

Enhancing Intermediate Science Students' Understanding of Scientific Concepts in Photosynthesis Using a Contextual Teaching Approach

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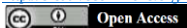
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ABSTRACT

The study investigated on enhancing Intermediate Science students' understanding of scientific concept on photosynthesis using contextual teaching approach. The study utilized a quasi-experimental pretest-posttest design. The population consisted of all Junior Secondary School 2 (JSS2) Intermediate Science students in the Etinan Local Government Area of Akwa Ibom State. 89 JSS2 students from two intact classes constituted the study sample. The instrument used for data collection was the Intermediate Science Test on Photosynthesis (ISTP). To ensure its validity, the ISTP underwent face and content validation by experts. The reliability of the ISTP was determined using the Kuder-Richardson Formula 20 (KR-20), yielding a coefficient of 0.81. Data were analysed using mean and standard deviation to answer the research questions, while Analysis of Covariance (ANCOVA) tested the hypotheses at a 0.05 significance level, controlling for pre-test scores. The result of findings revealed that there was a significant difference in the mean performance of Intermediate science students taught the concept of photosynthesis using contextual and conventional teaching approaches in favour of students taught using contextual and teaching approach. Also, there was no significant difference in the mean performance of male and female Intermediate science students taught the concept of photosynthesis using contextual and conventional teaching approaches. The study concluded that the contextual teaching approach has the potential to enhance Intermediate Science students' understanding of the scientific concept of photosynthesis more effectively than the conventional teaching approach. It was recommended among others that Intermediate Science teachers should adopt the contextual teaching approach when teaching photosynthesis by relating the concept to familiar experiences, such as plant growth, sunlight, water absorption, and food production in plants.

Introduction

Science is the systematic process of obtaining verifiable knowledge and experimentation about the universe, the structure and reaction of matter, including dynamic human activity which is concerned with understanding the working of the world, which helps man to explore his environment and other planets of the universe. It is the substratum of modern-day technological breakthroughs, where countries all over the world, especially the developing ones like Nigeria, among others, are striving hard to develop scientifically, since the world is turning scientific and all proper functioning of lives depends greatly on science (Umoh et al., 2026; Akpan et al., 2025).

Science education occupies a strategic position in national development because it equips learners with the knowledge, skills, and competencies required for scientific advancement, technological innovation, and economic growth. The achievement of students in science subjects such as Physics, Chemistry, Biology, and Basic Science has therefore become a major concern among educators,

policymakers, and stakeholders in education (Uboh et al., 2026). As a body of knowledge and a systematic process of inquiry, science equips learners with the intellectual tools required to understand natural phenomena, solve problems, and make informed decisions (Ntegwung, et al., 2026).

Consequently, developing students' scientific understanding requires active engagement in scientific processes, enabling them to construct meaningful knowledge and apply scientific concepts to explain natural phenomena and solve real-life problems (Oyakhirome & Akpan, 2024). This scientific understanding drives students with innovative ideas, emphasizes analytical thinking, and provides creative solutions to real-world problems (Etiubon & Akpan, 2015). It also prepares students for future jobs and global competitiveness. It also focuses on developing students' scientific literacy that will equip them to be rational and participative citizens having societal impact (Akpan et al., 2023). However, the foundational education of engaging students in science and technology processes commences from primary education and continues through Junior Secondary Schools (JSS) as Basic Science and Basic Technology, now Intermediate Science (Umoetuk et al., 2025a).

