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EFFECT OF LABORATORY APPROACH ON STUDENTS' INTEREST AND ACHIEVEMENT IN ENERGY CONCEPT IN LAFIA, NASARAWA STATE, NIGERIA

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Abstract

This study determined the effect of the laboratory approach on basic science students' interest and achievement in energy concepts in Lafia, Nasarawa State. Four research questions guided the study, and four null hypotheses were tested at 0.05 level of significance. Pre-test, post-test quasi-experimental research was used for this study. The population of the study comprised 3672 Upper Basic II students in Lafia, Nasarawa, for the 2024/2025 academic session. Simple random sampling technique was used to draw the sample for this study. Two instruments, namely, Energy Interest Rating Scale (EIRS) and Energy Achievement Test (EAT), were employed for data collection. Kuder-Richardson 21 (K-R21) reliability was used to determine the internal consistency of EAT, which yielded a coefficient of 0.79, and Cronbach's Alpha formula was used to determine the reliability of EIRS, yielding 0.81 as a coefficient. Descriptive statistics of mean and standard deviation were used to answer the research questions, while Analysis of Covariance (ANCOVA) was used to test the hypotheses. Findings from this research

revealed that the laboratory approach proved to be a more engaging and effective teaching strategy for both improving interest and achievement in energy topics compared to the conventional method. Gender disparities in achievement outcomes suggested a need for strategies to support female students better and ensure equity in interactive learning environments. The findings emphasize the importance of hands-on, student-centered instructional methods for fostering deeper engagement and better academic performance. Based on the findings of this study, the following recommendations were made to enhance the effectiveness of teaching energy through the laboratory approach and address the observed gender disparities: the laboratory approach should be adopted more widely in teaching energy. Schools and educational institutions should prioritize interactive, hands-on learning methods to engage students more effectively and improve learning outcomes.

Keywords: Education, Science education, Energy, Interest, Achievement, Laboratory approach.

Introduction

Education stands as one of the most influential and transformative tools crafted by humanity, enabling individuals to shape and refine themselves in meaningful and purposeful ways. Beyond its role in converting illiteracy into knowledge and competence, education serves as a vital mechanism for preparing and empowering individuals to navigate and thrive in diverse and dynamic environments. It fosters the resilience and adaptability needed to lead fulfilling personal lives and contribute effectively to society. Through education, people gain the skills, knowledge, and values necessary to develop their personalities and expand their capabilities. It equips individuals to undertake a wide range of responsibilities and adapt to ever-evolving circumstances, helping them achieve their fundamental needs and life aspirations. In essence, education is not merely an instrument of learning; it is a cornerstone of human development and progress, deeply embedded in the journey of life and integral to individual and collective growth (Hanachor & Wordu, 2021).

Science education is designed to equip learners with a functional understanding of scientific concepts and principles, enabling them to apply this knowledge to real-life situations. It fosters the development of essential skills, positive attitudes, and critical

values needed to analyze and solve everyday problems (Osarenren-Osaghae & Irabor, 2018). By providing both educators and students with the necessary tools and competencies, science education contributes to national development, supports technological advancement, and nurtures a generation of skilled scientists capable of elevating the educational and economic standards of their communities. At the heart of science education is Basic Science, which serves as its foundation—laying the groundwork for learners' future engagement in more specialized scientific disciplines.

Energy is a fundamental concept in science education, forming a critical foundation for understanding numerous phenomena and principles within the upper Basic Science curriculum. Despite its significance, energy remains a challenging topic for many students to comprehend, and effective teaching strategies for this concept have been a subject of ongoing educational research (Papadouris & Constantinou, 2016). According to Millar (2014), while energy is derived from basic quantities like force or mass, it is often introduced as a primary concept in the science curriculum. Hertting (2016) emphasized that teaching about energy dissipation and degradation in a simple and clear manner before addressing its conservation can help reduce conceptual difficulties for students.

Student interest is defined as an individual's positive feeling towards a particular topic or activity. A child is more likely to develop interest in subjects or activities that are perceived as attractive or stimulating. In a classroom setting, a student will remain attentive during a lesson only if the instruction is engaging and of interest to them (Kong, Chiu, & Lai, 2018). Interest refers to a preference for engaging in certain activities over others, and it is evident that children typically perform better in activities they prefer. Interest is a crucial aspect of the learning process because it is a fundamental factor in instilling the knowledge, skills, values, and attitudes that the curriculum aims to impart. It helps sustain concentration, purpose, commitment to learning, and cooperation with the teacher.

