

COMPARATIVE EFFECTIVENESS OF 5E AND SCAFFOLDING STRATEGIES ON STUDENTS' INTEREST AND ACHIEVEMENT IN READING SCIENCE-BASED TEXTS IN BENUE STATE, NIGERIA

*Usman Idris Mohammed PhD¹, Ahmodu Agada² & Geraldine Ezioma Ibelegbu³

¹*School of General Studies, Federal Polytechnic, Ohodo, Enugu State, Nigeria*

²*Department of English Language, Federal College of Education, Odugbo*

³*Department of Science Laboratory and Technology, Federal Polytechnic, Ohodo, Enugu State, Nigeria*

*Corresponding Author: usmanreigns@gmail.com/Orcid:<https://orcid.org/0009-0003-0342-7659>

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ABSTRACT

This study assessed the comparative effectiveness of 5E and scaffolding strategies on students' interest and achievement in reading science-based texts in Benue State, Nigeria. The design was quasi-experimental, specifically pretest, posttest non-randomised equivalent group design. Multi-stage sampling procedure was used to sample 44 senior secondary one students in two schools from a population of 5730 in Otukpo, Benue State. The students were sampled from two intact classes. Two research questions and two hypotheses guided the study. The instruments for data collection were Interest in Reading Science-based Texts Questionnaire (IRSTQ) and Science Reading Achievement Test (SRAT). The instruments were validated by experts and subjected to trial testing. IRSTQ yielded a coefficient of 0.83 while SRAT yielded 0.96. The research questions were answered using mean and standard deviation while the hypotheses were tested at 0.05 significance level using Analysis of Covariance (ANCOVA). It was found that both 5E and scaffolding significantly improved students' interest and achievement in reading of science-based texts. Since the strategies improved students' academic achievement and interest in science-based texts, it was recommended that English Language teachers should adopt 5E and scaffolding strategies in teaching students how to become proficient in reading science-based texts.

Keywords: Science-based texts, reading comprehension, scaffolding, 5E strategy, interest, achievement.

Introduction

Modern science has for decades provided cures and vaccines for diseases that were once elusive. The advancements in science have further widened the gap between developed and underdeveloped countries of the world. As a result, for a country to be considered developed, it must maintain a recognizable development in science and technology. As a nation that is striving to be strong and self-reliant (as enshrined in the National Policy on Education, 2022), Nigeria must make significant strides in in this direction.

In Nigeria, scientific advancement is a product of different indices; at the most basic and foundational level are interest and academic achievement of students in science subjects, especially at the senior secondary school level. Researchers (Obodo, 2025; Tolli & Kallery, 2021; Pohan, Maulina, Hassana, & Hardianti, 2018) established that interest is a notable index that determines the academic achievement of students in science. Schweder and Raulfelder (2022) define interest as a powerful motivational process that energizes learning by guiding academic and career trajectories. Due to its centrality in learning, students' learning of science content has often been link to their interest in reading science-based texts. Interest in reading science-based texts is therefore a core variable that is often considered when addressing students' abysmal achievement in science.

Reading is a vital language skill. As a receptive skill, reading is at the centre of every human learning. Raza (2019) defines reading as a skill that involves a number of related complex and interactive processes that helps an individual to decode written symbols in order to arrive at meaning. The search for meaning is therefore the onus of every effective reading and for the reader to arrive at the author's intended meaning, a variety of skills are deployed, depending on the nature of the text.

In furtherance of the foregoing, due to the practical basis of science and the abstract vocabularies that are often associated with the teaching of science subjects in Nigeria, science-texts have been known to debilitate students' interest and academic achievement. This fact is even more applicable to low-achieving students who often score below the pass mark of 50 in Chemistry, Biology and Physics.

