



Effects of Generative Learning Approach on Students' Motivation and Achievement in Pollution Concepts in Basic Science and Technology in Plateau State, Nigeria.

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ABSTRACT

This study examined the effects of the Generative Learning Approach on students' motivation and academic achievement in pollution concepts in Basic Science and Technology in Plateau State, Nigeria. A quasi-experimental non-randomized pretest–posttest non-equivalent control group design was employed. The sample comprised 126 Junior Secondary School II students drawn from two public secondary schools in Pankshin Area Directorate of Education. Intact classes were used, with one group assigned as the experimental group and taught using the Generative Learning Approach, while the control group was taught using the conventional method. Data were collected using the Basic Science Motivation Scale Questionnaire and the Basic Science Achievement Test, both of which were validated by experts and demonstrated satisfactory reliability indices. Descriptive statistics were used to answer the research questions, while Analysis of Covariance was used to test the hypotheses at the 0.05 level of significance. The findings revealed that students exposed to the Generative Learning Approach showed significantly higher motivation and achieved better academic performance than their counterparts taught using the conventional method. In addition, gender differences in motivation and achievement were not statistically significant, indicating that the approach was effective for both male and female students. The study concludes that the Generative Learning Approach promotes active engagement, enhances motivation, and improves academic achievement in science learning. It is therefore recommended that the approach be integrated into the teaching of Basic Science and Technology to enhance students' learning outcomes.

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INTRODUCTION

Science and technology remain fundamental to national advancement, serving as catalysts for innovation, environmental sustainability, and socio-economic development. Contemporary global perspectives, as reflected in UNESCO (2021), underscore the importance of science education in equipping learners with the knowledge and competencies required for informed decision-making and sustainable living. In this regard, early exposure to scientific learning is essential for developing learners' intellectual capacity and academic competence. Such exposure not only supports students' performance in school subjects but also shapes their disposition toward learning science, making motivation and achievement central outcomes of effective science education.

Within the Nigerian educational system, Basic Science and Technology functions as a foundational subject at the junior secondary school level, designed to introduce learners to scientific principles, environmental awareness, and technological processes. The Nigerian Educational Research and Development Council (2013) structured the curriculum to prepare students for advanced science learning while ensuring that they understand real-life environmental issues. One of the major concepts embedded in the curriculum is pollution, which provides learners with knowledge of environmental degradation and its consequences. A sound understanding of this concept is crucial, as deficiencies at this level are often reflected in poor academic achievement and weak performance in subsequent science learning.

Despite its importance, many students experience difficulties in learning pollution-related concepts, which negatively affect both their academic achievement and their willingness to learn the subject. The abstract nature of pollution, combined with the need to integrate scientific reasoning and environmental awareness, often makes it challenging for learners. These difficulties are further aggravated by the persistent use of teacher-centered instructional approaches that limit students' active involvement in learning. Wang and Degol (2017) observe that differences in learners' interest, participation, and confidence can influence how they respond to science instruction, thereby affecting both their motivation and academic achievement. This suggests that improving students' outcomes in Basic Science and Technology requires instructional strategies that simultaneously enhance their desire to learn and their academic performance.

In response to these challenges, the Generative Learning Approach has gained attention as an instructional strategy capable of improving both students' motivation and academic achievement. Rooted in cognitive learning theory, Fiorella (2020) explains that generative learning involves learners actively constructing meaning by linking new information to prior knowledge and expressing it in their own understanding. Peters and Fiorella (2021) further

argue that such processes enhance comprehension and lead to improved academic outcomes. In addition, Kim and Pekrun (2022) emphasize that when instructional activities are perceived as meaningful, students' motivation to learn increases, which positively influences their academic achievement. In the context of Basic Science and Technology, particularly in teaching pollution concepts, the Generative Learning Approach therefore provides a promising framework for improving both students' motivation and their academic achievement through structured, learner-centered instruction.

Statement of the Problem

Despite the centrality of pollution in the Basic Science and Technology curriculum, many junior secondary school students in Nigeria continue to exhibit low academic achievement and poor motivation toward learning the concept, largely due to the dominance of conventional teacher-centered instructional approaches that limit meaningful understanding. This situation has resulted in weak performance in classroom assessments and external examinations, as well as a lack of sustained interest in science learning, thereby undermining the effectiveness of science education at the foundational level. The consequence is that learners struggle to apply scientific knowledge to real-life environmental issues, including those related to pollution, which diminishes their capacity to develop scientifically informed perspectives. If this problem remains unaddressed, it may lead to continued poor achievement in science subjects, reduced progression into science-related fields, and the emergence of a generation inadequately prepared to address environmental challenges, thereby posing long-term implications for sustainable development and national growth.