Student achievement is measured by their ability to acquire knowledge and skills at the end of teaching and learning activities (Usman, 2020). Achievement is often reflected in examination results and indicates the effectiveness of learning. It can also be viewed as the successful accomplishment of challenging tasks through exertion, skill, practice, or perseverance (Eze, 2019). Achievement tests measure and compare skills in various academic fields, determining the degree of attainment in individual tasks, courses, or programs to which students have been sufficiently exposed (Anekwe, 2016).

Laboratory-approach aligns with constructivist theories of learning, which posit that students learn more effectively when they are actively involved in the learning process. It enables learners to observe, manipulate, and investigate scientific concepts, thus fostering critical thinking, collaboration, and deeper understanding. However, despite the recognized benefits of laboratory-based teaching, its use in Nigerian junior secondary schools, especially in public schools in Lafia, remains limited due to factors such as lack of resources, inadequate teacher training, and emphasis on theoretical instruction to meet examination demands. There is, therefore, a critical need to empirically examine the effect of the laboratory approach on students' learning outcomes, particularly in terms of their *interest and achievement* in energy concepts. The present study is motivated by the need to bridge this gap by investigating whether the laboratory approach can significantly improve Basic Science students' interest and achievement in energy concepts in Lafia, Nasarawa State. Specifically, the study sought to determine whether students exposed to laboratory-based instruction show greater interest and achievement in energy-related topics compared to their peers taught using conventional methods. The findings of this study are expected to provide evidence-based recommendations for improving science instruction, promoting student

engagement, and enhancing performance in Basic Science at the junior secondary school level.

Statement of the Problem

Science education plays a pivotal role in national development by equipping learners with critical thinking skills, problem-solving abilities, and the scientific knowledge necessary for innovation and technological advancement. At the core of science education at the upper basic II level in Nigeria is Basic Science, which lays the foundational knowledge for students in various scientific disciplines such as Physics, Chemistry, Biology, and Earth Science. Despite the centrality of energy concepts in science education, numerous studies have reported persistent challenges in students' understanding and achievement in this area. Energy is inherently abstract and multidimensional, making it difficult for students to grasp through traditional teaching approaches that rely heavily on rote memorization, textbook instruction, and teacher-centered lectures. These conventional methods often fail to make learning meaningful or stimulate students' curiosity, leading to low number of students shallow conceptual understanding, and declining interest in science among students. This problem is particularly evident in Lafia, Nasarawa State, where observations and

interactions with Basic Science teachers and students have revealed a general lack of enthusiasm and poor performance in topics related to energy. Many students struggle to explain basic principles such as energy transformation, conservation, and transfer, which suggests a gap between curriculum objectives and actual learning outcomes. Furthermore, classroom conditions in many schools in the region—marked by overcrowding, limited instructional materials, and inadequate use of practical activities—compound the challenges of effective science teaching and learning. Emerging research suggests that practical, learner-centered strategies such as the laboratory approach can address these issues by promoting hands-on experiences that help students construct knowledge through direct engagement with scientific phenomena.

Laboratory-based instruction aligns with constructivist theories of learning, which posit that students learn more effectively when they are actively involved in the learning process. It enables learners to observe, manipulate, and investigate scientific concepts, thus fostering critical thinking, collaboration, and deeper understanding. However, despite the recognized benefits of laboratory-based teaching, its use in Nigerian junior secondary schools, especially in public schools in Lafia, remains limited due to factors such as lack of

resources, inadequate teacher training, and emphasis on theoretical instruction to meet examination demands. There is, therefore, a critical need to empirically examine the effect of the

laboratory approach on students' learning outcomes, particularly in terms of their interest and achievement in energy concepts. The present study is motivated by the need to bridge this gap by investigating whether the laboratory approach can significantly improve Basic Science students' interest and achievement in energy concepts in Lafia, Nasarawa State. Specifically, the study sought to determine whether students exposed to laboratory-based instruction show greater interest and achievement in energy-related topics compared to their peers taught using conventional methods.

Objectives of the Study

The main purpose of this study was to determine the Effect of Laboratory Approach on Interest of Students in Energy Concepts in Lafia, Nasarawa State. Specifically, the study sought to;

1. ascertain the effect of Laboratory Approach on students' interest in Energy.
2. establish the effect of Laboratory Approach on male and female students' interest in Energy.

