lesson progresses.

In contrast to traditional methods, several studies have shown that using the Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend (7E) instructional model as an approach to teaching Mathematics has a more positive impact on student achievement than traditional approaches. However, these studies did not address the effect of the 7E instructional model on achievement and gender in Nigeria at a secondary school level. Hence, the need to investigate the effects of the 7E instructional model on students' performance in mathematics.

7E's model has seven phases: Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend.

(i) Elicit: Linking past memoir with the current learning environment requires full focus during the Elicit phase. The elicitation phase helps students identify the foundational

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knowledge (Santi & Atun, 2011). The community's interaction can help determine the learners' fundamental knowledge, which in turn can help impart the appropriate education (Suardana *et al*., 2018). This means that prior learning can help learners reach a higher learning level, and during the elicitation phase, the teacher helps students focus on their prior learning, which leads to the achievement of the desired outcome (Adesoji & Idika, 2015).

(ii) Engage: During this stage, learners are motivated to participate in the practice of education by persuasive and motivating strength (Cetin-Dindar & Geban, 2017). Teachers can exploit particular student feelings to accomplish desired aims, and do so. Thus, it can make the engagement phase more fruitful (Karolina *et al*., 2020). Students are actively involved with the material and are given the chance to share ideas in order to improve their comprehension.

(iii) Explore: Before the teacher assesses the student's level of learning, students are encouraged to tabulate contest results, separate variables, sketch out statistics, create diagrams, display results, and organize concluding statements. The "Explore" portion of the 7E model increases students' motivation and encourages them to engage with the lesson through a number of experiments (Yaman & Karasah, 2018). Experiments give students the opportunity to learn from observations and present circumstances, boost their desire, and instill a definitive mindset for a deeper level of comprehension (Celik *et al*., 2013).

(iv) Explain: The teacher now goes into greater detail on the subject to reveal more information that was previously unknown to the students after assessing their level of understanding. In order to clarify and improve their learning level, students are also encouraged to share their observations and experiences. This phase of 7E's model enhances the confidence level of learners with the method to involve them in questioning and answering gatherings (Purnamasari *et al*., 2017).

(v) Elaborate: Here, students are encouraged to discuss what they have learned in a novel setting, and they could be inspired to pose further queries and provide justifications for further research. This stage specifically aids students in problem-solving. Students get the chance to talk about their finished assignments throughout the elaboration phase (Riconscente, 2014). The 7Es model's elaboration phase enhances students' capacity for critical thought and logical reasoning, supports academic learning, and aids in the resolution of challenging issues (Adesoji & Idika, 2015).

(vi) Evaluate: Depending on the circumstances, assessment is used to determine the students' level of learning. Students' confidence is boosted during the evaluation phase once they realize they have completed the job (Lay & Cahndrasegaran, 2016).

(vii) Extend: Here, students get the chance to practice sharing their learning levels with instructors and peers. The teacher helps the students comprehensively articulate their acquired concepts. 7E's model gives possibility to students to grasp in a short time frame. Students who use the 7E's approach are more inspired, which results in improved academic performance (Qarareh, 2012).

Moreover, there is a need to examine how the teacher's implementation of the 7E instructional model will impact the learning outcomes of the learners in terms of gender. In some nations, there has been evidence of a widening gender discrepancy in educational attainment during the past few decades. Inequalities in curriculum, subject disciplines, enrolment, opportunity, and access are all created by gender discrimination in education. A survey of research indicates that male and female students perform differently on public

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exams and mathematics achievement assessments. According to earlier studies, male students scored better in mathematics than female students (Ajai & Imoko, 2015). There are also no discernible differences in math test scores between male and female students, according to findings from other studies. Contrary to previous reports (Achor *et al*., 2010), female students performed better in mathematics than male students. Gender is also recognized to have a major impact on students' understanding of mathematical issues when employing a range of teaching approaches because of the interaction of masculinity and femininity assigned to mathematics (Mahasneh, 2017; Chawla, 2015). Gender differences in academic achievement have been linked in several research areas to interactions between learners' physical, psychological, and physiological traits, particularly their learning style (Akanbi *et al*., 2021). The researchers felt that it was crucial to look into the connection between instructors' usage of the 7E instructional approach and the academic achievement of secondary school students in mathematics. Though widely supported and used in the social sciences, arts, and sciences, the viability of the 7E approach in math classrooms has not been thoroughly empirically verified, despite the many claims and counterarguments made by mathematic researchers regarding the method. The effectiveness of these methods in teaching and studying mathematics in senior secondary schools in Nigeria must thus be empirically investigated.