Science-texts within the purview of this investigation are texts in Chemistry, Physics and Biology. Students have over the years demonstrated unsatisfactory interest in the reading of texts in these subjects, a development that has negatively affected academic achievement in the contents (Johnson & Zabucky, 2011). To put this problem in perspective, reports from Chief Examiners of WAEC for 2021, 2022 and 2023 indicated that more than 50% of students failed to attain minimum credit pass in Chemistry. Reports from Chief Examiners also indicated that students performed below par in Biology and Physics.

The abysmal interest and academic achievement of students in reading of science-based texts have often been associated with teachers' use of ineffective strategies to teach reading comprehension (Chiemezie, Ozohu, Miracle & Obashi, 2023). and also, in most cases, their refusal to teach students how to comprehend science-based texts. To ameliorate this problem, researchers have developed cogent teaching strategies like 5E and scaffolding. This study examined the comparative effectiveness of these strategies in improving students' interest and achievement in reading of science-based texts.

5E strategy is one of the strategies that have been known to improve students' interest and achievement in reading comprehension. The strategy was developed by Roger Bybee in 1987 first to teach biological science, but has since been applied to other fields. The major tenet of the strategy is to help students understand concepts through a series of established steps (Lesly

University, 2024). The strategy was aptly named 5E because of the presence of the letter “E” in each word that makes up the acronym. 5E therefore stands for Engagement, Exploration, Explanation, Elaboration and Evaluation. The first stage the learner goes through when constructing meaning from the reading text is the engagement stage. Similar to teaching, when reading, the reader is expected to tap into his or her background knowledge in order to generate the needed link between the information in the text and his previous experience (whether direct or vicarious). The stage, if properly maximised, gives students the motivation to read and comprehend text with little or no difficulties.

The exploration phase builds on the progress made at the engagement phase. At this phase, students are encouraged to interact with the content either through hands-on or minds-on activities (Duran & Duran, 2004). The exploration stage is the opportunity for the student to not only explore the content but to also tap into their metacognition in order to discover aspects of the content that are difficult to comprehend (Tanner, 2010). This phase is the first in-depth encounter the learner has with the content. As such, the phase also enables the students to commence an individual or group investigation into the content (Science, Technology and Engineering and Mathematics Literacy, 2015). Similarly, the activities of the learner at the exploration phase helps the teacher make certain clarification at the explanation stage. As a result, during the explanation stage, the teacher helps learners to track their correct or incorrect knowledge of the content (Okafor, 2019). The teacher also encourages students to ask questions about aspects of the content in order to get further clarifications. The need to build on any progress made at the explanation phase necessitates the elaboration phase.

The elaborative phase is the final instructive phase of the 5E model. The phase extends the conceptual understanding of the students (Opara, Akudo & Agbarakwe, 2022). The elaboration phase consolidates on the gains of the explanation phase. At this stage, students are presented with the opportunity to develop greater and deeper comprehension of the content.

Like any other process in teaching and learning, evaluation is the final phase of the 5E strategy. Generally, evaluation is a systematic process of collecting, analysing, and interpreting information to determine the extent to which students are achieving instructional objectives (Chigeru, 2020). Evaluation provides answers that help students and teachers to determine the success or otherwise of instruction (Asuru, 2015). At the evaluation stage of the 5E model, the teacher seeks to find out the success of the previous phases in order to pass value judgement. Bybee (2014) explains that at the evaluation phase, the teacher should engage the students in activities that are in tandem with the other phases of the strategy.

Like the 5E strategy, researchers have often attested to the effectiveness of scaffolding. Scaffolding strategy emphasizes the role of teachers and others in supporting the learner development and providing support structures to get to that next stage or level. According to Azih and Nwosu (2011), scaffolding Instructional scaffolding is a teaching strategy that emphasizes the teaching of new skills by engaging students collaboratively in tasks that would be too difficult for them to complete on their own. Pennstate Extension (2026) adds that scaffolding is a technique (or tool) that provides support for thinking and learning, typically accomplished through a combination of social interactions and language. Scaffolding practices provide the opportunity for children to reach higher-level skills by building on and extending their existing skills.