Intermediate Science, recognized as a crucial subject, is imparted during the foundational (primary and Junior Secondary) educational level, serving as the cornerstone upon which the core scientific disciplines such as Biology, Chemistry, and Physics during senior secondary education are established (Umoetuk & Akpan, 2023; Umoetuk et al., 2026). Intermediate Science or Basic Science and technology at the primary level or at the Junior Secondary level is the bedrock develop interest, as well as prepare for further studies in science and technology (Akpan, 2022). Basic Science and Technology (BST) forms the bedrock of science education, being a subject delivered at the primary and junior secondary levels with the aim of cultivating scientific literacy, technological understanding, and critical thinking abilities (Umoetuk et al., 2025b). Its curriculum is designed to lay a solid foundation for the study of major science subjects such as Biology, Physics, and Chemistry. At this level, Intermediate Science is considered vital for student placement in the science stream, as it serves as a prerequisite for future studies in core sciences. Beyond academic progression, the subject equips students with fundamental scientific knowledge towards understanding everyday life, environmental awareness, and problem-solving skills (Etiubon & Udo, 2024; Utibe & Onwioduokit, 2019). However, the basis for acquiring and learning these skills is laid in elementary science. Thus, in Nigeria, it is divided into Basic Science for elementary pupils in grades one to six and Upper Basic Science for secondary school classes in years seven to nine (Nwosu et al., 2022). Having encountered science at the elementary level, these students should be able to consolidate their scientific process skills before studying it at the Senior Secondary level, ages ten to twelve. The Nigeria National Policy on Education has stated that an objective of Junior Secondary Education is “to provide the child with diverse basic knowledge and skills for entrepreneurship and educational advancement” (FRN 2013).

Despite the importance of Basic Science in fostering scientific understanding and preparing students for advanced science education, many school students continue to exhibit poor scientific understanding of fundamental scientific concepts. Among these concepts, photosynthesis remains one of the most challenging, as students often find it difficult to understand the process, the role of sunlight, chlorophyll, carbon dioxide, and water, as well as the relationship between photosynthesis and the survival of living organisms (Dimec & Strgar, 2017). This poor scientific understanding has resulted in misconceptions, inability to explain scientific phenomena correctly, and persistently low academic performance in Basic Science examinations.

The poor understanding of scientific concepts has largely been attributed to the continued use of teacher-centred instructional approaches that emphasize memorization of facts rather than meaningful learning and the application of scientific knowledge to real-life situations (Bhardwaj et al., 2025). As a result, students acquire fragmented knowledge, making it difficult for them to relate classroom learning

to their everyday experiences or develop a deep conceptual understanding of scientific concepts such as photosynthesis. To address these learning challenges, contextualized learning has emerged as a valuable instructional approach. By connecting academic content with real-world scenarios, contextual approach enhances student engagement, deepens scientific understanding, improves students' performance and enhance knowledge retention (Abdullah & Shohib, 2025).

Contextual teaching approach is a way of presenting lesson material by exposing students to problems that must be solved or resolved in order to achieve educational goals associated with everyday life. It is a teaching approach that helps teachers associate material taught with real world situations and encourages students to make connections between their knowledge and their application in their lives as family members and society (Dewi & Primayana, 2019). Contextual learning has provided the widest opportunity for students in groups or working together to develop and integrate a physics problem. Contextual teaching approach supports this process by linking lessons to real-life contexts, emphasizing student engagement, problem discovery, and practical application through six stages: constructivism, questioning, learning community, modeling, reflection, and authentic assessment (Abdullah & Shohib, 2025). This approach emphasizes the importance of relating the subject matter to students' real-life contexts, allowing them to understand and apply the concepts learned in everyday situations.

Madale et al. (2025) posited that contextual approach encourages meaningful interactions between students and teachers, thereby increasing motivation and supporting more effective learning through essential learning components, including inquiry-based learning, questioning strategies, learning communities, modeling, reflection, and authentic assessment. These components encourage students to explore scientific phenomena and understanding, engage in collaborative discussion, and reflect on learning performance. Such learning experiences are aligned with modern science education goals that prioritize inquiry, reasoning, and scientific problem-solving (Salma & Susanti, 2025). Rahmawati et al. (2022) has asserted that research has shown that contextual approach can significantly boost student interest and academic performance across disciplines. Ultimately, contextualized learning transforms the educational experience into one that is dynamic, interactive, and relevant, preparing learners for academic success and professional competence (Sudira & Wiyasa, 2020). Additionally, Oludipe (2022) found that there was no significant difference in academic performance and scientific understanding as a function of students' gender.

