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EFFECT OF SCAFFOLDING STRATEGY ON STUDENTS' ACADEMIC ACHIEVEMENT AND RETENTION OF SCIENCE-BASED TEXTS IN BENUE STATE, NIGERIA

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Abstract

This study investigated the effect of scaffolding strategy on students' academic achievement and retention of science-based texts in Benue State, Nigeria. The design was a quasi-experimental, pretest, posttest non-randomised equivalent group design. Purposive sampling technique was used to sample 44 senior secondary one students in two different schools from a population of 10,980 students in the 307 secondary schools in Benue State. Two research questions and two hypotheses guided the study. The instruments for data collection were Science Reading Achievement Test (SRAT) and Science Reading Retention Test (SRRT). The SRPT was subjected to trial testing and its reliability coefficient was analysed using Kuder-Richardson Formula 20 (K-R 20). This yielded a coefficient of 0.96. The

research questions were answered using mean and standard deviation and the hypotheses were tested at 0.05 significance level using Analysis of Covariance (ANCOVA). It was found that there is no significant difference in the achievement and retention scores of male and senior secondary one students taught reading comprehension of science-based texts using scaffolding strategy. It was recommended that teachers should ensure that both male and female students benefit equally when they use scaffolding strategy and that no gender should be given undue advantage, since the strategy improved the academic achievement and retention of both male and female students.

Key Words: Science-based texts, Retention ability, Reading Comprehension, Gender

Introduction

The development of any nation in the world is tied to its educational system. As a result, key objectives of education in Nigeria are to promote human capital development, an egalitarian society and advancement in science and technology (Federal Republic of Nigeria, 2014). To ensure that these lofty objectives are attained, the educational services to be delivered optimally. The World Bank Group (2020) identifies teaching strategy as a major indicator of education service delivery. It is therefore expected that specific attention be given to how teachers help students to read, comprehend and retain science-based texts, as no nation in the world can develop without science. Science is an index that gradually develops as pupils proceed from primary to secondary level of education. At the secondary school, science students are expected to read, comprehend, retain and pass core science subjects like Chemistry, Physics and Biology as stipulated in the National Policy on Education (FRN, 2014). Despite obvious advantages of these subjects to the development of science at the secondary school level, academic achievement of students in the subjects has been a source of concern for major stakeholders in education.

Reports from Chief Examiners of WAEC for 2021, 2022 and 2023 indicated that in 2021,

out of the 801,522 students that sat for Chemistry, a raw mean of 27.0 and a standard deviation of 6.93 indicated that students achieved poorly in the subject. The trend of poor achievement continued in 2022 which recorded a raw mean score of 28.0 over 50 and a standard deviation of 9.38. Like Chemistry, students' performance in Physics and Biology have also not been impressive. A 2023 report by WAEC Chief Examiner showed that students performed poorly in Physics as the raw mean was 29.0 out of 50. Similarly, in Biology, the Chief Examiner reports that out of the 1,068,567 that sat for the examination, the raw mean of 30.0 and a standard deviation of 10.91 indicated that students' achievement was not impressive. The Chief Examiners further explained that students' poor comprehension of Biology concepts which translates to their inability to explain these concepts, was one of the weaknesses of students. For students to pass these science-based subjects in internal and external examinations, they must learn how to read, comprehend and retain science-based texts.

Within the purview of the present study, Science-based text refers to books, journals and notes that explain science related contents. This is also referred to as content area texts in the domain of science. Despite the complexities that are commonly associated with science texts, adequate

insight in reading comprehension offers important point for authors to consider when designing texts that could assist students in reading to learn science (Gallagher, Fazio & Ciampa, 2017). Reading comprehension is a mix of both the information in the text and internal processes like background knowledge and metacognition of the reader. Comprehension is an active process that encompasses making predictions, summarising core ideas, questioning predictions and clarifying concepts that seem unclear (Liou, 2021). Reading therefore entails extracting information appropriate to the context of what is being read (Udu, 2021). Based on this view, reading is a meaning-making process that combines background knowledge with information from print in order to improve comprehension and retention. Students' level of achievement in science could therefore be connected not only to comprehension, but also to their ability to properly retain the text. The acquisition of new content therefore depends on the formation of association that is created in the memory (Ogunmodede, Ayinde & Ogunlade, 2021). It is this association that promotes retention and recall of textual information

Retention is closely connected to the reading and comprehension process. Comprehension is an adopted act that only stays for a short

time, mostly during the reading process. Retention on the other hand refers to one's ability to preserve or keep knowledge of learned materials and to remember and reproduce it when required (Musa, Achor & Ellah, 2021). Retention therefore complements the learner's effort during the comprehension process by ensuring that the information is stored for future recall. Windham, Rehfuss, Williams, Pugh & Tincher-Ladner (2014) stressed that for one to have a productive learning experience, the reader should acquire a strong sense of comprehension and retention of texts.