Studies (Anyanwunmelu & Okigbo, 2022; Sotáková & Ganajová, 2023) have over the years compared the efficacy of 5E and scaffolding in improving students’ interest and academic achievement. Ayiera, Owaa and Mwebi (2024) found that both strategies (5E and scaffolding) both have equal effects on students’ interest. Similarly, Anyanwumelu and Okigbo (2022) found that

students' interest improved significantly when taught with scaffolding strategy. The comparative gains of 5E and retention have also been reflected in students' academic achievement.

Findings by Baliwan (2023) showed that there is no significant difference in the achievement of students taught Physics using 5E and scaffolding strategies. This implies that both strategies have equal levels of effectiveness. Similarly, Tumasi (2021) found that while 5E and scaffolding significantly improved the academic achievement of students, the differences in the effects were not significant when compared with each other. The results of these findings prompted the researcher to investigate if when used to teach reading, 5E and scaffolding strategies could ameliorate the abysmal interest and academic achievement of SS I students as evidenced in their unsatisfactory grades in Chemistry, Physics and Biology.

Purpose of the Study

The purpose of this study was to investigate if 5E and scaffolding strategies could improve students' interest and achievement in science-based texts in Benue State. The study specifically sought to:

1. Determine the effect of 5E and scaffolding strategies on low-achieving students' interest in reading science-based texts.
2. Find out the effect of 5E and scaffolding strategies on low-achieving students' academic achievement in science contents.

Research Questions

The following research questions guided the study:

1. What is the difference in the mean interest ratings of low-achieving students taught reading comprehension of science-based texts using 5E strategy and scaffolding strategies?
2. What is the difference in the mean achievement scores of low-achieving senior secondary one students taught reading taught reading comprehension of science-based texts using 5E and scaffolding strategies?

Hypotheses

The following hypotheses were tested at 0.05 level of significance:

1. There is no significant difference in the mean interest ratings of low-achieving senior secondary one student taught reading comprehension of science-based texts using 5E and scaffolding strategies.
2. There is no significant difference in the mean achievement scores of low-achieving senior secondary one student taught reading comprehension of science-based texts using 5E and scaffolding strategies

Methods

The study adopted the quasi-experimental design, specifically the pre-test-post-test non-equivalent groups design. Quasi-experimental is a research design that establishes a cause-and-effect relationship between the dependent and independent variables (Isnawan, 2022; Thomas, 2020). The design was selected because it was not possible for the researcher to have complete randomization of subjects as this may disrupt the organization of the formal school. Pretest was administered to the experimental groups (in the two schools selected for the study) in the first week. The scripts were retrieved and marked. Treatment began in the second week and ended in the seventh week. The treatment took place once a week and lasted for 80 minutes. The post-test was administered in the eighth week. The two groups were separately exposed to scaffolding and 5E strategy.

The area of the study was Benue State, specifically Otukpo Local Government. 5730 (2937 males and 2793 females) senior secondary school students in the 28 secondary schools in Otukpo, Benue State (Teaching Service Board, 2026) constituted the population. The sample size of the study comprised 44 low-achievers from two intact classes in two secondary schools. The study utilized the multi-stage procedure, precisely the alternating of simple random sampling and purpose sampling techniques. At the first stage, the researcher employed purposive sampling technique. The technique enabled the researcher to purposively pick two schools from Otukpo Local Government Area in line with two criteria. One, schools that have separate arms for science students at SS1. Secondly, schools that are coeducational (combines boys and girls).

At the second stage, the researcher used the simple random sampling technique, specifically the hat and draw method to arrive at schools that were taught with 5E and scaffolding strategies respectively. To actualize this, the researcher writes the two strategies on a separate piece of paper, Squeezes and drops them in a hat. The hat also contains four more squeezed but blank pieces of paper which serves as distractors. The two research assistants were then asked to pick a piece of paper without replacement. A research assistant that picks a blank piece of paper was asked to pick again until he or she picks a strategy (either 5E or scaffolding).

