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Teaching-learning of Biology for sustainable development: The use of strategic intervention materials

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Abstract
The research examines how Strategic Intervention Material affects the Academic Achievement of Biology Students in Senior Secondary Schools within Epe Local Government Area, Lagos state. The study uses a pre-test, post-test control group quasi-experimental design with a 2x2 factorial matrix. The sample size consists of 239 SSII students from public co-education secondary schools in the study area. Four schools were randomly selected, with two schools each assigned to the experimental and control groups. The research instruments include the Strategic Intervention Material (SIM) in biology, a lesson plan, and a 20-item multiple-choice biology achievement test (BAT), which was subjected to thorough face and content validity and had a reliability coefficient of 0.82 using the Kuder-Richardson 21 formula. Three hypotheses were formulated to guide the study and were analyzed using descriptive and inferential statistics of the t-test. The study found a significant main effect of the strategy on the academic achievement of biology students. Students who were exposed to the use of the strategic intervention material package obtained significantly higher mean scores than their counterparts in the conventional group. The study also found no significant difference between the mean achievement scores of male and female students exposed to the SIM package. It is recommended that SIM should be incorporated into teacher education programs in tertiary institutions to educate teachers in training about its importance and use, and seminars, conferences, and workshops should be organized for in-service secondary school teachers to train them in the knowledge and skills of its effective use to enhance student academic achievement in biology.

Keywords: SIM, Achievement, Instructional Strategies, Method, Sustainable Development

Introduction

Teaching science entails educating those outside the scientific community about scientific concepts and practices. It has been recognized as a keystone for Nigeria's sustainable development, including benefits such as raising environmental consciousness and assisting in the acquisition of knowledge pertinent to science (Salami, 2021). According to Agarkar (2017), a country cannot advance without scientific education. Because of its importance and relevance to life and society, science is thus being given a lot of attention in education (Darling-Hammond et al., 2019). The scientific study of living organisms is known as biology. It greatly advances the country's technical advancement and is a prerequisite subject for many academic fields. Learning about biology can provide students with practical ideas, tenets, and theories that will help them overcome obstacles in life. Given its application to agriculture, pharmacy, medicine, biotechnology, biochemistry, microbiology, and other related sectors, biology education is crucial for the sustainable growth of the country. The scientific study of living things, such as plants and animals, is known as biology. This area of study includes an analysis of their interactions, growth, evolution, structure, and function within their own ecosystems. Biology is essential to comprehending biodiversity, conservation initiatives, and the effects of environmental changes on different species both in Nigeria and beyond (Anwadike, 2020). The utilization of biology permeates every aspect of human existence, making it the cornerstone of human survival. Numerous fields, including bioinformatics, bio-fermentation, bioremediation, biofuels, and many more, use biology (Sallau et al., 2018).

Achieving sustainable development requires a strong foundation in biology and biology education (Sallau et al., 2018). Sustainable development is the ability of the present human generation to meet its needs without jeopardising the ability of future generations to meet their own. The unchecked exploration and exploitation of natural resources has been linked to the decline of several environmental components over time. These

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resources might soon run out if this keeps going unchecked (Subramanian, 2018). According to French (2019), synthetic biology has the prospect of creating new products, services, and supplies that can help the United Nations achieve its sustainable development goals for 2020. The report also urged developing countries like Nigeria to support synthetic biology in order to benefit from the products that result from it. This demonstrates how biology can be used to promote sustainable development. According to the chief examiner's report of the West African Examinations Council (WAEC), Nigerian students perform poorly in biology. This implies that the application of biology to sustainable development may not happen as quickly as anticipated (Onanuga et al., 2020). The table below demonstrates the performance of students in Biology examinations conducted by the WAEC over the periods from 2013 to 2018

Table 1: Students Performance in WAEC Biology Examination

S/n	Year	Total number of candidates	% pass	%fail
1.	2013	182659	21	79
2.	2014	228953	35	65
3	2015	250099	34	66
4	2016	289520	29	71
5.	2017	326541	30	70
6	2018	367562	33	67

Source: (Chukwu & Arokoyu, 2019)

