

# Effect of the Use of Instructional Materials on Senior Secondary School Students' Achievement in Biology in Oyo Metropolis, Oyo State

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## ABSTRACT

The abstract nature of respiratory physiology, combined with limited hands-on experiences and interactive learning opportunities, impedes students' understanding and retention of crucial concepts. Furthermore, the inadequate access to high-quality instructional materials exacerbates the issue, leaving students without sufficient resources to supplement their classroom learning. This study therefore investigated the effects of standardized and improvised instructional materials on the academic achievement of Senior Secondary School Biology students in respiratory system topics in Oyo Metropolis, Nigeria. This study was based on constructivism and cognitive theories and utilized a Quasi-experimental research design. The study population consisted of 13,716 senior secondary school students in Oyo Metropolis. A purposive sampling technique was employed using intact classes of 149 SSS 11 students. Biology Achievement Test (BAT) (KR20 =0.8) was used as instrument for data collection. Three hypotheses were formulated at 0.05 level of significant and data were analyzed using Covariance (ANCOVA). The findings revealed that improvised instructional materials has a significant main effect on students' academic achievement in Biology ( $F(1;144) = 46.627$ ;  $P\text{-value} < 0.05$ ). Standardized instructional materials has a significant main effect on students' academic achievement in Biology ( $F(1;144) = 50.939$ ;  $P\text{-value} < 0.05$ ). And also there was significant interactive effect of conventional method, improvised instructional materials and standardized instructional materials on academic achievement of Senior Secondary School students in Biology in Oyo Metropolis  $F(1;134) = 11.619$ ;  $P\text{-value} < 0.05$ . These results underscore the importance of integrating diverse instructional strategies to foster equitable learning environments in science education. The study offered practical implications for educators, curriculum developers, and teacher training programs, emphasizing the need for a blended approach that combines standardized and improvised resources to improve educational outcomes. The study recommended further research to explore the long-term effect of standardized and improvised instructional materials across various contexts and subjects.

**Keywords:** Instructional Materials, Biology, Respiratory System, Academic Achievement, Gender

## INTRODUCTION

Academic achievement is a multi-dimensional, critical aspect of the entire educational terrain that embodies the experience, knowledge gained, and even the skills developed in students throughout an academic career. Assessment of academic achievement mostly revolves around measurement regarding performance in various subjects, examinations, assignments, and other related activities to education. Viewed as an asset, the academic achievement of students allows for both the effectiveness of instructional materials and teaching methods and individual success to be measured. Academic achievement is not solely about test scores; it also involves practical applications of knowledge, critical thinking, and solving problems. Teachers and policymakers willing to raise standards in regard to increasing the quality of education should have a broader understanding of those variables that influence academic achievement (Adeyemi and Adeyemi, 2022).

Biology forms the basis for the understanding of life and the different processes that occur around it, from the

studies of living organisms concerning their structure, function, growth, evolution, and interaction with the environment (Green et al., 2023). Biology studies in detail the intricate machinery operating at a variety of levels of organization that control life—from the molecular and cellular to ecological and global dimensions. This multivariate approach enables the biologist to search for an explanation of the diversification and unity of life and allows a glimpse of how life is intricate and interconnected (Oluwaseun et al., 2021). Indeed, biology has changed substantially over centuries due to scientific discovery and the development of technology, along with integration across disciplines. From the early observations of naturalists to the modern instruments of molecular biology and genomics, the field has continued to expand its purview as new layers of insight into the mechanisms of life were uncovered. Biology as a concept is in flux, always changing character, while reflecting the evolution of scientific inquiry and the search for knowledge about the natural world.

The basic principles and theories of biology provide a foundation to which the subject is hinged, establishing the frameworks with which the organization and interpretation of biological phenomena are carried out (Momsen et al., 2022). The relationship between structure and function, cell theory, and evolution by means of natural selection are some of the concepts guiding research in various ways; it joins different sub-disciplines together in their quest to unravel life.

The significance of biology in Nigerian education goes beyond classroom teaching into critical thinking skills development in students and an understanding of the natural world, which are crucial for both academic and professional lives.

The study of biology encompasses the fundamental branches of national curricula that have equipped students with the insightful abilities to explore life's wonders at various scales, from cellular life to ecosystems. The knowledge of biology education provides basic skills for scientific literacy, and scientific literacy acquires more importance as the society develops technologically and becomes more complex. Core competencies in the realm of scientific investigation include critical reasoning, hypothesis testing, data analysis, observation, and the like that the students would be able to develop through active involvement in investigative projects, fieldwork, and experiments (Momsen et al., 2022).