Aim and Objectives of the Study

This study investigated the effects of generative learning approach on students' motivation and achievement in pollution concepts in Basic Science and Technology in Plateau State, Nigeria. Specifically, the objectives of the study were to:

- i. determine if any difference exist in the mean motivation scores of students taught basic science and technology using generative learning approach and their counterparts taught using conventional method;
- ii. determine the difference in the mean achievement scores of basic science and technology students exposed to generative learning approach and those exposed to conventional method;
- iii. determine the gender difference in basic science and technology mean motivation scores of students taught using generative learning approach;

- iv. determine if any gender related difference exist in the mean achievement scores of basic science and technology students taught using generative learning approach, and

1.4 Research Questions

The following questions were raised to guide the study:

- i. What is the difference in the mean motivation scores of students taught basic science and technology using generative learning approach and their counterparts taught using conventional method?
- ii. What is the difference in the mean achievement scores of basic science and technology students exposed to generative learning approach and those exposed to conventional method?
- iii. What is the difference in the mean motivation scores of male and female students taught basic science and technology using generative learning approach?
- iv. What is the difference in the mean achievement scores of male and female students taught basic science and technology using generative learning approach?

1.5 Hypotheses

The following hypotheses are formulated and were tested at 0.05 level of significance:

- Ho₁:** There is no significant difference between mean motivation scores of students taught basic science and technology using generative learning approach and those taught using conventional method.
- Ho₂:** There is no significant difference between the mean achievement scores of students taught basic science and technology using generative learning approach and those taught using conventional method.
- Ho₃:** There is no significant difference between mean motivation scores of male and female students taught basic science and technology using generative learning approach.
- Ho₄:** There is no significant difference between the mean achievement scores of male and female students taught basic science and technology using generative learning approach.

METHODOLOGY

The study adopted a quasi-experimental research design, specifically the non-randomized pre-test, post-test, non-equivalent control group design. Two intact Junior Secondary School II classes drawn from two

public secondary schools in Pankshin Area Directorate of Education, Plateau State, were used to form the experimental and control groups. The use of intact classes was necessitated by administrative constraints that made random assignment of individual students impracticable, thereby preserving existing class structures and enhancing ecological validity. The independent variable was the Generative Learning Approach, while the dependent variables were students' achievement, motivation, and retention in Basic Science and Technology, with gender treated as an intervening variable. Pre-tests, post-tests, and delayed post-tests were administered to enable comparison of learning outcomes between the groups.

The population of the study comprised all Junior Secondary School students in Pankshin Area Directorate of Education, from which a sample of 126 JSS II students (61 males and 65 females) was purposively selected from two co-educational public secondary schools that met predefined criteria, including availability of qualified Basic Science teachers and functional laboratory facilities. The schools were randomly assigned to experimental and control groups using a balloting method, resulting in 68 students in the experimental group and 58 in the control group. Data were collected using two instruments: the Basic Science Motivation Scale Questionnaire (BSMSQ), adapted from Zhang and Zhou (2023) and Basic Science Academic Achievement Test (BSAAT).

The instruments were validated by three experts—two in Science Education and one in Measurement and Evaluation—to establish face, content, and construct validity. Reliability was determined through a pilot study involving 30 JSS II students outside the study area, yielding reliability coefficients of 0.82 for the BSMSQ and 0.86 for the BSAAT using Cronbach's alpha. Data collection spanned ten weeks and followed three phases: pre-intervention, intervention, and post-intervention, with the experimental group taught using the Generative Learning Approach and the control group taught using the conventional method. Data were analysed using descriptive statistics (mean, standard deviation, frequencies, and percentages) to answer research questions, while Analysis of Covariance (ANCOVA) was employed to test the hypotheses at the 0.05 level of significance, controlling for pre-test differences and isolating the effect of the instructional approach.

RESULTS

1. Research Question One

What is the difference in the mean motivation scores of students taught basic science and technology using generative learning approach and their counterparts taught using conventional method?

