

Improving Science Students' Academic Achievement Using Science Learning Techniques on Nitrogen Cycle in Secondary Schools in Esit Eket Local Government Area

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Abstract

This study examined on improving science students' academic achievement using science learning techniques on Nitrogen cycle in secondary schools in Esit Eket Local Government Area. Pretest posttest non-randomized quasi-experimental design was used for the study. Three research questions and three null hypotheses guided the study. A sample size of 180 students was used for the study. Three intact classes were randomly selected and assigned to experimental groups. Instrument used for data collection was Science Achievement Test (SAT) on Nitrogen cycle with reliability index of 0.83 using K-R20 formula. The data collected were analyzed using mean and standard deviation to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance. Findings of the study showed that there is a significant difference between the academic achievement of students taught using science learning techniques (linking vocabulary to imagery, imagery and vocabulary techniques). Findings also indicated that there is no statistically significant difference between the mean achievement scores of male and female students taught Nitrogen cycle using linking vocabulary to imagery science learning techniques. Findings also showed no interaction effect of science learning techniques and gender on students academic achievement taught Nitrogen cycle. From the findings, it was recommended that science learning techniques be utilized during science teaching and learning to help improve Biology students' academic achievement.

Keywords: Academic achievement, Gender and Science learning techniques

Introduction

The teaching of science involves the use of activity-oriented techniques where the students are given opportunity to gather facts on the current scientific knowledge. Students display intellectual abilities that characterize the practice of contemporary science. They develop rich knowledge in scientific inquiry and propose ways of explaining natural phenomena (Buskovitz, *et al.*, 2023). Boris, *et al.* (2021) stated that science teaching and learning techniques should be such that changes the nature of learning from teacher-centered to student-centered for the students to be able to increase their interests and motivations on science learning as a body of knowledge. Science teaching and learning ensure that students understand scientific concepts taught. Students need to understand basic concepts of and this cannot be achieved using verbal instructional packages only

because students should be able to see the images or pictures that represent the concept taught so as to be able to bring it to life experiences. This demands that suitable science learning techniques be utilized for effective instruction delivery to improve students' academic achievement (Best and Kahn, 2019). The different science learning techniques that could be used to improve students' academic achievement are basically the visual science learning techniques which include: vocabulary, imagery and linking vocabulary to imagery techniques

Vocabulary technique is a science learning technique that involves the use of texts and audio-recording to simplify complex terminologies embedded in science learning. Brown and Ryoo (2019) described vocabulary technique as instruction of new terminologies in ways that have ideal meaning to the

students and effectively communicate concepts through consistency. Hattie (2019) indicated the major elements of vocabulary technique in the teaching and learning of science to include: presenting individual terms and their description in rich context; relating the terms with words students had already known and providing multiple exposures to new terms and opportunities for use in the classroom.

A six-steps process of using vocabulary technique in science teaching and learning was developed by Marzano (2021). They are: providing a description, giving explanation and examples of terms on flaws. Reliance on flaw or dictionary definition is a tangible part science; asking the students to utilize terms in their own words; ask students to construct their ideas by finding out the appropriate meaning of words and terms; ask students to construct scientific phenomenon in context and make predictions. Zhu (2020) indicated that vocabulary technique helps students have ideas on the conceptual framework and understanding; engage students to periodically participate in lesson by adding experience to words; encourage the students to frequently use and speak the terms and words. This is done by discussing the scientific terminologies using well-structured discussions. Through these discussions, students are guided into the fundamental practice of the words used in sciences as the students participate in activities that allow them play with the terms. Different researchers have carried out empirical study on the effects of vocabulary technique on students' academic achievement. Some of which are:

Venida (2025) investigated on effect of integration of explicit vocabulary instructional technique in teaching science and found out that students taught using integration of explicit vocabulary instructional technique performed better than those taught without using vocabulary instructional technique. Vanuitert, *et al.* (2020) conducted a study on enhancing science vocabulary knowledge of students using explicit instruction and multimedia. The design adopted for the study was a counter-balanced design. The population comprised 41,000 sixth grade students in 12 high schools in Virginia, Texas. 550 sixth grade students were sampled and used for the study. The instrument for data collection was Students' Vocabulary Assessment. Results from the study demonstrated positive science vocabulary assessment outcomes when the students had access to multimedia videos. A study by Ricafrente (2019) examined the