3. determine the effect of Laboratory Approach on students' achievement in Energy.
4. find out the effect of Laboratory Approach on male and female students' achievement in Energy.

Research Questions

The following research questions guided the study;

1. What are the mean interest ratings of students taught Energy using Laboratory Approach and Conventional Method?
2. What are the mean interest ratings of male and female student' interest taught Energy using Laboratory Approach?
3. What are the mean achievements scores of students taught Energy using Laboratory Approach and Conventional Method?
4. What are the mean achievements scores of male and female students taught Energy using Laboratory Approach?

Statement of Hypotheses

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

H₀₁: There is no significance difference in the mean interest ratings of students taught Energy using Laboratory

Approach and the Conventional Method.

H₀₂: There is no significance difference in the mean interest ratings of male and female students taught Energy using Laboratory Approach.

H₀₃: There is no significance difference in the mean achievement scores of students taught Energy using Laboratory Approach and the Conventional Method?

H₀₄: There is no significance difference in the mean achievement scores of male and female students taught Energy using Laboratory Approach.

Methodology

The research adopted a quasi-experimental design of the non-randomized control group, pretest-posttest type. This design was deemed most appropriate for the study because it involved the use of intact classes as experimental and control groups. Random assignment of students to groups was not feasible, as doing so would have disrupted the existing school arrangements—a constraint not permissible by school authorities. As Creswell (2016) explained, quasi-experimental designs are suitable when randomization is impractical or ethically inappropriate, especially in natural classroom settings. In this study, the quasi-experimental approach enabled the researcher to determine the effect of the laboratory approach on students' interest and achievement in energy

concepts in Basic Science, while maintaining the integrity of the school's organizational structure.

The population for this research comprised 3,672 (2563 male and 1109 female) Upper Basic II students in Lafia, Nasarawa for 2024/2025 academic session. A sample for this study consisted of 103 students, comprising 61 males and 42 females. Two co-educational schools were drawn from a total of 23 schools in the area using a simple random sampling technique.

The draft version of the EIRS and EAT was subjected to review process by a panel of experts comprising experienced Basic Science teachers, curriculum specialists, and educational measurement professionals. These experts evaluated each test item for relevance, clarity, appropriateness of language, cognitive level, and alignment with the instructional content. The instruments were trail tested on a sample of students similar to the target population to examine the clarity of instructions, item difficulty, and overall suitability of the test format. This trail administration provided additional insights that informed further improvements. By incorporating expert judgment and empirical feedback, the EIRS demonstrated strong content validity, making it a reliable tool for assessing students' interest in energy concepts within the context of this study. The average validity indices for EIRS is 0.84 and

for EAT is 0.82. The validation process confirmed that the instruments were well-suited for measuring interest and achievement.

experimental group, the research assistant administered the pretest, with the scores serving as covariates for subsequent analysis. Following the pretest, the research assistant conducted the treatment over five weeks, teaching energy concepts using the Laboratory Approach. After the treatment period, a posttest was administered and scores recorded. The data from the pretests and

posttests of both groups were analyzed to assess the effect of the different teaching approaches on students' achievement.

Data were analyzed using both descriptive and inferential statistics. Descriptive statistics, including mean and standard deviation, were used to answer the research questions, while inferential statistics, specifically Analysis of Covariance (ANCOVA), were applied to test the formulated hypotheses at a 0.05 level of significance.

Results

The results of the study are presented according to the research questions and hypotheses.

Research Question One: What are the mean interest rating score of students taught Energy using Laboratory Approach and those taught using conventional teaching method?

Table 1: Mean Interest Rating Scores and Standard Deviations of Students Taught Energy Using Laboratory Approach and the Conventional Method

Methods		PreInterest	PostInterest
LA	Mean	52.60	63.94
	N	48	48
	Std. Deviation	5.085	6.166
CM	Mean	51.05	54.45
	N	55	55
	Std. Deviation	5.310	5.446

Table 1 compares the mean interest rating scores and standard deviations of students taught the concept of energy using two different teaching methods: the Laboratory Approach (LA) and the Conventional Method (CM). Interest was measured both before instruction (PreInterest) and after instruction (PostInterest). For students taught with the