At the third stage, the researcher used the purposive sampling technique to select the arms of senior secondary one with the highest number of low-achieving science students (for schools with two or more science classes at SS1). Low-achieving students as used here refers to students who score below 50 in Chemistry, Physics and Biology. To this end, students' dossiers and score sheets were scrutinized to select the class with the highest number of low-achievers in Chemistry, Physics and Biology. In addition, at the fourth stage, the researcher purposively selected individual constituents of the by further considering their Chemistry, Physics and Biology score sheets. Students who scored less than 50 were considered low-achieving and therefore selected.

The instrument for the study were Interest in Reading Science-based Texts Questionnaire (IRSTQ) and Science Reading Achievement Test (SRAT). Interest in Reading Science-based Texts Questionnaire (IRSTQ) 30 has items. The instrument had two sections. Section A elicited responses on students' bio-data (gender) while section B contained items on students' interest in reading science-based texts. The scoring of the instrument was done in line with an adapted Likert Scale of Strongly Agree (4), Agree (3), Disagree (2) and Strongly Disagree (1) for positively skewed items. This was reversed for items were negatively skewed. On the other hand, Science Reading Achievement Test (SRAT) was a 33-items test designed by the researcher. The test had two sections: Section A elicited information on students' gender and school while section B contained the SRAT questions. The items on section B covered Senior Secondary One (SS1) topics in Physics, Chemistry and Biology. The topics were : chemical bonding, diamond (Chemistry) force, Newton's laws of motion (Physics) and cell (Biology).

The instruments were subjected to trial testing by administering them to 20 students in a school outside the ones sampled for the study. Kuder Richardson Formula 20 (K-R₂₀) was used to ascertain the reliability coefficient of SRAT because the items were dichotomously scored while Cronbach Alpha was used IRSTQ as the items in the instruments were not dichotomously scored. The reliability coefficient of the instruments were 0.96 for SRAT and 0.83 for IRSTQ.

Two English teachers in the sampled schools served as research assistants. The research assistants were trained on how to use 5E and scaffolding strategies in teaching students how to read and comprehend science-based texts. Although the entire intact class of senior secondary one student benefited from the treatment, only the scores of low-achieving students were used for the study. Low achieving students, in line with the study, were students who fail to score 50 marks

and above in Chemistry, Physics and Biology. The researcher identified these students by scrutinizing their score sheets and dossiers in these content areas. The data collected from the study were analysed using mean and standard deviation to answer the research questions and Analysis of Covariance (ANCOVA) to test the null hypotheses at 0.05 level of significance.

Results

Research Question 1: What is the difference in the mean interest ratings of low-achieving senior secondary one students’ comprehension of science-based texts using 5E strategy and those taught using scaffolding strategy?

Table 1: Mean Interest Ratings of Students taught reading comprehension of Science-Based Texts using 5E and Scaffolding strategies

Strategy		Pre-test	Post-test	Mean gain
5E Strategy	Mean	9.10	24.00	14.90
	N	22	22	
	Std. Deviation	2.81	4.99	
Scaffolding	Mean	11.01	23.73	12.72
	N	22	22	
	Std. Deviation	2.51	3.35	
Mean difference				2.18

Table 1 shows the mean interest ratings of low achieving students taught reading comprehension using 5E and scaffolding strategies. The table shows that 22 low achieving students were taught using 5E strategy while 22 students were taught using scaffolding strategy. The table also shows that the mean interest ratings of students taught using 5E strategy is 9.10 with a standard deviation of 2.81 at pre-test and 24.00 with a standard deviation of 4.99 at post-test. On the other hand, the mean interest ratings of students taught using scaffolding is 11.01 with a standard deviation of 2.51 at pre-test and 23.73 with a standard deviation of 3.35 at post-test.