power of vocabulary technique on science vocabulary/words in improving the academic performance of Grade ix Pupils. Descriptive method was used as the research design. A total population of 2835 pupils formed the population of the study. A sample of 44 pupils form the sample size. Weighted mean was computed to determine the distribution of the respondents' vocabulary level. The instrument used for the collection of data was Science Vocabulary Test (SVT). The instrument was an audio recording of science vocabulary for the students to describe the context each word represented. Data were collected and analyzed using descriptive statistics. Findings indicated that vocabulary technique has power in building the science vocabulary for better and indepth understanding. At most instances, students still find it difficult understanding most Biology concepts because they need to see images or pictures that portray those concepts. Thus, the need for this investigation utilization of imagery technique to complement teaching and learning science concepts.

Imagery is a technique that uses figurative language for the description of conceptual and theoretical terms to concretize the abstract concepts in pictorial or diagrammatic forms. Imagery technique stimulates students' senses through touch, taste, sound, smell and sight to impart deeper understanding of science experience using images to coordinate their shared sensory experiences Awon (2020). Rosetta (2023) described imagery as a technique in which pictures are used to display ways in which ideas and images like statues appear in an individual's mind. It is also seen as a stockpile of one's imagination. Malewitz (2019) described imagery as the use of pictures and images to create impression and represent situations. Imagery utilizes images of paintings, printed materials and photographs of objects for discussion and explanation of naturally occurring phenomena. Images are found online but are accessible under copyright exceptions licensed to be reproduced and these types of images are licensed images but they can be reproduced (Keister, 2021). Many past researchers have carried out research on the use of this technique and students' academic achievement. Some of such researches are: Scott, *et al.* (2021) researched on the utilization of imagery to enhance science teaching and knowledge acquisition. Quasi-experimental research design was adopted for the study. The population of the study comprised 11,543 high school students in Scotland. Findings showed that imagery technique promotes

student-centered learning. Aliyu (2019) researched on enhancing imagery: pictures and photographs for effective science teaching and learning in secondary schools. The study adopted pretest post-test control group design. A total of 300 SS2 students were sampled from the population of 1235 students using simple random sampling technique. Findings showed that students exposed to imagery technique had higher performance as compared to those taught without imagery. The effectiveness of imagery technique on students' learning outcomes in Biology was a research work carried out by Kareem (2020). 180 students were randomly selected from three secondary schools and were randomly divided into three groups. A pretest, post-test control group quasi experimental design was employed for the study. Two instruments were used for data collection and these were validated Attitude Towards Biology scale (ATBS) and Biology Achievement Test (BAT) ATBS was tested for reliability using Cronbach Alpha and reliability coefficient of 0.76 was gotten whereas BAT was tested for reliability using Kudar-Richardson 20 which yielded a coefficient of 0.89. the data collected were analyzed using descriptive and inferential statistics. Results indicated a statistically significant difference between students learning outcomes in that students under multimedia aided imagery had better outcomes than the students in the traditional teaching approach. Results indicated that there was no significant difference existing between the academic achievement of males and females studying in colleges of Education in Borno State. Eventhough imagery helps to describe science phenomena but it has been observed that students still find it difficult understanding science concepts because of their inability to interpret the images. This has been the reason the researcher seeks to investigate on this topic.

Linking vocabulary to imagery technique is a combination of the text resources, animations, graphics and videos to produce effective representation of a process or phenomenon (Alsahafi, 2023). Combining vocabulary and imagery techniques makes it possible for students to understand abstract and difficult concepts instead of using either only vocabulary technique or only imagery technique. In teaching science concepts, the images give students deeper insights of how concepts are related to real life situations. Linking vocabulary to imagery uses combination of words with pictures to reflect certain activities in life processes. This provides clarity to

science illustrations for improved academic achievement and retention (Hazamy, 2019). Altherr, *et al.* (2022) posited that utilizing the technique of linking vocabulary to imagery is capable of stimulating students' senses allowing them to interact with other students and instructors thereby making science teaching and learning more attractive and interesting. This also enhances students' motivation, understanding and retention thus, making the lesson more meaningful and authentic but most science instructors use diagrams with labels, this still make the students find some difficulty understanding science concepts. Past researchers have carried out study on incorporating vocabulary and imagery techniques for effective teaching and learning process. Cindy, *et al.* (2020) conducted a study on vocabulary-imagery link and students' academic achievement in science learning. The research design adopted for the study was a true experimental design. The population comprised 3428 students in 15 high schools in Bloomington. The sample size of 120 students randomly selected from the population were for the study. Findings showed that students in the experimental group performed better than students in the control group. Zahedi and Abdi (2022) examined the impact of imagery-vocabulary instruction on science students' vocabulary learning. Pretest posttest quasi experimental design was adopted for the study. Results showed that experimental group who received lesson using imagery-vocabulary instruction outperformed the control group in terms of science vocabulary mastery. In the various research work reviewed, the researcher compared those taught using the technique of linking vocabulary to imagery with those taught using the conventional approach. This creates the gap which need to be filled as the research intends to compare utilizing vocabulary, imagery and linking vocabulary to imagery techniques on science students' academic achievement.