Gender is another crucial variable that warrants consideration in this study. It is a socio-cultural construct that delineates certain characteristics and duties that are ascribed to individuals based on their identification as male or female within society. Gender is the socially constructed roles, behaviours, and expectations associated with being male or female (Umanah & Atabang, 2025; Akpan & Akpan, 2017). It is used to indicate the distinction between human beings in terms of masculinity and femininity, in relation to their expected roles and how each perceives science learning (Ukpong et al., 2026). Umanah and Akpan (2024) defined gender as the range of attributes, roles, expectations, and behaviors that a society assigns to individuals based on their perceived identity as male or female. However, gender factors have been addressed through sensitization by governments, NGOs, and scholars, yet the gender disparity in BST performance persists (Mbuk et al. 2025). This therefore indicates that the reasons for the disparity in gender and students' performance in Intermediate Science have not been identified and therefore necessitate more research. The need to provide solutions to secondary school students' poor performance in Intermediate Science, especially when related to scientific understanding of concepts.

Umoetuk and Akpan (2023) and Umoetuk et al. (2025) found that females performed better than males in Basic Science and Technology. Etukakpan et al. (2025) and Akpan (2022) asserted that there was no significant difference in the performance mean scores between male and female students taught the concept of cell structure. Akpan, et al. (2025) and Sunday et al. (2025) also asserted that there is no

significant effect of gender on academic performance. Ukpong et al. (2026b) also asserted that gender difference was not statistically significant on students' academic achievement. In view of the inconsistent findings reported in previous studies, this study sought to examine the effect of the contextual teaching approach on intermediate science students' scientific understanding of the concept of photosynthesis, with emphasis on improving conceptual understanding and students' academic performance in Intermediate Science in Etinan Local Government Area.

Statement of the Problem

Despite the importance of Intermediate Science in developing scientific knowledge and preparing students for further studies, students continue to demonstrate poor scientific understanding of important concepts, including photosynthesis, among others. This challenge is often reflected in students' inability to explain scientific phenomena, relate concepts to real-life situations, and apply acquired knowledge in solving problems, resulting in persistent poor academic performance in Intermediate Science. The problem has been attributed largely to the continued use of teacher-centred instructional methods that encourage memorization rather than meaningful conceptual understanding. To address this challenge, innovative learner-centred approaches have been advocated. One such approach is the contextual teaching approach, which connects scientific concepts to students' everyday experiences, thereby promoting active participation, meaningful learning, and deeper scientific understanding. Although studies have reported the effectiveness of contextual teaching in enhancing students' learning outcomes, there is limited empirical evidence on its influence on intermediate science students' scientific understanding of photosynthesis. This gap necessitated the present study on enhancing Intermediate Science students' understanding of the concept of photosynthesis using the contextual teaching approach.

Research Question

1. What is the difference in the mean performance of Intermediate science students taught the concept of photosynthesis using contextual and conventional teaching approaches?
2. What is the difference in the mean performance of male and female Intermediate science students taught the concept of photosynthesis using contextual and conventional teaching approaches?

Hypotheses

The following null hypotheses were formulated

1. There is no significant difference in the mean performance of Intermediate science students taught the concept of photosynthesis using contextual and conventional teaching approaches.
2. There is no significant difference in the mean performance of male and female Intermediate science students taught the concept of photosynthesis using contextual and conventional teaching approaches.

Methodology

The study utilized a quasi-experimental pretest-posttest design. The population consisted of all Junior Secondary School 2 (JSS2) Intermediate Science students in the Etinan Local Government Area of Akwa Ibom State. The study was carried out in Etinan Local Government Area, which is located within the South-South part of Nigeria as well as the North East zone of Akwa Ibom State. This area includes eleven (11) public coeducational secondary schools, totaling 2,442 Intermediate Science students. 89 JSS2 students from two intact classes constituted the study sample. These students were chosen using a simple random sampling method, specifically through balloting, from two public coeducational secondary schools in the area. The instrument used for data collection was the

Intermediate Science Test on Photosynthesis (ISTP). To ensure its validity, the ISTP underwent face and content validation by an Intermediate Science teacher, an expert in test, measurement, and evaluation, and a lecturer from the Science Education Department, Faculty of Education, Akwa Ibom State University. The research instrument was subjected to trial testing to measure its internal consistency using 20 students in JSS2 in a school entirely different from the sample of the study. The reliability of the ISTP was determined using the Kuder-Richardson Formula 20 (KR-20), yielding a coefficient of 0.81.