Table 1 further show that the mean gain in interest ratings of low achieving students taught reading comprehension using 5E strategy is 14.90 while that of students using scaffolding is 12.72. The difference in the mean interest ratings of students taught using 5E strategy and those taught using scaffolding strategy is therefore 2.18 in favour of scaffolding strategy. This implies that scaffolding strategy increases students’ interest in reading science-based texts more than 5E strategy.

Research Question 2: What is the difference in the mean achievement scores of low-achieving senior secondary one students taught reading comprehension of science-based texts using 5E and scaffolding strategies?

Table 4: Mean Achievement Scores of Students taught reading comprehension of Science-Based Texts using 5E and Scaffolding strategies

Strategy		Pre-test	Post-test	Mean gain
5E Strategy	Mean	10.11	27.00	22..51
	N	22	22	
	Std. Deviation	2.91	4.49	
Scaffolding Strategy	Mean	13.04	30.10	17.06
	N	22	22	
	Std. Deviation	3.41	7.68	
Mean difference				5.45

Table 2 shows the mean achievement scores of low achieving students taught reading comprehension using 5E and scaffolding strategies. The table shows that 22 low achieving students were taught using 5E strategy and 22 students were taught using scaffolding. The table shows that the mean performance scores of students taught using 5E strategy is 10.11 with a standard deviation of 2.91 at pre-test and 27.00 with a standard deviation of 4.49 at posttest. On the other hand, the mean achievement scores of students taught using scaffolding is 13.04 with a standard deviation of 3.41 at pre-test and 30.10 with a standard deviation of 7.68 at post-test. Table 2 further shows that the mean gain in achievement of low achieving students taught reading comprehension using 5E strategy is 22.51, while that of students using scaffolding is 17.06. The difference in the mean achievement scores of students taught using 5E strategy and those taught using scaffolding strategy is 5.45 in favour of 5E strategy. This result means that students taught using 5E strategy performed better than their counterparts taught using scaffolding strategy.

Hypothesis 1: There is no significant difference in the mean interest ratings of low-achieving senior secondary one students' taught reading comprehension of science-based texts using 5E and scaffolding strategies

Table 3: ANCOVA of Interest Ratings of Low achieving Students Taught Reading Comprehension of Science-based Texts Using 5 E and Scaffolding Strategies

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	18.270 ^a	2	9.135	.504	.608	.024
Intercept	594.881	1	594.881	32.830	.000	.445
PRETEST	17.452	1	17.452	.963	.332	.023
GROUP	.113	1	.113	.006	.938	.003
Error	742.911	41	18.120			
Total	25818.000	44				
Corrected Total	761.182	43				

a. R Squared = .024 (Adjusted R Squared = -.024)

Table 3 shows that $F(1,44) = 0.006$; $p = 0.938 > 0.05$. Based on this result, the null hypothesis which states that there is no significant difference in the mean interest ratings of low-achieving senior secondary one student taught reading comprehension of science-based texts using 5E strategy and those taught using scaffolding strategy is not rejected. This implies that there is no significant difference between the interest level of low-achieving senior secondary one student's taught comprehension of science-based texts using 5E and scaffolding strategies. The partial eta square of .003 (3%) obtained for the strategies means that they have small effect size as regards to students' interest after controlling for other effects.