Many science teachers teach science concepts verbally with a few using diagrams to illustrate phenomena for the students to understand scientific concepts. There have been re-occurring decline and mass failures among students in external examinations of WAEC and NECO. WAEC Chief Examiner's reports indicated that students find it difficult to answer questions involving Nitrogen cycle (WAEC Annual Reports, 2010-2024). This continuous decline in students' performance in the sciences is posing serious challenges to students' knowledge outcome and is a thing of concern for Biology teachers, school

administrators, educational stakeholders and researchers and they ask ‘what would have been the cause of this continuous failures in Biology examination?’ Many researchers have attributed this problem to the utilization of ineffective techniques by science teachers to teach the students science concepts. Science teachers hardly apply science learning techniques in the classroom as they have little or no knowledge of the utilization of these techniques. It is on this basis, the study poses the question ‘which science learning technique will help students to effectively master the concepts of Nitrogen cycle?’

Students instructed using any vocabulary-imagery intervention would demonstrate full mastery of the vocabulary than when presented with only words because adding imagery component to vocabulary facilitate vocabulary learning allowing student to remember the vocabulary and words presented to them (Sadoski, 2022). Students are helped to acquire the meaning of those words as well as retain the knowledge gained over time. Vocabulary linked to imagery makes learning more active, fun-filled and effective (Wilson, 2021). The Biology teacher can also use vocabulary technique for students to have deeper understating of terminologies used in the concept taught and learnt.

Nitrogen cycle is a concept in the science curriculum taught and learnt at the senior secondary levels/classes of the secondary schools in Nigeria. Different phenomena take place in nature ranging from microscopic to macroscopic organisms, plants to animals and non-living things are taught and learnt in science. One of the concepts taught and learnt is Nitrogen cycle. Aczel (2019) described Nitrogen cycle as a repeating cycle of processes that enables Nitrogen to move through both living and non-living things. It has five (5) stages are involved in Nitrogen cycle which are: fixation or volatilisation, absorption, ammonification, nitrification and denitrification. The terms embedded in this concept need to be explained for students to have deeper understanding and a clearer view of what happens in reality. When students have a clear view of the concept they are learning, it will help to improve their academic achievement. Gender is still a controversial issue in science classes.

Gender is described as socially constructed roles, behaviors, activities and attributes that differentiate a man and woman. These attributes include norms and relationships that give an individual the personality and description as male or female (World Health Organization, 2021). Raphael (2020) stated that gender

is one of the variables relating with differences in academic achievement. Gender differences in cognitive, intellectual abilities, areas of interest, stereotypical perceptions of students’ behaviors and ability to perform various tasks have significant influence on students’ academic achievement. Klein (2024) indicated that the differences in the scholastic achievements of males and females are generally attributed to biological causes and/or to cultural stereotype.

Differences between students’ gender and academic achievement in colleges of Education in Borno State was carried out by Goni, *et al.* (2019). Experimental research design was adopted for the study. The population included all the NCE students in three colleges of Education in Borno State. The sample size of 322 participants was adopted for the study. The sample was gotten from proportionate sampling technique. The instrument for data collection was Students’ Academic Performance Aptitude Test (SAPAT) which was validated by experts in the science and research field of specialization. A reliability coefficient of 0.62 was obtained using Cronbach Alpha index. T-test was used to test the hypotheses that were raised for the study. Results indicated that there was no significant difference existing between the academic achievement of males and females studying in colleges of Education in Borno State.

A study on influence of gender on students’ academic achievement in public schools in Oredo Local Government Area of Edo State was conducted by Oriakhi and Igbudu (2021). Ex-post facto research design was adopted for the study. The population of 10822 students in 11 public secondary schools in Edo State. Multi-stage sampling technique was used to the students for study. Examination Proforma was the instrument used for data collection. Data collected were analyzed using frequency counts, percentages and proportions. Findings indicated that there is gender difference in academic achievement of students in public secondary schools in Edo State.