Two teaching packages were developed to implement the contextual and conventional teaching approaches. Permission was obtained from school authorities, and a pre-test was administered to both groups to establish baseline equivalence. Students in group one were taught the concept of photosynthesis using contextual teaching approach. Students in group two were taught the same concept using conventional teaching approach. After the treatment, a post-test was administered. Data were analysed using mean and standard deviation to answer the research questions, while Analysis of Covariance (ANCOVA) tested the hypotheses at a 0.05 significance level, controlling for pre-test scores

Results

Research Question One: What is the difference in the mean performance of Intermediate Science students taught the concept of photosynthesis using contextual and conventional teaching approaches?

Table 1: Mean and standard deviation of students' performance scores on pretest and posttest based on teaching approaches

Teaching Approach	N	Pretest Mean	SD	Posttest Mean	SD	Mean Gain
Contextual Teaching Approach	4	35.54	10.2	75.52	14.1	39.9
Conventional Teaching Approach	4	35.62	12.0	60.17	21.8	24.5

The results in Table 1 show that students taught the concept of photosynthesis using the contextual teaching approach recorded a pretest mean score of 35.54 with a standard deviation of 10.20, which increased to a posttest mean score of 75.52 with a standard deviation of 14.11, resulting in a mean gain of 39.98. Students taught using the conventional teaching approach recorded a pretest mean score of 35.62 with a standard deviation of 12.07 and a posttest mean score of 60.17 with a standard deviation of 21.82, producing a mean gain of 24.55. A comparison of the mean gains indicates that students taught using the contextual teaching approach achieved a higher gain than those taught using the conventional teaching approach. This suggests that both approaches improved students' performance in photosynthesis, but the contextual teaching approach produced greater improvement.

Research Question Two: What is the difference in the mean performance of male and female Intermediate Science students taught the concept of photosynthesis using contextual and conventional teaching approaches?

Table 2: Mean and standard deviation of students' performance scores on pretest and posttest based on gender and teaching approach



Teaching Approach	Gender	N	Pret est Mean	SD	Postt est Mean	SD	Mean Gain
Contextual	Male	2	36.1	8.8	76.5	13.	40.
		0	4	4	2	40	38
	Female	2	35.1	11.	74.7	14.	39.
		3	0	22	9	79	69
Conventional	Male	2	35.3	8.4	59.8	23.	24.
		2	3	4	7	37	54
	Female	2	35.7	13.	60.3	21.	24.
		4	5	57	1	44	56

Table 2 shows that under the contextual teaching approach, male students improved from a pretest mean score of 36.14 with a standard deviation of 8.84 to a posttest mean score of 76.52 with a standard deviation of 13.40, producing a mean gain of 40.38. Female students improved from a pretest mean score of 35.10 with a standard deviation of 11.22 to a posttest mean score of 74.79 with a standard deviation of 14.79, resulting in a mean gain of 39.69. This indicates that both male and female students benefited from the contextual teaching approach, although male students recorded a slightly higher mean gain. Under the conventional teaching approach, male students improved from a pretest mean score of 35.33 with a standard deviation of 8.44 to a posttest mean score of 59.87 with a standard deviation of 23.37, producing a mean gain of 24.54. Female students improved from a pretest mean score of 35.75 with a standard deviation of 13.57 to a posttest mean score of 60.31 with a standard deviation of 21.44, resulting in a mean gain of 24.56. Overall, the descriptive results indicate that the contextual teaching approach produced greater achievement gains for both male and female students than the conventional teaching approach. The differences between male and female students within each approach were relatively small.

Test of Hypotheses

Hypothesis One: There is no significant difference in the mean performance of Intermediate Science students taught the concept of photosynthesis using contextual and conventional teaching approaches.

Table 3: ANCOVA of Students' Understanding of Photosynthesis by Teaching Approach

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6330.571	2	3165.286	9.590	.000
Intercept	30308.294	1	30308.294	91.823	.000
Pretest Score	622.349	1	622.349	1.885	.173
Teaching Approach	5721.310	1	5721.310	17.334	.000
Error	28375.000	86	329.942		
Total	486974.000	89			
Corrected Total	34705.571	88			

The result in Table 3 indicates that teaching approach had a statistically significant effect on students' understanding of photosynthesis, ($F(1,86)=17.334$, $p<.05$). Therefore, the null hypothesis was rejected. This suggests that students' performance differed significantly according to whether they were taught using the contextual or conventional teaching approach. Based on the descriptive results, students

taught using the contextual teaching approach recorded a higher mean performance than those taught using the conventional approach.