Hypothesis 2: There is no significant difference in the mean achievement scores of low-achieving senior secondary one students taught reading comprehension of science-based texts using 5E model and scaffolding strategy

Table 4: ANCOVA Result of achievement Scores of Low achieving Students' Taught Reading Comprehension of Science –based Texts 5 E and Scaffolding Strategies.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	179.813 ^a	2	89.907	2.391	.105	.109
Intercept	1176.001	1	1176.001	31.271	.000	.445
Pretest	79.137	1	79.137	2.104	.155	.051
GROUP	42.204	1	42.204	1.122	.296	.028
Error	1466.663	38	37.607			
Total	35704.000	44				
Corrected Total	1646.476	42				

Table 4 shows that $F(1,44) = 1.122$; $p = 0,296 > 0.05$. Thus, the null hypothesis which states that there is no significant difference in the mean achievement scores of low-achieving senior secondary one students taught reading comprehension of science-based texts using 5E and scaffolding strategies is not rejected. This implies there is no significant difference between the achievement of low-achieving senior secondary one student taught reading comprehension of science-based texts using 5E model and scaffolding strategy. The partial eta square of .028 (3%) shows that the strategies have small effect size.

Discussion of Findings

The first finding of the study is that there is no significant difference between the interest level of low-achieving senior secondary one student taught reading comprehension of science-based texts using 5E and scaffolding strategies. This means that 5E and scaffolding strategies both significantly improve students' interest in reading science-based texts. This result could be due to the effective operational mechanisms of 5E and scaffolding strategies. For instance, the five stages of the 5E strategy help teachers to engage students by utilizing their background knowledge, encourage them to explore the learning content, guides them to gain vital explanation about the content, elaborate key points and then evaluate the process. These phases of 5E strategy spark students' interest and may have been responsible for the effectiveness of the strategy.

Similarly, scaffolding strategy helps the teacher to make the teaching and learning process learner-oriented. It guides him or her to understand the learning needs of students, provide the necessary support (with the help of their prior knowledge) and gradually withdraw

such support when low-achieving students become independent learners. By considering students' ineptitude, the strategy spurs students' interest in science-based texts. The finding agrees with Ayiera, et al. (2024) who found no significant difference in the interest of students taught Geometry using 5E and scaffolding strategies. The finding however disagrees with Anyanwumelu and Okigbo (2022) who found a significant difference in the interest ratings of students taught with scaffolding and those taught with conventional method. The difference between Anyanwumelu and Okigbo's finding and the present study could be due to contextual differences. In this regard, variations in sociolinguistic settings of the environment could be a major consideration.

The second finding of the study is that there is no significant difference between the achievement of low-achieving senior secondary one student taught reading comprehension of science-based texts using 5E and scaffolding strategies. The result indicated that low achieving students performed better when taught with 5E and scaffolding strategies. It could be inferred from the finding that although there are certain dissimilarities in the tasks students perform while using 5E and scaffolding strategy, there are certain areas of similarities. Firstly, both strategies give students the opportunities to pace their learning. This implies that scaffolding and 5E strategies introduce activities that are designed and deployed to improve students' academic performance. For 5E, the teacher guides students to progress through five phases of Engagement, Exploration, Explanation, Elaboration and Evaluation. In the scaffolding class, the teacher builds on students' background knowledge by introducing tasks that could expose their ineptitudeness. The teacher further provides informed assistance as the learning progresses and withdraw same when it becomes obvious that students could learn independently. Secondly, both the strategies are activity-based. The learner-centred nature of the strategies makes them efficacious in enhancing low-achieving students' performance in science-based texts.

The finding concurs with Baliwan (2023) who found that there was no significant difference in the performance of students taught Physics using 5E and scaffolding strategies. The finding also aligns with Tumasi, et al. (2021) who found that though the strategies significantly improved the academic performance of students, the differences in the effects were not significant when compared with each other.

Conclusion

It is evident from the findings of the study that the interest and academic achievement in science-based texts could be improved with the use of innovative and student -centered strategies like scaffolding and 5E. The comparative effectiveness of the strategies could therefore ameliorate students' abysmal interest and achievement in science contents.

Recommendation

The following recommendations were made based on the findings of this study:

1. English Language teachers should adopt 5E and scaffolding strategies in teaching students how to become proficient in reading science-based texts .
2. Federal and State Ministries of education should make policies that would promote the use of students-centered strategies like 5E and scaffolding strategies in improving students' level of retention.

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