The chief examiner's reports have often underlined the necessity for teachers to engage students with activity-based methodologies in the teaching of biology as part of the steps to address the unpleasant trends in students' performance. Teachers should teach students how to draw biological diagrams and encourage them to do so, according to the WAEC chief examiners' reports from 2018, 2019, and 2020. In order to support their teaching, they should also regularly attend seminars and workshops, encourage teachers to take part in WAEC coordination and marking exercises, and offer teaching tools and models to help students comprehend biological concepts. As a result, there is a critical need to use student-centered, activity-based teaching practices that will engage students in all subject areas in the classroom. Using strategic intervention material (SIM) is one method that can help students close the learning gaps in biology. It is the goal of strategic intervention materials (SIM) to re-teach students topics and skills that they have not yet acquired. These resources are essential for filling up knowledge gaps and improving comprehension in students (Dacumos, 2016; Sadsad, 2022).

Teachers may give students Strategic Intervention Material (SIM) materials to assist them in mastering competency-based skills that they were not able to acquire during scheduled classroom instruction. These materials include content enhancement for teachers as well as learning strategies for students (Suarez & Casinillo, 2020). It is a comprehensive strategy to assist students in becoming successful and self-sufficient. The goal of strategic intervention materials (SIM) is to support educators and give students the tools they need to succeed in their academic endeavours. These resources seek to improve and expand students' abilities, comprehension, and knowledge in a variety of subject areas, including science, math, and other areas of the curriculum (Cagape et al., 2023; Segarino et al., 2022). After students have grasped the material, answering questions properly and with ease leads to improved academic achievement.

Furthermore, in order to aid students in mastering the material, SIMs frequently re-teach topics that are unclear to them. Each intervention resource consists of five parts: the guide card, activity card, assessment card, enrichment card, and reference card. The guide card stimulates students' interest in the subject matter by offering a preview of what they will learn. The activity card communicates the focus skills in at least three tasks. Students can assess their understanding of the material they have studied, make any necessary corrections, monitor their progress, and use feedback to get better with the exercises, drills, and tasks on the evaluation card. The enrichment card gives students opportunities to apply what they have learnt to different topic areas or contexts and offers exercises that reinforce the lesson's content, while the reference card offers additional reading to the students (Arpilleda, 2021). The use of strategic intervention materials (SIM) to improve biology instruction in Nigerian secondary schools with an eye towards sustainable development has not received much research. To the best of the researchers' knowledge, the majority of these studies are conducted outside of the nation.

According to UNICEF (2011), gender differences should not lead to a gap in academic achievement between males and females because research indicates that students' academic performance in school topics is influenced

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by their gender. Research results on the gender disparity in students' science achievement, however, have generated debate. Gender has a major effect on students' academic performance in physics, according to research by Afolabi and Olajuyigbe (2018). Following exposure to the jigsaw instructional technique, researchers have similarly documented a substantial difference in the mean biology scores of male and female students, favouring the males (Amedu, 2015). Ariyo and Gabriel's (2018) study, on the other hand, found no evidence of a gender difference in biology students' academic performance in Ekiti State, Nigeria, despite examining the effectiveness of two novel methodologies. Furthermore, when exposed to an investigative laboratory technique, male and female students' mean achievement scores in biology did not significantly differ, according to Abakpa et al. (2016). What has been said thus far makes it clear that there is further work to be done on the gender gap in pupils' academic achievement. As a result, the current study chooses to include gender as a moderating factor.

This study is grounded in three key theories: Bandura's social learning theory (Bandura, 1969), which asserts that people learn from one another through imitation, modelling, and observation; Vygotsky's social development theory (Vygotsky, 1978), which emphasizes the critical role of social interaction in cognitive development; and the constructivist approach, which suggests that new concepts are built upon existing knowledge (Von Glasersfeld, 2012).

Research objectives

The purpose of the study was to determine how biology students in Lagos State's Epe Local Government area fared academically in response to strategic intervention materials. In particular, the research;

1. to investigate the relative effectiveness of strategic intervention material (SIM) on students' academic achievement in biology.
2. to determine the moderating effect of gender on students' academic achievement in biology.

Hypotheses

The study was guided by the following hypotheses tested at a 0.05 level of significance.

$H0_1$: There is no significant difference in the level of SS2 students' achievement in Biology.

$H0_2$: There is no significant difference in the mean achievement scores of biology students exposed to Strategic Intervention Material (SIM) and the lecture method.