Laboratory Approach (LA), the average interest score increased from a pre-instruction mean of 52.60 to a post-instruction mean of 63.94, indicating a substantial improvement in their interest levels. The standard deviation increased slightly from 5.09 to 6.17, suggesting a modest increase in variability of interest scores after the intervention. For students taught with the Conventional

Method (CM), the mean interest score also increased but to a lesser extent, rising from 51.05 before instruction to 54.45 afterward. The standard deviation remained relatively stable, shifting only slightly from 5.31 to 5.45, indicating consistent variability in interest scores before and after instruction. Overall, the data suggest that the Laboratory Approach

was more effective in enhancing students' interest in energy concepts compared to the Conventional Method, as reflected in the larger increase in mean interest scores. Additionally, the sample sizes were comparable (48 students in LA and 55 in CM), supporting a fair comparison between the two groups.

Hypothesis One: There is no significant difference in the mean interest rating of students taught Energy using Laboratory Approach and those taught using conventional method of teaching.

Table 2 Result of ANCOVA of Students Taught Energy Using Laboratory Approach and the Conventional Method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2797.536 ^a	2	1398.768	48.303	.000
Intercept	1397.715	1	1397.715	48.267	.000
PreInterest	492.625	1	492.625	17.012	.000
Methods	1952.587	1	1952.587	67.428	.000
Error	2895.824	100	28.958		
Total	362704.000	103			
Corrected Total	5693.359	102			

Table 2 presents the results of an ANCOVA analysis comparing the mean interest rating scores of students taught Energy using the Laboratory Approach and the Conventional Method. The analysis reveals a statistically significant difference between the two groups, with an F-ratio of 67.428 and an associated p-value of 0.000. Since this p-

value is less than the 0.05 threshold for significance, the null hypothesis—stating that there is no difference in interest ratings between the two methods—is rejected. The findings suggest that the Laboratory Approach is significantly more effective at increasing student interest in Energy than the Conventional Method.

Research Question Two: What are the mean interest rating score of male and female students taught Energy using Laboratory Approach?

Table 3: Mean Interest Rating Scores and Standard Deviations of Male and Female Students Taught Energy Using Laboratory Approach

Gender		PreInterest	PostInterest
Male	Mean	52.70	63.85
	N	27	27
	Std. Deviation	5.434	6.649
Female	Mean	52.48	64.05
	N	21	21
	Std. Deviation	4.729	5.643

Table 3 presents the mean interest rating and standard deviations of male and female students who were taught energy concepts using the Laboratory Approach, measured before (PreInterest) and after (PostInterest) the teaching intervention. For male students, the average interest score increased from a pre-instruction mean of 52.70 to a post-instruction mean of 63.85, indicating a notable improvement in their interest following the laboratory-based teaching. The standard deviation increased slightly from 5.43 to 6.65, showing a modest increase in the variability of male students' interest scores after the intervention. For female students, the mean interest score also rose from 52.48 before instruction to 64.05 after instruction,

showing a similar positive effect on interest. The standard deviation decreased from 4.73 to 5.64, suggesting that female students' interest scores became slightly more varied post-intervention but overall remained relatively consistent. The number of students was 27 males and 21 females, making both groups reasonably comparable in size. Both male and female students demonstrated an increase in interest after learning through the Laboratory Approach, with females showing a slightly higher post-interest mean score (64.05) compared to males (63.85). This suggests that the Laboratory Approach positively influenced students' interest in energy concepts regardless of gender.

Hypothesis Two: There is no significant difference in the mean interest rating of male and female students taught Energy using Laboratory Approach.

Table 4: Result of ANCOVA of Male and Female Students Taught Energy Using Laboratory Approach

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	153.599 ^a	2	76.800	2.116	.132
Intercept	892.222	1	892.222	24.583	.000
PreInterest	153.147	1	153.147	4.220	.046
Gender	.903	1	.903	.025	.875
Error	1633.213	45	36.294		
Total	198011.000	48			
Corrected Total	1786.812	47			

Table 4 reveals that there is no statistically significant difference in the mean interest ratings of male and female students taught Energy using the Laboratory Approach. An F-ratio of 0.025 and a p-value of 0.875 were obtained, with the p-value exceeding the significance threshold of 0.05. Therefore, the null hypothesis, which posits no difference in interest ratings between genders, was not rejected. This indicates that the Laboratory Approach equally promotes interest in Energy among male and female students. The absence of gender disparity in interest development highlights the method's effectiveness in engaging diverse learners.