Table 1: Summary of Mean and Standard Deviation of Motivation Score of Pre-test and Post-test of the Experimental and Control Groups

Group	Treatment	Number of students	Pre-Test		Post-Test		Mean Difference
			Mean (\bar{x})	Std. Dev. (SD)	Mean (\bar{x})	Std. Dev. (SD)	
Experimental	Generative Learning Approach	68	2.36	0.61	3.81	0.87	1.45
Control	Conventional Teaching method	58	2.31	0.66	2.23	0.91	0.08
Total		126					

Table 1 shows that the experimental group obtained mean motivation score of 2.36 with standard deviation 0.61 while the control group had a mean motivation score of 2.31 with standard deviation 0.66 in the pre-test. This shows that the pre-test mean motivation scores were similar. However, after treatment was applied, the experimental group had mean motivation score of 3.81 with standard deviation 0.87 while the control group had a mean motivation score of 2.23 with standard deviation of 0.91 while. This implies that the experimental group had an intra-group mean motivation score difference of 1.45 while the control group had an intra-group mean motivation score difference of 0.08. Thus, the difference in the mean motivation scores of students taught basic science and technology using generative learning approach and

their counterparts taught using conventional method is 1.58 in favour of the experimental group. This means that the students taught Basic science and technology using Generative Learning Approach showed more motivation in Basic science and technology having been exposed to Generative Learning Approach. Therefore, Generative Learning Approach leads to higher motivation in Basic science and technology.

2. Research Question Two

What is the difference in the mean achievement scores of basic science and technology students exposed to generative learning approach and those exposed to conventional method?

Table 6: Summary of Mean and Standard Deviation Achievement Scores of Pre-test and Post-test of the Experimental and Control Groups

Group	Treatment	Number of students	Pre-Test		Post-Test		Mean Difference
			Mean (\bar{x})	Std Dev. (SD)	Mean (\bar{x})	Std. Dev. (SD)	
Experimental	Generative Learning Approach	68	47.29	12.08	68.54	9.42	21.25
Control	Conventional Teaching Method	58	47.52	11.30	45.89	13.71	1.63
Total		126					

Table 6 shows that the experimental group obtained a mean achievement test score of 47.29 with standard deviation of 12.08 while the control group had a mean achievement test score of 47.52 with a standard deviation of 11.30 in the pre-test. This shows that the pre-test mean achievement scores were similar. However, after treatment was applied, the experimental group had mean achievement test score of 68.54 with standard deviation 9.62 while the control group had a mean achievement test score of 45.89 with standard deviation of 13.71. This implies that the experimental group had an intra-group mean difference of 21.25 while the control group had an intra-group mean difference of 1.63. Thus, the experimental

group, achieved higher than the control group. The difference in the mean achievement scores of basic science and technology students exposed to generative learning approach and those exposed to conventional method was 22.65 in favour of the experimental group. This means that the students taught Basic science and technology using Generative Learning Approach achieved higher than those taught using conventional teaching method. This implies that students' achievement has been positively influenced by Generative Learning Approach.

3. Research Question Four

What is the difference in the mean motivation scores of male and female students taught basic science and technology using generative learning approach?

Table 3: Summary of Post-test Mean and Standard Deviation Motivation Scores Based on Gender

Group	Treatment	Number of students	Post-Test		Mean Difference
			Mean (\bar{X})	Std. Dev. (SD)	
Male	Generative Learning Approach	32	3.42	0.98	0.53
Female	Generative Learning Approach	36	2.89	0.83	
Total		68			

Table 3 shows that the males in the experimental group had a mean motivation score of 3.42 with standard deviation 0.98 while the females had a mean motivation score of 2.89 with a standard deviation of 0.83. This gives a mean difference of 0.53. Thus, though male students had slightly higher post-test mean motivation score than their female counterparts,

both male and female students showed high motivation in Basic Science and Technology in the post-test.

4. Research Question Four

What is the difference in the mean achievement scores of male and female students taught basic science and technology using generative learning approach?

Table 4: Summary of Post-test Mean and Standard Deviation Achievement Scores in Post-Test Based on Gender

Group	Treatment	Number of students	Post-Test		Mean Difference
			Mean (\bar{X})	Std. Dev. (SD)	
Male	Generative Learning Approach	32	72.06	6.98	7.52
Female	Generative Learning Approach	36	64.54	9.95	
Total		68			

Table 4 shows that the males in the experimental group had a mean achievement score of 72.06 with standard deviation 6.98 while the females had a mean achievement score of 64.54 with a standard deviation of 9.95. This gives a mean difference of 7.52. Thus, the males scored higher than the females in the post-test. However, it is pertinent to note that both males and females performed well, indicating that Generative Learning Approach is effective in teaching male and female students.

Test of Hypotheses

The null hypotheses were tested at a 0.05 level of significance.