The study is guided by the following research questions:

(i) What is the mean difference in performance of the students in the experimental group and the conventional group?

(ii) What is the mean difference in terms of gender in the performance of students utilizing 7Es?

In addition, the following research hypotheses were tested at the 0.05 level of significance:

(i) There is no significant difference between the mean achievement scores of students taught mathematics using the 7E learning model and those taught using the discussion method;

(ii) There is no significant difference between the mean achievement scores of male and female students when taught mathematics using the 7E learning model.

2. METHODS

The study's population was all Senior Secondary School 2 (SSS2) math students. Two public secondary schools in Ogun State, Nigeria's Ijebu North East local government area, were purposively chosen for the study. Two groups (one from each of the chosen schools) were regarded as the control group and the experimental group, respectively. The experimental group consisted of fifty-two respondents, while the control group consisted of fifty-five respondents. The responders were chosen using a randomized procedure.

To complete this quasi-experimental investigation, a pretest-posttest control group design was chosen. The study's matrix distribution is displayed in **Table 1**.

We manipulated the independent variable, that is teaching strategy, and observed the effect on the students' achievement and gender.

A pre-test consisting of fifty items was used as the instrument for data collection, and the post-test was created after the test items were rearranged. The items measure students' achievement in mathematics. The instrument's reliability was evaluated using Kuder-Richardson formula 20 (K-R20), which had a coefficient of 0.87. Both descriptive (mean and standard deviation) and inferential (independent sample t-test) statistics were used to analyze the data at the 0.05 level of significance.

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Table 1. Matrix design of the study.

Groups	Pre-test	Intervention	Post-test
7E instructional model	P1	X*	P2
Conventional	P1	X**	P2

Notes: Notes: P1 is the Pre-test for both experimental and control groups; P2 is the Post-test for both experimental and control groups; X* is the Experimental group treatment (7E instructional model); and X** is the Control group treatment (discussion method).

3. RESULTS AND DISCUSSION

3.1. Research Question One: What is The Mean Difference in Performance of The Students in The Experimental and The Conventional Group?

Table 2 shows that students who received instruction using the 7E learning model had mean math scores of 20.62 with a standard deviation of 4.935. The students who employed the discussion approach scored on average 20.64 with a standard deviation of 5.492 on the pretest. After the intervention, students exposed to the 7E learning approach had mean math scores of 28.98 with a standard deviation of 5.425. Those who received instruction using the traditional discussion technique had a mean score of 21.27, with a standard deviation of 4.763. The mean differences between students using the traditional approach and those exposed to the 7E learning methodology were 0.63 and 8.36, respectively. The mean gain for the 7E learning model was 7.73 times higher than that of the discussion method groups.

Table 2. Mean and standard deviation of the 7E learning model and discussion method in mathematics before and after treatment.

Groups	N	Pre-test Mean	Pre-test Std. Dev	Post-test Mean	Post-test Std. Dev	Mean Difference
7E Method	52	20.62	4.935	28.98	5.425	8.36
Discussion Method	55	20.64	5.492	21.27	4.763	0.63

Note: The mean gain for the 7E learning model was 7.73 times higher than that of the discussion method group.

3.2. Research Question Two: What is The Mean Difference in Terms of Gender in The Performance of Students Who Were Taught Using 7E's?

According to **Table 3**, the pre-test mean math scores for male and female students exposed to the 7E learning paradigm were 20.25 and 20.93, respectively, with standard deviations of 4.443 and 5.381. Following treatment, both male and female students' mean scores in mathematics were 29.67 and 28.39, respectively, with corresponding standard deviations of 4.488 and 6.136. Male students benefited from a mean gain differential of 1.99.

Table 3. Mean and standard deviation of the 7E learning model based on the gender of students in mathematics before and after treatment.

Gender	N	Pre-test Mean	Pre-test Std. Dev	Post-test Mean	Post-test Std. Dev	Mean Difference
Male	24	20.25	4.443	29.67	4.488	9.42
Female	28	20.93	5.381	28.39	6.136	7.43

Note: Male students had a mean gain that was 1.99 points higher than female students, but the difference was not statistically significant.

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3.3. Hypothesis One: There is No Significant Difference between The Mean Conceptual Achievement Scores of Students Taught Mathematics using The 7E Learning Model and Those Taught using The Discussion Method.