Research Question Three: What are the mean achievement scores of students taught Energy using Laboratory Approach and those taught using conventional teaching method?

Table 5 Mean Scores and Standard Deviations of Students Taught Energy Using Laboratory Approach and the Conventional Method

Methods		Pretest	Posttest
LA	Mean	20.17	25.08
	N	48	48
	Std. Deviation	5.171	6.418
CM	Mean	21.31	23.18
	N	55	55
	Std. Deviation	5.470	5.929

Table 4.5 presents the mean scores and standard deviations of students taught energy concepts using two different instructional methods: the Laboratory Approach (LA) and the Conventional Method (CM). The scores were measured both before instruction (pretest) and after instruction (posttest). Students taught with the Laboratory Approach had a pretest mean score of 20.17, which increased to 25.08 after instruction.

This indicates a notable improvement in their academic achievement. The standard deviation increased slightly from 5.17 to 6.42, suggesting a modest rise in the variability of students' scores following the intervention. In contrast, students taught using the Conventional Method had a pretest mean score of 21.31, which rose to 23.18 in the posttest. While there was also an improvement in this group, the increase in mean score was smaller compared to the Laboratory Approach group. The standard deviation increased marginally from 5.47 to

5.93, indicating relatively consistent variability before and after instruction. The sample size for the Laboratory Approach group was 48 students, while the Conventional Method group consisted of 55 students. Overall, both teaching methods resulted in improved student performance; however, the greater increase in mean scores for the Laboratory Approach suggests that it may be more effective in enhancing students' understanding of energy concepts compared to the Conventional Method.

Hypothesis Three: There is no significant difference in the mean achievement scores of students taught Energy using Laboratory Approach and those taught using conventional method of teaching.

Table 6 Result of ANCOVA of Students Taught Energy Using Laboratory Approach and the Conventional Method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2189.626 ^a	2	1094.813	63.033	.000
Intercept	257.948	1	257.948	14.851	.000
Pretest	2096.950	1	2096.950	120.730	.000
Methods	209.800	1	209.800	12.079	.001
Error	1736.898	100	17.369		
Total	63591.000	103			
Corrected Total	3926.524	102			

Table 6 presents the ANCOVA results comparing the achievement scores of students taught Energy using the Laboratory Approach and the Conventional Method. A significant difference was observed, with an F-ratio of

12.079 and a p-value of 0.001. The null hypothesis, which states no difference in achievement scores between the two methods, was rejected. This finding reinforces the effectiveness of the Laboratory Approach in

promoting greater achievement compared to the Conventional Method. The significant influence of pretest scores ($F = 120.730$, $p =$

0.000) also emphasizes the importance of prior knowledge in shaping learning outcomes.

Research Question Four: What are the mean achievement scores of male and female students taught Energy using Laboratory Approach?

Table 7 Mean Scores and Standard Deviations of Male and Female Students Taught Energy Using Laboratory Approach

Gender		Pretest	Posttest
Male	Mean	22.11	28.30
	N	27	27
	Std. Deviation	5.056	5.312
Female	Mean	17.67	20.95
	N	21	21
	Std. Deviation	4.235	5.315

Table 7 shows the mean scores and standard deviations of male and female students taught energy concepts using the Laboratory Approach, measured before (pretest) and after (posttest) instruction. Male students had a pretest mean score of 22.11, which increased to 28.30 after the instructional period, indicating a significant improvement in their academic achievement. The standard deviation slightly increased from 5.06 to 5.31, suggesting consistent variability in the scores before and after the treatment. Female students had a lower pretest mean score of

17.67, which improved to 20.95 in the posttest. Although females also showed improvement, their mean scores remained lower than those of the males both before and after instruction. The standard deviation increased from 4.24 to 5.32, indicating a slight increase in the spread of scores after instruction. The sample sizes were 27 males and 21 females. Overall, while both genders showed gains in achievement using the Laboratory Approach, male students performed better than female students in both the pretest and posttest assessments.

Hypothesis Four: There is no significant difference in the mean achievement scores of male and female students taught Energy using Laboratory Approach.