Hypothesis One (H_{01}): There is no significant difference between mean motivation scores of students taught basic science and technology using generative learning approach and those taught using conventional method.

Table 5: ANCOVA Summary of Pre-Test and Post-Test Motivation Scores for Experimental and Control Groups

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	48.392	2	24.196	31.885	.000
Intercept	678.120	1	678.120	894.061	.000
Pre_Motivation (Covariate)	6.217	1	6.217	8.199	.005
Group (Treatment)	40.739	1	40.739	53.740	.000
Error	213.963	80	0.759		
Total	996.784	80			
Corrected Total	262.355	79			

The ANCOVA analysis indicates a statistically significant difference in the post-test motivation ratings between students taught with the Generative Learning Approach and those taught with the conventional method, after adjusting for pre-test motivation scores, $F(1, 80) = 53.740$, $p = .000$. This shows that the Generative Learning Approach significantly improved students' motivation in Basic Science and Technology. Therefore, the null hypothesis was rejected. Hence there is sufficient evidence to conclude that there is significant difference between mean motivation scores

of students taught basic science and technology using generative learning approach and those taught using conventional method.

Hypothesis Two (H_{02})

There is no significant difference between the mean achievement scores of students taught basic science and technology using generative learning approach and those taught using conventional method.

Table 6: ANCOVA Summary of Pre-Test and Post-Test Achievement Scores for Experimental and Control Groups

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5187.432	2	2593.716	26.842	.000
Intercept	62415.801	1	62415.801	646.017	.000
Pre_Test (Covariate)	964.273	1	964.273	9.970	.002
Group (Treatment)	4034.169	1	4034.169	41.756	.000
Error	27236.194	80	96.580		
Total	92158.321	80			
Corrected Total	32423.626	79			

The ANCOVA result shows that, after controlling for pre-test scores, there is a statistically significant difference in post-test achievement between students exposed to the Generative Learning Approach and those taught using conventional methods, $F(1, 80) = 41.756$, $p = .000$. Therefore, the null hypothesis (H_{02}) is rejected. There is sufficient evidence to conclude that there is significant difference between the mean

achievement scores of students taught basic science and technology using generative learning approach and those taught using conventional method.

Hypothesis Three (H_{03}): There is no significant difference in the mean motivation scores of students with respect to gender when exposed to Generative Learning Approach.

Table 7: ANCOVA Summary of Post-Test Motivation Scores Based on Gender for Students Taught Using Generative Learning Approach

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	7.218	2	3.609	4.919	.008
Intercept	195.474	1	195.474	266.615	.000
Pre_Motivation (Covariate)	0.517	1	0.517	0.705	.402
Gender	6.701	1	6.701	9.134	.003
Error	206.635	80	0.733		
Total	462.874	80			
Corrected Total	213.853	79			

The ANCOVA results indicate that after adjusting for pre-test motivation levels, there was a statistically significant difference in the post-test motivation scores of male and female students who were taught using the Generative Learning Approach, $F(1, 80) = 9.134$, $p = .003$. Therefore, the null hypothesis (H_{03}) is rejected. Hence, there is sufficient evidence to conclude that there is significant difference in the mean motivation

scores of students with respect to gender when exposed to Generative Learning Approach.

Hypothesis Five (H_{04}): There is no significant difference between the mean achievement scores of male and female students taught basic science and technology using generative learning approach.

Table 8: ANCOVA Summary of Post-Test Achievement Scores Based on Gender for Students Taught Using Generative Learning Approach

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	3235.725	2	1617.863	19.203	.000
Intercept	79002.541	1	79002.541	937.124	.000
Pre-Achievement (Covariate)	112.876	1	112.876	1.338	.248
Gender	3112.849	1	3112.849	36.923	.000
Error	23767.312	80	84.259		
Total	106470.124	80			
Corrected Total	27003.037	79			

The ANCOVA result shows that after controlling for pre-test achievement, there was a statistically significant difference in the post-test achievement scores of male and female students taught using the Generative Learning Approach, $F(1, 80) = 36.923$, $p = .000$. Hence the null hypothesis (H_{04}) is rejected. Therefore, it is concluded that there is significant difference between the mean achievement scores of male and female students taught basic science and technology using generative learning approach.