One of the topics included in the curriculum under Biology is on the respiratory system. The Biology of respiration forms one of the major aspects of the field, where it offers in-depth details about the different mechanisms that help in sustaining life. The respiratory system provides the path for the exchange of gases between the organisms and the environment, through which organisms take in oxygen, used by many in cellular respiration, and expel carbon dioxide, a product of metabolism. This basic function forms the basis for aerobic metabolism, describing how organisms achieve energy from nutrients and, hence, power cellular activities essential to their maintenance and growth.

The respiratory system is an attractive point of focus in understanding how anatomical structure interrelates with physiological function and interaction with the environment in biological studies. It is anatomically a very complicated system of organs like lungs, bronchi, trachea, diaphragm, and associated structures. It does so from an anatomical perspective. Thus, with such detailed anatomical studies on the structural adaptations and functional specialization of respiratory organs, one can gain a deep insight into morphological features associated with gas exchange, airways' maintenance, and respiratory defense mechanisms ( Damilola and Olaoye, 2021).

Besides the purely biological importance of the respiratory system, knowledge in this subject area is of practical importance to a variety of disciplines, such as public health, sports physiology, environmental science, and medicine. The application of respiratory physiology and pathology enables decision-making and drives innovation in healthcare and environmental protection, workplace safety initiatives—from diagnostic techniques and therapeutic interventions in the clinical setting through air quality monitoring to occupational health assessments. In short, the respiratory system is a subject in the study of biology that is interesting and complex because one may look into it from various interdisciplinary, anatomical, physiological, and pathological viewpoints. The students learn not only principles of biology but also find valuable insight into the dynamic relationship between living things and their environment, while studying the complexities of respiratory anatomy, function, and health that enriches an all-rounded appreciation of life's wonders and the fragile balance that supports it (Nicolo et al., 2020).

In Nigeria, the poor performance of students in Biology remains an issue of concern in topics involving the respiratory system. Recent studies and assessment have reinstated issues faced by students regarding understanding and performance in biology examinations in specific topics touching on the respiratory system. This is evident from the 2020 WAEC report, which compared the performance of students in Nigeria in aspects of biology; the average scores realized for the questions related to the respiratory system were far lower compared to other sections in the Biology curriculum. This situation shows that the difficulty faced by students is not isolated but rather is a common problem that is prevalent among students regarding the intricacies of respiratory physiology and anatomy, an integral part of biological education.

Poor performance in the respiratory system topics among Nigerian students emanates from a set of factors. First, during the learning process, the students have to face significant challenges; the nature of respiratory physiology is abstract, and it can be better comprehended by students who have access to a range of good instructional materials and laboratory facilities. One of such studies pointed out that because of a lack of laboratory facilities and instructional materials in the majority of schools in Nigeria, especially those in rural areas, students cannot demonstrate their practical understanding about the structure and functions of the respiratory system to develop manipulative skills (Mokoro, 2020). Secondly, teaching modes and instructional approaches vary significantly within different schools operating in Nigeria. Other noticeable distinctions include student-centered learning and inquiry-based learning.

Contrary to that, however, most systems of education still extensively employ obsolete, inefficient lecture formats where rote memorization of topics is encouraged over the development of critical thinking and problem-solving skills. Because of this discrepancy in the way teaching is carried out, there is inequality between students in terms of receiving effective teaching methods; this may lead to such students performing poorly in topics related to the respiratory system or any other area of biology (Berhanu and Shefaraw, 2022). Instructional materials are those which augment the teaching-learning process in any educational setting and include several materials and tools to be able to do so. There is a long list of types, including textbooks, multimedia equipment presentations, laboratory, digital resources, and manipulative that educators can use within the classroom setting to engage students in active learning, illustrate concepts, and present information (Bello and Adeola 2023). Recent literature has pointed out that the range of learning materials promotes more adequate comprehension and memorization of content, enhancing interest and decreasing the school dropout rate of the learners, considering the variety in learning styles and preferences (Spinola et al, 2023).

Educators must make a critical decision in the choice of instructional materials, which reflects the effectiveness of their teaching methods. Important considerations are such as: appropriateness and relevance of material content to the curriculum, matching the various learning needs of the students. Continuous development in educational technology has broadened the possibilities for original and effective instructional materials, which give educators a variety of options to improve the learning and teaching process. Instructional materials used in teaching students about the Respiratory System in biology will be important determinants in the way they understand and participate in the subject matter. In the school setting, instructional materials refer to learning aids, resources, and tools. These materials can broadly be classified into two main categories, namely: improvised instructional materials and standardized instructional materials (Ordu, 2021).