Hypothesis Two: There is no significant difference in the mean performance of male and female Intermediate Science students taught the concept of photosynthesis using contextual and conventional teaching approaches.

Table 4: ANCOVA of Students' Understanding of Photosynthesis by Gender

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	729.488	2	364.744	.936	.396
Intercept	30733.060	1	30733.060	78.872	.000
Pretest Score	600.537	1	600.537	1.541	.218
Gender	120.227	1	120.227	.309	.580
Error	33400.000	86	388.372		
Total	486974.000	89			
Corrected Total	34129.488	88			

The result in Table 4 indicates that gender did not have a statistically significant effect on students' understanding of photosynthesis, ($F(1,86)=0.309$, $p=.580$). Since the significance value was greater than .05, the null hypothesis was not rejected. This suggests that there was no statistically significant difference between the adjusted mean performance of male and female students in the analysis.

Discussion of Findings

The findings of the study revealed that students taught the scientific concept of photosynthesis using the contextual teaching approach recorded a higher mean gain in performance than those taught using the conventional teaching approach. This suggests that contextual teaching may enhance students' understanding of photosynthesis by connecting scientific concepts to familiar experiences and situations in their environment. Through this approach, students can relate the processes involved in photosynthesis to observable phenomena, such as the growth of plants, the role of sunlight, and the importance of water and carbon dioxide in food production. These connections may make abstract scientific ideas easier to understand and retain. The finding agrees with Rahmawati et al. (2022), who asserted that contextual teaching can significantly improve students' interest and academic performance across disciplines. It also aligns with Salma and Susanti (2025), who emphasised the importance of inquiry, reasoning, and scientific problem-solving in contemporary science education. Furthermore, Sudira and Wiyasa (2020) observed that contextualised learning makes educational experiences more interactive and relevant to learners. The implication is that teaching photosynthesis through meaningful real-life contexts may help students develop a deeper understanding of the concept rather than relying solely on memorisation of scientific facts.

The findings concerning gender indicated that the mean performance of male and female students taught using the contextual teaching approach was relatively similar. This suggests that the approach may support the understanding of photosynthesis among both male and female students without a substantial difference in their mean performance. The finding is consistent with Oludipe (2022), who reported no significant difference in students' academic performance and scientific understanding based on gender. It also agrees with Etukakpan et al. (2025) and Akpan (2022), who reported no significant difference between the mean performance scores of male and female students taught cell structure. Similarly, Akpan et al. (2025), Sunday et al. (2025), and Ukpong et al. (2026b) reported that gender did

not have a statistically significant effect on students' academic achievement. These findings suggest that the use of an appropriate teaching approach may provide male and female students with comparable opportunities to understand scientific concepts. However, Umoetuk and Akpan (2023) and Umoetuk et al. (2025) found that female students performed better than male students in Basic Science and Technology. This difference in previous findings indicates that gender-related performance patterns may vary across subject areas, learning contexts, and instructional experiences. Therefore, science teachers should provide equal opportunities for participation and learning rather than assume that either male or female students will perform better in photosynthesis.

Conclusion

Based on the findings, the study concludes that the contextual teaching approach has the potential to enhance Intermediate Science students' understanding of the scientific concept of photosynthesis more effectively than the conventional teaching approach. By relating scientific ideas to familiar experiences and observable events, contextual teaching can make learning more meaningful and promote students' active engagement with scientific concepts. The findings also suggest that male and female students can benefit from the approach without a substantial difference in their mean performance. Consequently, the contextual teaching approach is a promising instructional option for improving students' understanding of photosynthesis and supporting inclusive science education.

Recommendations

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

1. Intermediate Science teachers should adopt the contextual teaching approach when teaching photosynthesis by relating the concept to familiar experiences, such as plant growth, sunlight, water absorption, and food production in plants.
2. School administrators should encourage and support the use of contextual teaching approaches by providing relevant instructional materials, including living plants, charts, models, and other locally available resources that help students connect scientific concepts with real-life situations.
3. Education authorities and professional development providers should organise workshops and training programmes for Intermediate Science teachers on how to plan and implement contextual lessons, particularly for abstract scientific concepts such as photosynthesis, to improve students' understanding and learning outcomes.

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