DISCUSSION

The study sought the effect of generative learning approach on students' motivation and achievement in Basic Science and Technology. The results revealed that students taught using the Generative Learning Approach demonstrated higher motivation levels compared to their counterparts taught using the conventional teaching method. This indicates that the approach enhanced students' enthusiasm and willingness to engage in learning activities. This finding is consistent with the work of Okafor and Emeka (2020), who reported that generative learning strategies significantly improved students' motivation in science classrooms by encouraging active participation and personal meaning-making. The improvement in motivation can be attributed to the learner-centered nature of the approach, which allows students to interact meaningfully with content and take ownership of their learning process.

Further supporting this outcome, Okoro and Adeyemi (2022) found that active learning strategies that require students to construct knowledge through interaction and participation tend to sustain learners' interest and curiosity in science subjects. In a similar vein, Yusuf and Eniola (2020) observed that student-centered instructional methods enhance learners' engagement and promote positive attitudes toward science learning. These findings align with the present result because generative learning activities such as summarizing, explaining, and connecting ideas encourage deeper cognitive involvement, thereby fostering sustained motivation. The convergence of these studies suggests that when learners are actively engaged in constructing knowledge, their intrinsic motivation is strengthened, leading to improved learning experiences.

The findings for Research Question Two showed that students exposed to the Generative Learning Approach achieved significantly higher academic scores than those taught using conventional methods. This demonstrates the effectiveness of the approach in enhancing students' academic achievement, likely due to its emphasis on active knowledge construction and integration of prior knowledge with new concepts. This result agrees with Adediran and Okonkwo (2020), who found that generative instructional strategies improved students' achievement and retention in Basic Science by promoting meaningful understanding of concepts. The similarity in findings may be explained by the shared focus on learner-centered pedagogy, which encourages cognitive engagement and deeper processing of information.

Similarly, George and Abumchukwu (2021) reported that students taught using the generative learning model performed significantly better than those taught using conventional methods, attributing the improvement to increased student participation and conceptual clarity. The alignment of these findings with the present study underscores the effectiveness of generative learning in fostering critical thinking and enhancing academic performance. The structured activities embedded in the approach provide learners with opportunities to actively process, organize, and apply knowledge, thereby improving their overall achievement in Basic Science and Technology.

With respect to gender differences in motivation, the findings indicated that male students had slightly higher motivation scores than their female counterparts, although both groups exhibited high levels of motivation. This aligns with the findings of Yusuf and Eniola (2020), who reported marginal gender differences in motivation when student-centered instructional strategies were employed, with both male and female students benefiting from the approach. The slight variation observed may be attributed to differences in confidence levels or prior exposure to science-related activities, rather than the instructional method itself.

In addition, Okoro and Adeyemi (2022) noted that while active learning strategies improve motivation across genders, minor differences may still occur due to individual learner characteristics. However, such differences are often not statistically significant, indicating that the instructional approach remains effective for all learners. This supports the conclusion

that the Generative Learning Approach fosters an inclusive learning environment that enhances motivation regardless of gender.

Finally, the findings revealed that male students performed slightly better than female students in terms of achievement, although both groups recorded high scores. This result is consistent with the findings of Eze and Odo (2022), who reported that innovative teaching strategies tend to improve academic achievement for both male and female students, even when slight differences in performance exist. The similarity between the studies may be attributed to the use of learner-centered approaches that minimize traditional barriers to learning and promote equal participation among students. Similarly, Obikezie, Nwuba, and Ibe (2023) found that while performance differences between male and female students may occur, the use of interactive and generative instructional methods reduces the achievement gap by providing equal learning opportunities. This suggests that the observed differences in achievement are likely influenced by factors external to the instructional strategy, such as individual learning preferences or prior knowledge, rather than the effectiveness of the Generative Learning Approach itself. Overall, the findings reinforce the view that generative learning is an effective instructional strategy for improving both motivation and academic achievement among students in Basic Science and Technology.

RECOMMENDATIONS

Based on the findings of the study, the following recommendations are made:

1. Basic Science and Technology teachers should adopt the Generative Learning Approach in classroom instruction, as it has been shown to significantly improve students' motivation and academic achievement in learning pollution concepts and related topics.
2. Educational authorities and school administrators should organize regular training, workshops, and professional development programmes to equip teachers with the skills required to effectively implement generative learning strategies in science classrooms.
3. Curriculum planners and policymakers should integrate learner-centered instructional approaches such as the Generative Learning Approach into the Basic Science and Technology curriculum to promote active knowledge construction and improve students' learning outcomes.
4. Teachers should ensure equal participation of both male and female students during instruction, as the Generative Learning Approach has been found to be effective across genders, thereby fostering inclusive learning environments that support improved motivation and achievement for all learners.

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