The comprehension and retention of textual information in the domain of science could be enhanced if teachers use effective strategies to teach reading, with focus on content area passages in Chemistry, Physics and Biology. Researchers have over the years evolved effective strategies to improve students' comprehension. Prominent amongst these strategies are: The Think-Pair-Share, Directed Reading and Thinking Activity (DRTA), Project Based learning (PBL), reciprocal teaching, 5E model, scaffolding and many others. These modern teaching strategies were designed to ensure that teaching reading is student-centered as against the conventional approach that treats reading as a product rather than a process of helping students to get meaning from print. The present investigation is on the effect of

scaffolding strategy in helping male and female students comprehend and retain science-based texts.

Scaffolding is a teaching strategy that has been used over the years to simplify instruction. Scaffolding is an instructional strategy the teacher uses to deliver instruction in distinct segments by providing graduated support for students to master new concepts or skills (University of San Diego, 2023). The essence of the scaffolding is to constantly provide a support-based instruction for students as they learn (Boonmoh & Jumpakate, 2019). Scaffolding emanates from the works of Vygotsky (1978). According to Vygotsky in his cognitive development theory, the potential for cognitive development is limited to a Zone of Proximal Development (ZPD). This zone is the area of exploration or learning that is influenced by cognitive preparedness and the help students get from social interaction in order to fully develop. Simply put, the help students get when they interact with pairs and the teacher determine how they develop cognitively.

Scaffolding was also popularised by Bruner (1986.). The scholar gives a clear explanation of the term in education. According to Bruner, the teacher provides scaffolds to ensure that the child's ineptitude is rescued or rectified by appropriate intervention, and then remove the scaffolds'

part by part as the reciprocal structure can stand on its own. This implies that learning activities and content are structured from simple to complex. As a result, as students read, they gradually are able to comprehend complex contents. The teacher achieves this by making the purpose for the reading obvious to the students through asking purpose setting questions and encouraging students to constantly do same as they read.

Scaffolding could be used in the reading class to help students comprehend complex texts. It provides students with scaffolds which are in the form of how to use the content in meaningful contexts. This is what Gonser (2021) refers to as “don't jump in – slow down and set it up” which implies that the first component of scaffolding in reading is ensuring that students stand on a platform that gradually connects their background knowledge to the text. The teacher adds further scaffolds by teaching unfamiliar words in the text. This is necessary because science-based texts contain words that appear to be strange to students. This step is vital because in research that was aptly named “knowledge threshold study” by O'Rilly, Wang and Sabatini (2019), the finding indicated that if students are unfamiliar with 50% of the terms in the text, comprehension may be compromised. The conscious explanation of the meaning of science concepts conveys helps students to

build their vocabulary and become independent in their reading.

While reading comprehension and retention are core indications of literacy, gender is an issue that has been observed to influence the efficacy of any strategy. Gender is a factor that has often been considered by researchers when addressing issues surrounding academic performance and knowledge retention. Despite the fluid use of the word in the 21st century, gender refers to the socially constructed roles, behaviours, expressions and identities of girls, women, boys and men (Canadian Institute of Health Research, 2023). These roles and behaviour may pertain to dissimilarities in the ability of one sex to perform a task better than the other sex. John Hopkins University (2020) adds that gender is the economic, social and political attributes that are associated with being a male or a female. This implies that there are only two genders, male and female.

Being a male or female has been observed to influence the academic opportunities of individuals, especially in a developing country like Nigeria. In some parts of the country (mostly in the highly populated rural settlements), it has been observed that females are forced into early marriage with little or no exposure to formal education. On the other hand, the male gender is often allowed to seek formal education. However, in recent times, due to the impacts of

campaigns from the Nigerian government, coupled with constant sensitisation of parents by non-governmental organisations, this practice is almost antiquated in most parts of the country, though it has been documented in findings that the practice of tagging female as weaker sex and associating them with the arts and humanities is still pronounced (Saad, 2017).