$H0_3$: There is no significant difference in the mean achievement scores of male and female biology students exposed to Strategic Intervention Material (SIM).

Materials and Methods

A 2x2 factorial matrix with a quasi-experimental pre-test and post-test control group design was employed in the study. The participants in the study were all biology students enrolled in Epe Local Government Area, Lagos State's public coeducational secondary school II (S.S. II). Through the use of a straightforward random sampling technique, a sample of 239 S.S.II biology students from four schools' intact classes were selected. The instruments used to gather the data were the lesson plan, the biological strategic intervention material (SIM) package, and a 20-item multiple-choice achievement test (BAT) with a reliability coefficient of 0.87 based on the Kuder Richardson 21 (KR 21) formula. The SIM method differs from the traditional lecture method in its treatment by providing students with structured, targeted intervention materials that are designed to directly address specific learning gaps, thereby offering personalized reinforcement of key concepts. In contrast, the lecture method primarily delivers content in a general manner, emphasizing the instructor's role in disseminating information, with limited adaptation to individual student needs. Descriptive statistics, specifically frequency counts, mean, and standard deviation, were used to analyse the data. To test the hypotheses at the 0.05 level of significance, t-test inferential statistics were used.

Results

H01: There is no significant difference in the level of SSS II students' achievement in biology between the SIM and lecture method groups.

Table 2: Test of significance for the variation in the mean pretest scores of Biology students in the experimental and control groups.

Group	N	Mean	S.D	Df	Cal t-value	Crit t-value	p-value	Remark
SIM	126	9.79	0.79					Retain H01
Lecture method	113	9.27	0.90	237	0.40322	1.96	0.564205	

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There was no discernible difference between the pretest means scores of the students in the two groups, according to the results from Table 2. This suggests that during the pretest, both groups performed equally well. Following the acceptance of the hypothesis, there was no discernible variation in the biology achievement of SSS II students.

H02: There is no significant difference in the mean achievement scores of biology students exposed to strategic intervention material (SIM) and the lecture method.

Table 3: Test of significance for the difference between the experimental and control groups' mean achievement scores for biology students.

Treatment	N	Mean	S.D	Df	Cal t-value	Crit t-value	p-value	Remark
SIM	126	16.80	1.39					Reject H02
Lecture Method	113	12.76	1.38	237	26.4857	1.96	.001	

The data in Table 3 shows a comparison between the mean achievement scores of biology students who were taught using the Self-Instructional Method (SIM) and those who were taught using the Lecture Method. The experimental group, which received the SIM treatment, had a mean score of 16.80 with a standard deviation of 1.39, while the control group, which was taught using the Lecture Method, had a mean score of 12.76 with a standard deviation of 1.38. The calculated t-value was 26.4857, which is significantly higher than the critical t-value of 1.962 at 237 degrees of freedom and a p-value of 0.001. Since the calculated t-value exceeds the critical value and the p-value is less than 0.05, we reject the null hypothesis (H_o2). This indicates that there is a statistically significant difference in the achievement scores between students taught using the SIM and those taught using the Lecture Method, with the SIM proving to be more effective in enhancing students' achievement in biology.

H03: There is no significant difference in the mean achievement scores of male and female biology students exposed to strategic intervention material (SIM).

Table 4: Test of the significance of the difference between the male and female Biology students in the experimental and control groups.

Treatment	N	Mean	S.d	Df	Cal t-value	Crit t-value	p-value	Remark
Male	54	16.80	1.56					
Female	72	16.81	1.29	124	-0.04342	1.96	0.96544	Retain H03

The results in Table 4 present the comparison of mean achievement scores between male and female biology students in both the experimental and control groups. The male students had a mean score of 16.80 with a standard deviation of 1.56, while the female students had a mean score of 16.81 with a standard deviation of 1.29. The calculated t-value was -0.04342, which is far below the critical t-value of 1.962 at 124 degrees of freedom. The p-value was 0.96544, which is much greater than the threshold of 0.05. Given that the calculated t-value does not exceed the critical t-value and the p-value is well above 0.05, we accept the null hypothesis (H_o3). This result suggests that there is no statistically significant difference in the achievement scores between male and female biology students in the experimental and control groups. The performance of male and female students was essentially equivalent in this study.