From the different empirical studies reviewed above on utilizing vocabulary, imagery, linking vocabulary techniques and science students’ academic achievement, it has shown that past researchers compared each technique with conventional approaches which formed the control groups and this created gaps which this work intends to fill as it compares utilizing vocabulary, imagery, linking vocabulary techniques to improve science students’ academic achievement. Also,

this research has not been carried out on the concept of Nitrogen cycle in secondary schools in Esit Eket Local Government Area which also creates a gap which this work intends to fill.

Research Questions

1. What is the difference between the achievement mean scores of science students taught Nitrogen cycle using science learning techniques (linking vocabulary to imagery, imagery and vocabulary techniques) respectively?
2. What is the difference between the achievement mean scores of male and female science students taught Nitrogen cycle using visual science learning techniques (linking vocabulary to imagery, imagery and vocabulary techniques) respectively?
3. What is the interaction effect of science learning techniques and gender on Biology students' academic achievement on the concept of Nitrogen cycle?

Research Hypotheses

1. There is no significant difference between the achievement mean scores of biology students taught the concept of Nitrogen cycle using science learning techniques (linking vocabulary to imagery, imagery and vocabulary techniques) respectively.
2. No significant difference exists between the achievement mean scores of male and female science students taught Nitrogen cycle using visual science learning techniques (linking vocabulary to imagery, imagery and vocabulary techniques) respectively.
3. There is no significant interaction effect between science learning techniques and gender on Biology students' academic achievement on the concept of Nitrogen cycle.

Research Methodology

The study adopted a pre-test, post-test non-randomized quasi experimental research design. From the population comprising 15,222 SS1 in all the 10 co-educational public secondary schools of the 2024/2025 academic session. A sample size of one hundred and eighty (180) SS1 students was used for the study. Three co-educational public secondary schools were sampled using purposive sampling technique while the arms of the SS1 classes were selected using simple random sampling technique. The schools were divided into three experimental groups. The instrument used for data collection was Science Achievement Test (SAT). The instrument was validated by five experts: two from the Department of Psychological Foundations (test and measurement unit), two from faculty of science (Department of Botany and Department of Animal and Environmental Science) and one from the Department of Science Education. A reliability coefficient of 0.82 was obtained using K-R20 formula by trial testing the instrument on 30 SS1 students using split-half method. The students in the three different secondary schools selected for the study were taught the concept of Nitrogen cycle for four weeks. Those in experimental group one were taught using the technique of linking vocabulary to imagery, those in experimental group two were taught using imagery technique while those in experimental group three were taught using vocabulary technique. At the end of the fourth week, BAT was administered to the students in each group. Data were collated for analysis. Mean and Standard Deviation was used for answering research questions while ANCOVA was used for testing the hypotheses at 0.05 level of significance. The decision to accept or reject the stated null hypotheses was with reference to the p-value. If the calculated p-value for F-ratio was lower than 0.05 alpha level of significance, the hypothesis was rejected but if the calculated p-value for F-ratio was higher than 0.05 alpha level of significance, the hypothesis was retained. Extraneous variables were controlled by measuring the variables used for the study and accounting for them mathematically during data analysis.

Results

Table 1: Mean and Standard Deviation of Students' Pre-test and Post-test Scores Classified by Treatment Groups

Treatment Groups	N	Pre-test		Post-test		Mean Gain Score
		Mean	SD	Mean	SD	
Linking vocabulary to imagery	62	14.90	2.61	42.29	3.34	27.39
Imagery technique	58	15.10	2.61	32.17	3.57	17.07
Vocabulary technique	60	15.23	2.71	25.32	2.55	10.09

Data in table 1 shows the pre-test and post-test mean scores and standard deviation of scores of the three groups of students taught using science learning techniques (linking vocabulary to imagery, imagery and vocabulary techniques). The post-test and pre-test mean scores of 42.29 and 14.90 respectively, for those in linking vocabulary to imagery group yielded the best mean gain score of 27.39. This is followed by the post-test - pre-test mean gain scores of 17.07 and 10.09 for those in imagery technique and vocabulary technique

groups respectively. The post-test standard deviation scores of 3.34, 3.57 and 2.55 for students in linking vocabulary to imagery, imagery technique, vocabulary technique groups indicate that, though students taught using linking vocabulary to imagery had the highest mean achievement scores and the widest scattering of raw scores about the group mean, those taught using vocabulary technique had their raw scores closest to the group mean.