Improvised instructional materials refer to a resourceful and innovative method for improving the teaching and learning process (Lukman, 2021). These materials are generated either by the teachers themselves or sometimes with the help of students, whether in response to particular teaching needs or with a view to attending to the particular configuration of any given classroom, and often by exploiting resources available locally. The development of improvised materials fosters the interactive and practical learning method that makes students more connected to the concept being taught (Drinko, 2020).

By contrast, standardized instructional materials are commercially produced resources designed for educational uses. Typically, education experts, publishers, or curriculum developers with the intention of providing a uniform and structured approach in teaching any particular subject create these. Textbooks, multi-media presentations, e-learning modules, and laboratory packages are just a few forms of standardized materials offering a structured and detailed framework where the educational content is delivered (Jefrey, 2020). The structure and presentation of standardized resources allow facilitators to cover step-by-step processes in dealing with specific areas, making

it easier for learners to learn in a standardized and uniform manner irrespective of geographical location or learning institution.

The choice between standardized and improvised materials becomes a major concern (Ezeliora et al, 2021). Researching on the effects of these materials on the achievement of the students, one might wish to know which method is more superior than the other in enhancing a greater understanding and retaining information concerning the Respiratory system. There is a great need for instructional materials in Respiratory System teaching, as they permit visualization of the complex biological processes and reinforcement of theoretical knowledge hands-on. The effectiveness of instructional materials is related to their capacity to accommodate different learning styles and actively involve the students in learning processes (Okafor, 2021). On the other hand, the teaching aids used in delivering the lesson in the Respiratory System in Biology greatly influence the learning process of students. In any case, it is still the general effectiveness of lesson delivery whether in standardized or improvised materials which will determine student performance in the particular area in biology being studied (Ezeliora et al., 2021).

In biology education, gender dynamics can impact and help shape differences in academic achievement, engagement, and self-concepts among students. Such influential factors include societal and cultural influences about gender roles and expectations that may affect the way students view science as a subject and biology as a discipline. Stereotypes and prejudices have fostered, over time, the notion that Science, Technology, Engineering, and Mathematics-related disciplines of which biology is one, are more applicable to males rather than females. Besides, the presence of differences in self-efficacy beliefs, learning styles, and preferences can lead to differences in performance in the biology subject (Asante et al., 2023).

### **Statement of the Problem**

Due to its complex anatomy structures and physiological functions, learning of the abstract conceptions of the respiratory systems in biology becomes complex for the students. The rather abstract nature of respiratory physiology, along with a general lack of interactive learning opportunities and hands-on experiences, impairs the students' ability to understand and retain key concepts. Furthermore, due to the limited availability of quality instructional materials, further support of learning is greatly restricted outside of the classroom, adding to the problem. Apart from this, the performance of students in the biology examination, such as that conducted by WAEC, is partly affected by inconsistencies in their exposure to effective learning strategies, which is a consequence of the disparateness of teaching methodologies and instructional approaches among institutions in Oyo State.

This study has, therefore, looked into the effects of improvised and standardized instructional materials on the academic performance of senior secondary school students in Oyo Metropolis, Oyo State, as a means to address these challenges. The interventions must be holistic and concentrated on improving the quality and availability of instructional materials through the provision of student-centered learning environments and equal opportunity for all students in Oyo State.

### **Aim and Objectives of the Study**

The purpose of the study was an attempt to find out what effect standardized and improvised instructional materials have on the academic performance of senior school students in the field of Biology, within Oyo Metropolis, Oyo State.

The specific objectives are as follows:

- i. establish the main effect of improvised instructional materials on the academic achievement of Senior Secondary School Biology students in the Oyo Metropolis concerning topics on the respiratory system.
- ii. examine the main effect of standardized instructional materials on the academic achievement of Senior Secondary School Biology students in the Oyo Metropolis concerning topics on the respiratory system.

- iii. examine the main effect of conventional method, improvised and standardized instructional materials on the academic achievement of Senior Secondary School Biology students in the Oyo Metropolis concerning topics on the Respiratory system.

**Hypotheses**

**Ho1:** There will be no significant main effect of improvised instructional materials on academic achievement of Senior Secondary School Biology students in respiratory system topics in Oyo Metropolis.