Discussion

The study's findings suggest that there is no statistically significant difference in the pretest academic performance of SSS II Biology students. This showed that, as a result of traditional classroom training, all students had about the same starting level of biology knowledge prior to the study's conduct. The results support those of Dumdumaya et al., (2024) and Mojar (2020), who found no statistically significant difference in students' academic achievement in biology from his study analyzing secondary school students' achievement. The results corroborate those of Lazo and de Guzman (2021), who noted in his research that prior to the use of strategic intervention materials in economics, there was no discernible variation in students' academic achievement scores.

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An additional finding demonstrated that biology students who received SIM instruction outperformed their peers who received instructions through the lecture method. Additionally, the hypothesis's outcome demonstrated a substantial difference between biology students exposed to the lecture technique and SIM in terms of their mean achievement scores. This is because SIM allows students to experiment with different theories and notions that deepen and improve their comprehension of the subject. When using the SIM approach, students found learning to be more engaging and intelligible than when studying through lectures, which may occasionally be tedious and challenging. These results corroborate those of Gregorio (2024) and Mojar (2020), who observed from their biology studies that SIM was an effective teaching method for science since students who received SIM instructions performed better than those who received traditional instruction. The findings corroborate a study conducted in Science by Dumdumaya et al. (2024), which found a medium effect size statistical difference in test scores between participants in the experimental and control groups. Manlapig et al. (2024) revealed a statistically significant difference between the learning motivation and academic performance of students using SIM in Physics.

Finally, the study demonstrated that the mean achievement scores of male and female biology students taught with the strategic intervention material were not significant. That is, the findings did not indicate a gender difference among students who were exposed to SIM. This suggests that the approach is not biased towards any one gender and that gender has no bearing on students' performance in biology when using SIM. These results corroborate those of Jamandron (2020) and Mojar (2022) prior research on gender and biology achievement. Nevertheless, their findings are at odds with those of Dumdumaya et al., (2024), who noted that female students exposed to specific biology information through SIM performed better than their male counterparts who received the identical instruction.

Conclusion

There is compelling evidence from this study supporting the importance of SIM in biology instruction. Through the use of SIM, procedural, methodical, and abstract concepts can be made more relatable to biology students, making learning more engaging and ultimately leading to higher achievement. In order to help students enhance their performance in biology, the study advises teachers to implement the usage of SIM. To ensure that aspiring educators fully understand how to use the approach, it should also be incorporated into teacher education programs.

References

Abakpa, V. O., Achor, E. E., & Odoh, C. O. (2016). Effect of laboratory strategy on senior secondary school students' achievement in Biology. *ICSHER Journal*, 2(2), 68-75.

Afolabi, F., & Olajuyigbe, O. (2018). Bridging gender gap in Physics classrooms: Do teaching approaches matter? *KIU Journals of Social Sciences*, 4(2), 69-80.

Agarkar, S. C. (2017). Science education for national development: Indian perspective. In B. Akpan (Ed.), *Science education: A global perspective* (pp. 105-122). Springer, Cham. https://doi.org/10.1007/978-3-319-32351-0_6

Amedu, O. I. (2015). The effect of gender on the achievement of students in Biology using jig-saw method. *Journal of Education and Practice*, 6(17), 176-179.

Anwadike, B. C. (2020). Biodiversity conservation in Nigeria: Perception, challenges and possible remedies. *Current Investigations in Agriculture and Current Research*, 8(4). https://doi.org/10.32474/ciacr.2020.08.000293

Ariyo, B. O., & Gabriel, M. (2018). Two innovative teaching strategies and academic performance of senior secondary students in Biology: Ekiti experience. *American Journal of Education Science*, 8(4), 127-135.

Arpilleda, A. J. (2021). Strategic intervention material: A tool in enhancing grade nine students' mathematical performance. *International Journal of Research Studies in Education*, 10(5). https://doi.org/10.5861/ijrse.2021.5051

Bandura, A. (1969). Social-learning theory of identificatory processes. In D. A. Goslin (Ed.), *Handbook of socialization theory and research* (pp. 213-262). Rand McNally.