Table 8 Result of ANCOVA of Male and Female Students Taught Energy Using Laboratory Approach

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1088.646 ^a	2	544.323	28.918	.000
Intercept	319.458	1	319.458	16.972	.000
Pretest	451.561	1	451.561	23.990	.000
Gender	185.515	1	185.515	9.856	.003
Error	847.021	45	18.823		
Total	32136.000	48			
Corrected Total	1935.667	47			

Table 4.8 presents the ANCOVA results for male and female students' achievement scores when taught Energy using the Laboratory Approach. The analysis reveals a significant difference in achievement between genders, with an F-ratio of 9.856 and a p-value of 0.003. The null hypothesis—stating no difference in achievement scores between male and female students was rejected. These findings indicate that male students achieved

significantly higher posttest scores than female students, even after controlling for pretest differences. While the Laboratory Approach is effective overall, the results suggest that male students may derive greater benefits from this method. This calls for targeted strategies to ensure equitable learning outcomes and address potential barriers to female students' success in interactive learning environments.

Discussion of Findings

The study revealed that students taught energy concepts using the Laboratory Approach showed significantly higher interest compared to those taught using the Conventional Method. This finding aligns with earlier research by Clement and Opara (2020), which emphasized that laboratory-based teaching enhances students' motivation and engagement by providing opportunities

for hands-on learning. Similarly, Ugwuanyi, Elejere, Gana, Josiah, Abraham, Ugwuanyi, Ezeugwu and Ogili (2019) found that interactive and practical approaches, such as laboratory activities, stimulate curiosity and engagement, making abstract concepts more relatable and meaningful for students. The Laboratory Approach fosters active involvement, curiosity, and problem-solving, which naturally triggers situational interest. As posited by Pekrun's Control-Value

Theory, this approach enhances students' perception of control (they actively engage in experiments and make decisions) and value (they see the relevance of their learning). This heightened interest is also supported by Vygotsky's Sociocultural Theory, which underscores the role of interactive, socially mediated learning experiences in fostering cognitive and emotional development. The Conventional Method, by contrast, relies heavily on teacher-centered instruction and rote learning, which may limit students' sense of control and relevance, leading to lower engagement and interest. The Laboratory Approach aligns with the Control-Value Theory by creating a learning environment that enhances control (students manipulate variables and explore outcomes) and value (real-life applications of energy concepts), thus fostering sustained interest. This approach aligns with the principle of social constructivism, as the collaborative and interactive nature of laboratory work provides a "zone of proximal development" where students can achieve higher learning outcomes with the support of peers and teachers. Akinwumi and Falemu (2020); Ojo and Owolabi (2020) and Ezra and Agah (2019) also found that students exposed to laboratory-based instruction scored higher on assessments due to their improved conceptual understanding and critical thinking skills. The absence of gender differences in interest suggests that the Laboratory Approach is

inherently inclusive and engaging for both male and female students. However, achievement differences may stem from external factors, such as prior exposure to STEM content, societal expectations, and confidence levels, which often favor male students in science-related subjects. The theory explains the equal levels of interest in terms of shared situational triggers in the laboratory environment. However, differences in achievement may be influenced by varying levels of achievement emotions, such as anxiety or confidence, which are shaped by sociocultural contexts. The Laboratory Approach supports collaborative learning across genders. However, achievement differences may indicate that scaffolding and guidance were not equally effective for all students, potentially due to pre-existing skill gaps or differences in support needs.

Conclusion

The findings suggest that the Laboratory Approach significantly outperforms the Conventional Method in both fostering student interest. Students taught using the Laboratory Approach showed greater increases in interest and achievement, highlighting the benefits of interactive, hands-on learning experiences in science education. While both male and female students benefited from the Laboratory Approach.

However, no significant gender disparity in interest was found, suggesting that both male and female students equally engage with the method. The results also underscore the importance of considering pretest scores, as prior knowledge was found to significantly influence posttest outcomes. This emphasizes the need for tailored instructional strategies that account for individual students' starting points.

Recommendation

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

1. Schools and educational institutions should adopt the Laboratory Approach more extensively due to its proven effectiveness in enhancing students' interest and academic achievement. Emphasis should be placed on interactive, hands-on learning experiences that actively engage students and improve conceptual understanding.
2. The observed difference in achievement between male and female students highlights the need for gender-responsive interventions. Educators should provide additional encouragement, mentorship, and resources designed to help female students fully benefit from the Laboratory Approach, thereby bridging the performance gap between genders.
3. Teachers should be provided with continuous professional development opportunities focusing on laboratory-

based instructional strategies. Training should emphasize the design and facilitation of engaging experiments, safety procedures, and effective classroom management techniques to ensure active participation and learning for all students.

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