Gender has continued to play crucial roles in the field of education. This understanding is usually based on the belief that male and female humans possess varying cognitive, emotional and psychomotor potentials. As a result, studies (Rodriguez, Requiro, Peneiro, Estivez & Valle, 2019; Ekineh & Adolphus, 2019) have attributed the ability of students to be proficient in a skill to gender differences. These scholars have different opinions regarding the gender that performs better in one field and the other. In this light, Lin (2015) found that female students perform less in science when compared with their male counterparts. A contrary finding revealed that girls outperform boys in science in 21 countries (OECD, 2011).

Gender differences in students' achievement could also be found in reading comprehension abilities and the efficacy or otherwise of scaffolding strategy. Abumchukwu and Okeke (2020) who carried out a study on effects of cues and prompts instructional scaffolding on

academic achievement of secondary school students in Chemistry in Ogidi Education Zone of Anambra State and found that gender was not a significant factor in the mean achievement scores of students when taught with scaffolding strategy. Abiodun and Fabiyi (2021) also found that that male student significantly outachieved the females and as a result, there was significant difference in the academic performance of male and female students when with scaffolding strategy.

Like achievement, studies have also presented the effect of scaffolding on retention abilities of male and female students. In this light, Chinelo and Onukwube (2024) who investigated the effect of scaffolding instructional strategy (SIS) on secondary school students' achievement and retention ability in Mathematics in Otuocha Education Zone of Anambra State, Nigeria found that the strategy helped male students to outperform their female counterpart. On the other hand, Chinedu, Abugu and Okeke (2020) who carried out an investigation on the effect of Scaffolding Instructional techniques (SIT) on academic achievement among junior secondary school (JSS) Mathematics students in Obollo-Afor Education Zone of Enugu State found that there was no significant difference in the mean achievement scores of male and female

students in Mathematics as result of Scaffolding Instructional Techniques (SIT). The need to ensure that students perform optimally in science subjects is crucial. This is only possible when teachers utilise productive strategies that help students across genders to comprehend and retain science-based texts with little or no difficulties. The present study presents the efficacy level of scaffolding strategy in the context of gender.

Statement of the Problem

Science texts have been observed to present special difficulties for Nigerian students, despite the relevance of science in the development of any nation of the world. The facts presented in these texts are characterised by lexical density and the use of unfamiliar words. These challenges may negatively influence the academic achievement and retention ability of students in core science subjects like Physics, Chemistry and Biology. This worry is evidently reflected in the low academic achievement of students in these subjects as espoused by chief examiners of external examination bodies like WAEC and the National Examination Council. A key cause of this problem, as observed by scholars, is the use of inappropriate teaching strategy in teaching reading. The use of appropriate strategy in the teaching of reading comprehension is vital in every educational

institution. Due to the importance of science, it is also vital for the teacher to ensure that he or she uses effective strategies to improve students' achievement and retention of science texts. There is therefore need to take conscious steps towards addressing these problems. This is particularly owing to the fact that science is seen as a requisite content that should be promoted at all levels of education (Samilsha, 2023). The study therefore investigated effects of scaffolding strategy on students' academic achievement and retention of science-based texts in Benue State, Nigeria.

Purpose of the study

The purpose of this study was to investigate the effect of scaffolding strategy on students' academic achievement and retention of science-based texts in Benue State, Nigeria. Specifically, the study sought to:

1. Find out the difference in the achievement scores of male and female senior secondary students taught reading comprehension of science-based texts using scaffolding strategy
2. Ascertain the difference in the retention scores of male and female senior secondary students taught reading comprehension of science-

based texts using scaffolding strategy

Research Questions

The following research questions guided the study.

1. What is the difference in the mean achievement scores of male and female senior secondary students taught reading comprehension of science-based-texts using scaffolding strategy?
2. What is the difference in the mean retention scores of male and female senior secondary students taught reading comprehension of science-based-texts using scaffolding strategy?

Hypotheses

The following hypotheses were formylated and were tested at 0.05 level of significance

1. There is no significant difference in the mean achievement scores of male and female senior secondary students taught reading comprehension of science-based texts using scaffolding strategy.
2. There is no significant difference in the mean retention scores of male and female senior secondary students taught reading comprehension of science-based texts using scaffolding strategy.