Table 2: Summary of Analysis of Covariance (ANCOVA) of the Students' Post-test Scores Classified by Treatment Groups

Source	Sum of Squares	Df	Mean Square	F	Sig.	Decision at .05 alpha level
Corrected Model	8928.173 ^a	3	2976.058	295.609	.000	S
Intercept	5212.642	1	5212.642	517.767	.000	S
Pretest Scores	20.145	1	20.145	2.001	.159	NS
Science Learning Techniques	8927.987	2	4463.993	443.404	.000	S
Error	1771.889	176	10.068			
Total	211167.000	180				
Corrected Total	10700.061	179				

a. R Squared =.832 (Adjusted R Squared = .834 S = Significant at .05 alpha level, NS= Not significant at 0.05 alpha level

In table 2, the calculated F-ratio for the effect of instructional strategies at df 2, 179 is 443.404, while its corresponding calculated level of significance is 0.000 alpha. This level of significance is less than 0.05 in which the decision is based, indicating that there is a significant difference between the achievement mean scores of Biology students taught Nitrogen cycle using science learning techniques (linking vocabulary to imagery, imagery and linking vocabulary to imagery techniques). With this observation, null hypothesis one was rejected. In order to determine the direction of significance, the scores were subjected to post hoc analysis as shown in Table 3.

Table 3: Scheffe Post Hoc Tests for Posttest Classified By Treatment Groups

SCIENCE LEARNING TECHNIQUES (I)	SCIENCE LEARNING TECHNIQUES (J)	Mean Difference (I-J)	Std. Error	Sig. ^b
Technique of linking vocabulary to imagery	Imagery technique	10.143*	.580	.000 ^S
	Vocabulary technique	17.016*	.575	.000 ^S
Imagery technique	Technique of linking vocabulary to imagery	-10.143*	.580	.000 ^S
	Vocabulary technique	6.872*	.584	.000 ^S
Vocabulary technique	Technique of linking vocabulary to imagery	-17.016*	.575	.000 ^S
	Imagery technique	-6.872*	.584	.000 ^S

S= Significant at .05 level of significance

The Scheffe Post Hoc test presented in Table 3 provides a clear indication of the differences in the achievement mean scores of Biology students exposed to the three science learning techniques. The results show that there is a significant difference between students taught the Nitrogen cycle using the technique of linking vocabulary to imagery and those taught with

the imagery technique, with the former achieving higher mean scores. Similarly, students taught with the linking vocabulary to imagery technique achieved significantly better than those taught using the vocabulary technique. In the same vein, students taught with the imagery technique scored significantly higher than those taught with the vocabulary technique.

Table 4: Mean and Standard Deviation Scores of Male and Female Students' Pretest and Posttest Scores when Taught Using Linking Vocabulary to Imagery, Imagery and Vocabulary Techniques

Groups	Gender	N	Pretest		Posttest		Mean Gain score
			Mean	SD	Mean	SD	
LVI	Males	37	15.08	2.65	42.03	3.66	26.95
	Females	25	14.64	2.58	42.68	2.82	28.04
Imagery	Males	28	15.46	2.74	32.00	3.93	16.54
	Females	30	14.77	2.49	32.33	3.26	17.56
Vocabulary	Males	27	14.43	2.27	29.67	3.19	15.24
	Females	31	14.32	2.25	30.74	3.12	16.42

LVI - Linking Vocabulary to Imagery

Data in Table 4 shows the mean gain scores of 26.95 and 28.04 for male and female students taught Nitrogen cycle using the technique of linking vocabulary to imagery; mean gain scores of 16.54 and 17.56 for those taught using imagery technique and

mean gain scores of 15.24 and 16.42 for male and female students taught using vocabulary technique. It indicated that female students academically achieved better than male students in the three groups.