Table 4 shows the analysis of the students' academic performance in the experimental class (7E method) and the control class (Discussion method). Following the intervention, the experimental class's math achievement was noticeably higher than the control group's (Mean = 28.98; Std. Dev = 5.425). Additionally, the experimental group class's mean difference was 7.708, 95% CI [5.754 to 9.662]. Similarly, the mean difference in the control class was 7.708, 95% CI [5.746 to 9.670]. Additionally, a significant difference in the students' achievement levels in mathematics following the intervention was obtained in **Table 4** ($t = 7.821$, $df = 105$; $p<0.05$).

Table 4. Independent t-test analysis of students' achievement scores in the 7E learning model class and the discussion method class.

Strategies	Mean	Std. Dev.	df	Mean Difference	95% Confidence Interval of the Difference (lower)	t (upper)	Sig.
7E Method	28.98	5.425	105	7.708	5.754	9.662	7.821
Discussion Method	21.27	4.763		7.708	5.746	9.670	

Note: The result shows a statistically significant difference ($p < 0.05$) in mathematics achievement favoring the 7E learning model over the discussion method.

3.4. Hypothesis Two: There is No Significant Difference between The Mean Achievement Scores of Male and Female Students when Taught Mathematics using The 7E Learning Model

Table 5 shows the gender-specific analysis of the experimental class's students' academic achievement. Following the intervention, there was no discernible gender difference in the experimental class's math achievement. The mean difference for the male group class was 1.274, 95% CI [-1.766 to 4.314], and the mean difference in the female class was 1.274, 95% CI [-1.696 to 4.244]. Hence, following the intervention, there was no discernible gender difference in the students' math proficiency (**Table 5**; $t = 0.842$, $df = 50$; $p<0.05$).

Table 5. Independent t-test analysis of students' achievement scores in the 7E learning model class based on gender.

Gender	Mean	Std. Dev.	df	Mean Difference	95% Confidence Interval of the Difference (lower)	t (upper)	Sig.
Male	29.67	4.488	50	1.274	-1.766	4.314	0.842
Female	28.39	6.136		1.274	-1.696	4.244	

3.5. Discussion

Due to the positive impact of 7E's model learning strategy, which raised the experimental group's learning level, the study's findings demonstrated a significant difference in the performance of students in the experimental and control groups. According to the current study, the experimental group's students were able to better understand and develop their problem-solving skills, attributed to the 7E model. The results of the current study are consistent with previous papers, who found that the 7E's model improves student comprehension and that it is an activity-based teaching methodology that allows students to fully engage in the lesson, thereby increasing their learning level (Jack & Ogunleye, 2024;

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Libata *et al*., 2021; Hornejas & Guntalidad, 2024; Bertiliya *et al*., 2023). The results of the current study are supported by the literature (ShuaibuAbdullahi & Muzirah, 2021) that the 7E model teaching technique enhances students' problem-solving abilities. The findings of this study were supported by another study (Githae *et al*., 2015), which discovered that, in comparison to the conventional teaching method, the 7E model considerably enhanced the learning of the experimental group's pupils. Furthermore, when interacting and collaborating with others, the 7E learning paradigm provides ample opportunities for students to expand their own knowledge based on past experiences, which could be the cause of the enhanced mathematical performance. In order to perform a given activity during the math sessions, the students collaborated depending on their existing knowledge.

When students were able to explain something, the teacher used mathematical language to convey the ideas. Improved mathematics comprehension among students may also result from the 7E learning model's ability to provide them the chance to reflect, look for, locate, and describe examples of how the subject they have learned has been used. The results also showed that the mean mathematical achievement of male and female students learning mathematics using the 7E learning strategy did not differ significantly. This is consistent with the previous findings (Komikesari *et al*., 2019), who discovered that when teaching human biology using the 7E instructional model, there is no significant difference in the conceptual knowledge of male and female students. These results also support other studies (Ajai & Imoko, 2015) that found no discernible relationship between gender and mathematics achievement. In other words, teaching strategy (rather than gender) should be the focus for improved mathematics achievement.

4. CONCLUSION

The results of this study indicate that students who were taught mathematics using the 7E learning model had better mathematical comprehension than those who were taught using the discussion technique. When it comes to students' comprehension of mathematics, the 7E learning model is also gender-neutral. In other words, using the 7E learning model to teach mathematics improved mathematical comprehension and achievement for both male and female students.

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6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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