Methodology

The study adopted the quasi-experimental design. Specifically, the study adopted 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 is not possible for the researcher to have complete randomization of subjects, as this may disrupt the organisation 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, while the post-posttest was administered two weeks after the post-test to ascertain the retention level of the students. The Experimental group was exposed to scaffolding strategy while the control group was not given any intervention

The population comprised all the 10,980 secondary school students in Benue State (Teaching Service Board, 2024). Two intact classes of 53 students (31 boys and 22 girls) drawn from two secondary schools in Otukpo Local Government Area of Benue State were purposively sampled. The

instrument for the study were Science Reading Achievement Test (SRAT) and the Science Reading Retention Test (SRRT). Science Reading Achievement Test (SRAT) had two sections. Section A elicited information on students' Bio-data while section B contains SRAT questions. The items on section B covered Senior Secondary One (SS1) topic in Physics, Chemistry and Biology. The test specifically covered the topics: chemical bonding, diamond (Chemistry) force, Newton's laws of motion (Physics) and cell (Biology).

The Science Reading Retention Test (SRRT) had the same items as the SRAT. However, the items were reshuffled and administered two weeks after administering the SRPT. The reason for administering SRRT two weeks after the SRAT was to verify if students can recall the content after a while. The Science Reading Achievement Test (SRAT) was 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. This yielded a coefficient of 0.96.

Two English teachers in the sampled schools served as research assistants. The research assistants were trained on how to use scaffolding strategies in teaching students how to read and comprehend science-based texts. The assistants administered the pre-test, post-test and the post-post-test

(retention test). The data collected 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 One: What is the difference in the mean achievement scores of male and female senior secondary students taught reading comprehension of science-based-texts using scaffolding strategy?

Table 1: Mean Achievement Scores of Male and Female Students Taught Reading Comprehension of Science- Based Texts Using Scaffolding Strategy

Strategies		Pre-SRAT	Post-SRAT	Mean gain
Male	Mean	14.05	29.83	15.78
	N	12	12	
	Std. Deviation	3.44	8.91	
Female	Mean	13.01	31.30	18.25
	N	10	22	
	Std. Deviation	3.41	7.10	
Mean difference				2.47

Table 1 shows the mean achievement scores of male and female students taught reading comprehension using scaffolding strategy. From the table, 12 male students and 10 females were taught using scaffolding strategy. The table also shows that the mean performance score of male students is 14.05 with a standard deviation of 3.44 at pre-test and 29.83 with a standard deviation of 8.91 at posttest. On the other hand, the mean achievement scores of female students is

13.01 with a standard deviation of 3.41 at pre-test and 31.30 with a standard deviation of 7.10 at post-test. Table 1 further shows that the mean gain in achievement of male students is 15.78 while that of female student is 18.25. The difference in the means is 2.47 in favour of female students. This implies that female students perform better than their male counterparts when taught using scaffolding strategy.

Research Question Two: What is the difference in the mean retention scores of male and female senior secondary students taught reading comprehension of science-based-texts using scaffolding strategy?

Table 2: Mean Retention Scores of Male and Female Students Taught Reading Comprehension of Science- Based Texts Using Scaffolding Strategy

Strategies		Pre-SRPT	Post-Post SRPT	Mean gain
Male	Mean	14.05	25.58	11.53
	N	12	12	
	Std. Deviation	3.44	5.71	
Female	Mean	13.01	28.80	15.79
	N	10	10	
	Std. Deviation	3.41	5.32	
Mean difference				4.26

Table 2 shows the mean retention scores of low achieving male and female students taught reading comprehension using scaffolding strategy. From the table, 12 low achieving male students and 10 females were taught using scaffolding strategy. The table also shows that the mean retention score of male students is 14.05 with a standard deviation of 3.44 at pre-test and 25.58 with a standard deviation of 5.71 at post-post-test. On the other hand, the mean retention scores

of female students is 13.01 with a standard deviation of 3.41 at pre-test and 28.80 with a standard deviation of 5.32 at post-post-test. Table 2 further shows that the mean gain in retention ability of low achieving male students is 11.53 while that of female student is 15.79. The difference in the means is 4.26 in favour of female students. This means that female students retain better than male students when taught using scaffolding strategy.

Hypothesis One: There is no significant difference in the mean achievement scores of male and female senior secondary students taught reading comprehension of science-based texts using scaffolding strategy.