Cagape, W. E., Lloveras, M. J. A., & Bangoy, D. Y. E. (2023). Strategic intervention material: Innovative approach in learning addition of similar and dissimilar fractions. *International Journal of Research Publications*, 127(1). https://doi.org/10.47119/ijrp1001271620235040

Dacumos, L. P. N. (2016). Perspective of secondary teachers in the utilization of Science Strategic Intervention Material (SIM) in increasing learning proficiency of students in science education. *AsTEN Journal of Teacher Education*, 1(2), 1-15.

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Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2019). Implications for educational practice of the science of learning and development. *Applied Developmental Science*, 24(2), 97–140. https://doi.org/10.1080/10888691.2018.1537791

Dumdumaya, C. C., Nahial, W. L., Sabacajan, B. T., & Morados, A. N. (2024). Effect of strategic intervention materials on the learning competencies of learners. *International Journal of Multidisciplinary Applied Business and Education Research*, 5(6), 2088–2094. https://doi.org/10.11594/ijmaber.05.06.11

French, K. E. (2019). Harnessing synthetic biology for sustainable development. *Nature Sustainability*, 2, 250-252. https://doi.org/10.1038/s41893-019-0270-x

Gregorio, F. H. S. (2024). Utilization of strategic intervention material (SIM) in teaching biology. *Pedagogy Review: An International Journal of Educational Theories, Approaches and Strategies*, 3(1), 1-8.

Jamandron, H. E. (2020). Teacher-made science strategic intervention materials: A tool for remediation. *Journal of Educational Research*, 5(8), 1-15.

Lazo, D. L., & de Guzman, M. F. (2021). "Strategic intervention material": A learning approach in teaching economics in distance education. *International Journal of Engineering in Research Trends*, 8(5), 76-84.

Manlapig, E., Jr., Acuña, E. B., & Manuel, A. M. (2024). Exploring student academic performance and motivation in physics through electronic-strategic intervention material (E-SIM). *Anatolian Journal of Education*, 9(1), 145–156. https://doi.org/10.29333/aje.2024.9110a

Mojar, L. M. C. (2020). Effectiveness of strategic intervention materials (SIM) in biology for grade 8 students. *International Journal of Science and Research (IJSR)*, 10(11), 1207-1214.

Onanuga, P. A., Saka, A. O., & Onyeanwusi, C. S. (2020). Relative effectiveness of generative learning strategies on students' academic achievement in senior secondary school biology: Sustainable development perspective. *Journal of Technical University of Varna Bulgaria*, 4(1), 11-22. https://doi.org/10.29114/ajtuv.vol4.iss.1.134

Sadsad, M. P. (2022). Utilizing the competency-based strategic intervention materials as a tool to assess performance of students in grade 9 physical education. *International Journal of Advanced Multidisciplinary Studies*, 2(7), 76-107.

Salami, A. T. (2021). Environment and sustainable development in Nigeria. *Journal of Sustainable Development in Africa*, 23(3), 34-52.

Sallau, I. A., Abubakar, B. B., & Yau, S. (2018). Biology education: A panacea for sustainable national development. *Frontiers in Environmental Microbiology*, 4(2), 71-74. https://doi.org/10.11648/j.fem.20180402.14

Segarino, G. M. A., Labisig, J. C., Calmerin, L. S., & Cabello, C. A. (2022). SIMs as intervention in enriching the teaching of fundamental operations in. *Zenodo*. https://doi.org/10.5281/zenodo.7162173

Suarez, M. G., & Casinillo, L. F. (2020). Effect of strategic intervention material (SIM) on academic performance: Evidence from students of Science VI. *Review of Socio-Economic Research and Development Studies*, 4(1), 20-32.

Subramanian, K. R. (2018). The crisis of consumption of natural resources. *International Journal of Recent Innovations in Academic Research*, 2(4), 8-19.

United Nations Children's Fund. (2011). Promoting gender equality: An equity-focused approach to programming. Retrieved February 15, 2019, from https://www.unicef.org/gender/files/Overarching_2Pager_Web.pdf

Von Glasersfeld, E. (2012). A constructivist approach to teaching. In T. M. Duffy & D. H. Jonassen (Eds.), *Constructivism in education* (pp. 3-15). Routledge.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

West Africa Examination Council. (2018). Chief examiners' report: General comment, weakness/remedies and strength. Retrieved December 2, 2018, from https://waeconline.org.ng/elearning/Biology/Bio227

Cite this article as:
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