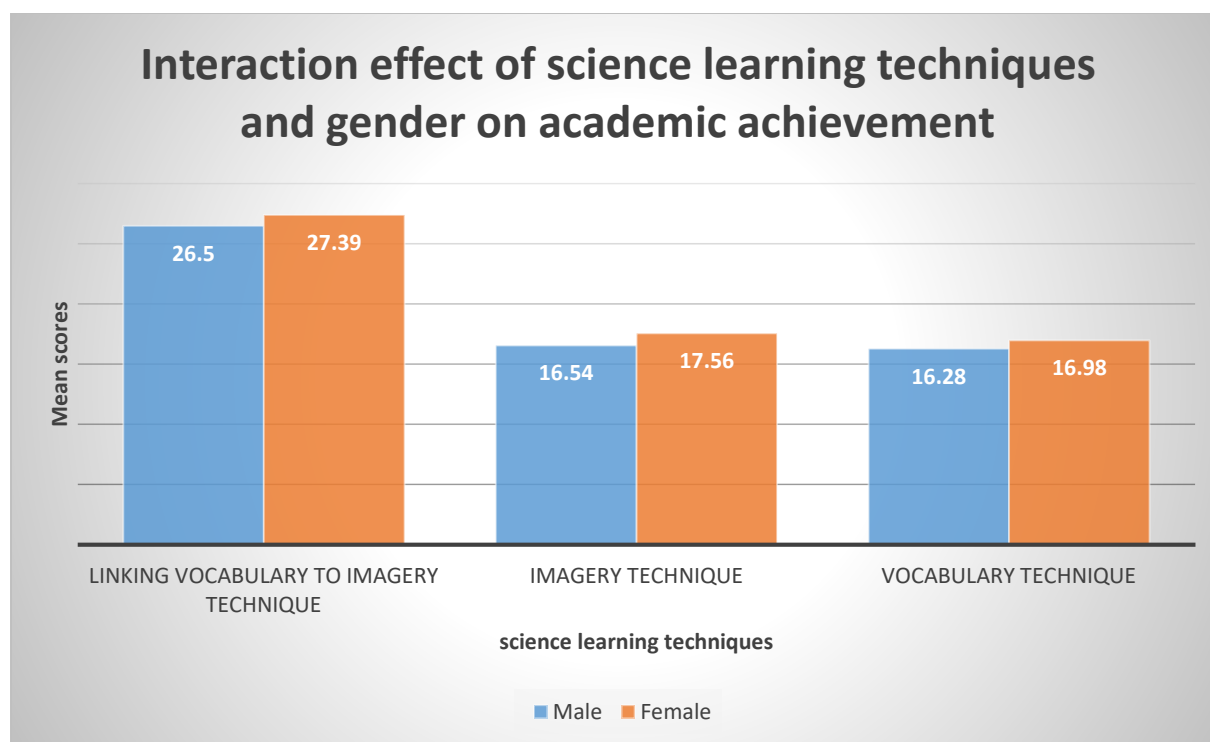
Table 5: Summary of Analysis of Covariance (ANCOVA) of Students' Academic Achievement Scores Classified by Gender when Taught Nitrogen Cycle Using Technique of Linking Vocabulary to Imagery, Imagery and Vocabulary Techniques with Pre-test Scores as Covariate

Source	Sum of Squares	df	Mean Square	F	Sig.	Decision at .05 alpha level
Corrected Model	6.447	2	3.224	.283	.755	NS
Intercept	3282.151	1	3282.151	288.025	.000	S
Pretest scores	.086	1	.086	.008	.931	NS
Gender	6.194	1	6.194	.544	.464	NS
Error	672.327	59	11.395			
Total	111564.000	62				
Corrected Total	678.774	61				

a. **R Squared = .009 (Adjusted R Squared = -.024), S= Significant at .05 alpha level, NS= Not significant at .05 alpha level.**

In Table 5, the calculated F-ratio for the effect of gender on achievement scores of students in Biology when taught using the technique of linking vocabulary to imagery at df 1, 61 is 0.544, while its corresponding calculated p-value is 0.464 alpha. This p-value is greater than 0.05 in which the decision is based,

indicating that no significant difference exists between the mean achievement scores of male and female students taught the concept of Nitrogen cycle using the technique of linking vocabulary to imagery. With this observation, the null hypothesis was retained.



Bar Chart Showing the Interaction Effect of Science Learning Techniques and Gender on Biology Students' Academic Achievement

From the Figure above which examined the interaction effect of science learning techniques and gender on Biology students' academic achievement, the mean scores showed that both male and female students improved in their achievement after being taught using the science learning techniques. However, the difference in mean gains across gender was not wide enough to suggest that one gender consistently

benefited more than the other. This means that while there were observable improvements, the gains recorded by males and females were generally comparable, and the learning techniques did not favor either group disproportionately. Therefore, the interaction between science learning techniques and gender was not effective on achievement.