Table 3: ANCOVA on Achievement Scores of Male and Female Student’s Taught Reading Comprehension of Science–based Texts Using Scaffolding Strategy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	812.750 ^a	2	406.375	15.297	.000	.617
Intercept	63.297	1	63.297	2.383	.139	.111
Pretest	801.017	1	801.017	30.152	.000	.613
Group	2.151	1	2.151	.081	.779	.004
Error	504.750	19	26.566			
Total	21783.000	22				
Corrected Total	1317.500	21				

Table 3 shows that $F(1,22) = 0.81$; $p = 0.779 > 0.05$. Based on this result, the null hypothesis which states 4. There is no significant difference in the mean achievement scores of male and female senior secondary students taught reading comprehension of science-based texts using scaffolding strategy is not rejected. This implies that there is no significant difference

in the mean achievement scores of male and female senior secondary students taught reading comprehension of science-based texts using scaffolding strategy. The partial eta square of .004 (0.4%) obtained for scaffolding strategy means that the strategy has small effect size as regards to gender after controlling for other effects.

Hypothesis Two: There is no significant difference in the mean retention scores of male and female senior secondary students taught reading comprehension of science-based texts using scaffolding strategy

Table 4: ANCOVA of Retention Ratings of Male and Female Students Taught Reading Comprehension of Science–based Texts Using Scaffolding Strategy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	377.551 ^a	2	188.775	12.225	.000	.563
Intercept	199.058	1	199.058	12.890	.002	.404
Pretest	321.113	1	321.113	20.794	.000	.523
Group	39.183	1	39.183	2.537	.128	.118
Error	293.404	19	15.442			
Total	16763.000	22				
Corrected Total	670.955	21				

Table 4 shows that $F(1,22) = 2.537$; $p = 0.128 > 0.05$. Based on this result, the null hypothesis which states that there is no significant difference in the mean retention scores of male and female senior secondary students taught reading comprehension of science-based texts using scaffolding is not rejected. This implies that there is no

Discussion of Findings

The first finding of the study is that there is no significant difference in the mean achievement scores of male and female low-achieving senior secondary one student taught reading comprehension of science-based texts using scaffolding strategy. This result attests to the relevance of scaffolding strategy in improving the academic performance of male and female students. The finding also means that though scaffolding strategy improved the achievement of male and female students, the differences between the scores of the two genders is not significant. The finding could be due to the propensity of scaffolding strategy to build the confidence of students while helping them to become independent in their learning. This finding concurs with Abumchukwu and Okeke (2020) who carried out a study on effects of cues and prompts instructional scaffolding on academic achievement of secondary school

students in Chemistry in in Ogidi Education Zone of Anambra State and found that gender was not a significant factor in the mean achievement scores of students. This implies that the researchers found no significant difference in the academic performance of male and female students when taught Chemistry using scaffolding strategy. The study however disagrees with the finding by Abiodun and Fabiyi (2021) who examined the effect of scaffolding instructional strategy on senior secondary school students' performance in Mathematics in Ekiti State and found that those male students significantly outperformed the females and as a result, there was significant difference in the academic achievement of male and female students.

The study also found that there is no significant difference in the mean retention scores of male and female low-achieving senior secondary one student taught reading

comprehension of science-based texts using scaffolding strategy. The finding is due to the positive effect of the scaffolding strategy in improving the retention ability of male and female students. It could also be deduced that while the strategy separately improved the retention abilities of both male and female students, there exist no significant difference in the means of both genders. This finding disagrees with Chinelo and Onukwube (2024) who investigated the effect of scaffolding instructional strategy (SIS) on secondary school students' achievement and retention ability in Mathematics in Otuocha Education Zone of Anambra State, Nigeria and found that the strategy helped male students to outperform their female counterpart. The finding however agrees with Chinedu, Abugu and Okeke (2020) who carried out an investigation on the effect of Scaffolding Instructional techniques (SIT) on academic achievement among junior secondary school (JSS) Mathematics students in Obollo-Afor Education Zone of Enugu State and found that there was no significant difference in the mean achievement score of male and female students in Mathematics as result of Scaffolding Instructional Techniques (SIT).

Conclusion

It is evident from the findings of the study that the academic performance and retention ability of students in science-

based texts could be improved with the use of innovative and student-centred strategy like scaffolding. Based on the findings, the strategies could particularly improve the academic achievement and retention ability students in science-based texts across genders.

Recommendations

1. Teachers should ensure that both male and female students benefit equally when they use scaffolding strategy. No gender should be given undue advantage since the strategy improved the academic achievements of both male and female students.
2. Based on its positive effect on the retention ability of students, head teachers should ensure that teachers use scaffolding strategy to improve the retention abilities of both male and female students, especially in the reading and comprehension of science-based texts.

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