Table 6: Summary of Analysis of Covariance (ANCOVA) of Male and Female Students' Post- test Scores Classified by Treatment Groups and Gender with Post-test Scores as Covariate

Source	Type III Sum of Squares	Df	Mean Square	F-value	P-value
Corrected Model	8937.853 ^a	5	1787.571	176.504	.000 ^S
Intercept	5213.321	1	5213.321	514.762	.000 ^S
Covariate (Pretest Scores)	20.945	1	20.945	2.068	.152 ^{NS}
Main Effect (Techniques)	8681.821	2	4340.910	428.621	.000 ^S
Main Effect (Gender)	.809	1	.809	.080	.778 ^{NS}
Techniques * Gender	8.878	1	8.878	.877	.350 ^{NS}
Error	1762.208	174	10.128		
Total	211167.000	180			
Corrected Total	10700.061	179			

S= Significant at .05 Level of Significance, NS= Not Significant at .05 Level of Significance

Results in Table 4.17 on the interaction effect of techniques and gender show that the calculated F-value (0.87) having a calculated p-value of 0.35 is greater than the significant level (0.05). Therefore, the null hypothesis nine is retained. This implies that there is no significant interaction effect between science learning techniques and gender on biology students' academic achievement. It can be inferred from the result that the academic achievement of male and female students with regards to the science learning techniques are at the same levels as seen in the figure above indicating that the interaction of science learning techniques (vocabulary, imagery and linking vocabulary to imagery techniques) and gender have no significant effect on Biology students' academic achievement.

Discussion of Result

Findings for research question one indicated those in linking vocabulary to imagery group yielded the best mean gain score, followed by those in imagery technique and vocabulary technique groups respectively. Result for hypothesis one indicate that there is a significant difference between the academic achievement of students taught Nitrogen cycle using science learning techniques (linking vocabulary to imagery technique, imagery and vocabulary techniques). This implies that students taught using linking vocabulary to imagery technique performed better than those taught using vocabulary and expository techniques. This may be due to the fact that the technique of linking vocabulary to imagery helped the students to have full description and pictorial representation of the concept. This also had made them to have deeper understanding of the concept than those taught using imagery and vocabulary techniques. This agrees with Wilson (2021) who asserted that when vocabulary is linked to imagery and used for the science teaching and learning, it makes the learning process more active, fun-filled and effective.

Result for research question two showed that the mean gain scores for female students was higher than that of the male students indicating that female students academically achieved better than male students in the three groups. Findings for hypothesis two showed that there is no significant difference between the mean scores of male and female students taught using linking vocabulary to imagery technique. This indicates that both the male and female students

performed at the same achievement level. This coincides with the findings of Goni, *et al.* (2019) who stated that there is no significant difference between the academic achievement of male and female students when they conducted a study on differences between students' gender and academic achievement.

For research question three, result showed that the gains recorded by males and females were generally comparable, and the learning techniques did not favor either group disproportionately. Therefore, the interaction between science learning techniques and gender was not effective on achievement. Findings for the interaction effect of science learning techniques and gender on Biology students' academic achievement when taught Nitrogen cycle was not significant. This is due to the fact that the students in each group were exposed to the same learning environment and conditions meant for each group. The interaction effect of treatment and gender on achievement was not significant meaning that both male and female students were at similar achievement level at all levels of treatment. This contradicts with the findings of Mwihia (2020) whose findings indicated significant interaction effect of teaching strategies and gender on students' academic achievement. It also contradicts with the findings of Raphael (2020) who indicated that there was an interaction effect of instructional methods and gender on academic achievement of students as he observed gender difference in the academic achievement of male and female students when taught using different instructional methods.

Conclusions

From the findings of the study, it was concluded that utilization of the technique of linking vocabulary to imagery enhances improved academic achievement better than the use of vocabulary and expository techniques.

Recommendations

From the findings of the study, it was recommended that:

- i. Science students should endeavor to be actively involved in learning when the technique of linking vocabulary to imagery is utilized in the teaching and learning process.
- ii. Science teachers especially the Biology teachers should ensure the use of linking



- vocabulary to imagery technique during science learning process
- iii. School administrators should endeavor to conduct in-house seminars and workshops for science teachers on regular utilization of the technique of linking vocabulary to imagery technique during the teaching and learning process.

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