**Ho2:** There will be no significant interaction effect of standardized instructional materials on academic achievement of Senior Secondary School Biology students in respiratory system topics in Oyo Metropolis and;

**Ho3:** There will be no significant interaction effect of conventional method, improvised instructional materials and standardized instructional materials on academic achievement of Senior Secondary School Biology students in respiratory system topics in Oyo Metropolis

**METHODOLOGY**

The research employed 3x1x1 factorial matrix quasi-experimental design of pre-test and post-test non-randomized and non-equivalent experimental control groups. It focused treatment at three (3) levels (improvised instructional materials, standardized instructional materials and control group), moderating variable at one level (gender) and the dependent variable (academic achievement) at one level. The population for this study comprised all the thirteen thousand seven hundred and sixteen (13,716)1 senior secondary school II students in Oyo Metropolis. A purposive sampling techniques was used to select a total of one hundred and forty nine (149) of three intact classes of Senior Secondary School II (SS II) Biology students and three Local Governments Areas were randomly selected within the Oyo Educational Zone of Oyo State. Biology Achievement Test was used to collect the data. It was constructed by the researcher based on Biological knowledge and competencies that can support the learning of Science in Senior Secondary School. It consisted of two sections: section A and B Section A contains demographic information about the students, while Section B contains twenty multiple-choice questions designed to assess their biological knowledge. The instrument was given to experts in Science Education for content relevance after which it was trial tested and validated using sample of students that were not part of the sample that participated in the study. Kuder Richardson-20 (KR-20=0.8) was used to established the reliability of the instrument. The information gathered was examined using frequency counts and standard deviation while the hypothesis for the study were tested using ANCOVA at 0.05 level of significance.

**RESULTS**

Table 1: Distribution of Respondents based on Gender

Variable	Frequency	Percentage
Gender		
Male	65	43.6%
Female	84	56.4%
Total	149	100.0%

Source: Field Survey Report, 2024

Table1 illustrates the gender distribution of the participants. Out of the total, 65 participants (43.6%) identified as male, while 84 participants (56.4%) identified as female. This reflects a relatively balanced representation of both genders in the study.

Table 2: Descriptive Statistics of the Dependent Variable – Students Achievement in Biology

	Pretest	Posttest
N	149	149
Missing	0	0
Mean	29.55	52.61
Median	32.00	55.00
SD	10.060	17.938
Minimum	10.00	22.00
Maximum	56.00	92.00

Source: Field Survey Report, 2024

Table 2 provides descriptive statistics for the dependent variable, which is the academic performance of students in Probability, as assessed by the Biology Achievement Test (BAT). The pretest sample size (N) is 149, indicating that all participants completed the pretest without any missing values. The mean pretest score was 29.55, which is below the average score of 50.00. Additionally, the median score of 32.00 suggests a slight skew in the distribution towards lower performance. The standard deviation of 10.060 indicates moderate variability in the pretest scores, with minimum and maximum scores of 10 and 56, respectively.

In contrast, the post-test also included a sample size of 149, with no missing values. The mean post-test score improved to 52.60, reflecting a significant enhancement from the pretest results. The median post-test score of 55.00 indicates a slight skew towards higher performance. The standard deviation for the post-test scores was 17.938, suggesting moderate variability, with minimum and maximum scores of 22 and 92, respectively. This observed improvement in students' performance following the intervention (the implementation of new teaching strategies) suggests a positive effect.

Table 3: Summary of Analysis of Covariance (ANCOVA) on the Post-test Achievement Scores in Biology According to Teaching Strategies and Gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Main effects					
Corrected Model	25163.999a	4	6291.000	42.658	.000
Intercept	387212.325	1	387212.325	2625.634	.000
Standardized	7512.243	1	7512.243	50.939	.000
Improvised	6876.235	1	6876.235	46.627	.000
Conventional	213.506	1	213.506	1.448	.231
Gender	447.474	1	447.474	3.034	.084
Error	20203.917	144	147.474		

Total	438332.000	149			
Corrected Total	45367.915	148			
a. R Squared = .555 (Adjusted R Squared = .542)					

Source: Field Survey Report, 2024

Findings from the study are presented below following the hypotheses tested.

**H01:** There will be no significant main effect of improvised instructional materials on academic achievement of Senior Secondary School Biology students in respiratory system topics in Oyo Metropolis.

Table 4.2 shows that there was a significant main effect of improvised instructional materials on the academic achievement of senior secondary school students in Biology instructional materials [ $F(1;144) = 46.627$ ;  $P\text{-value} < 0.05$ ]. Hence the  $H_0$  is rejected. This implies that there is significant difference in the pretest and posttest scores of students taught with improvised instructional materials.

**H02:** There will be no significant main effect of standardized instructional materials on academic achievement of Senior Secondary School Biology students in respiratory system topics in Oyo Metropolis.

There was significant main effect of standardized instructional materials on academic achievement of Senior Secondary School Biology students in respiratory system topics in Oyo Metropolis. [ $F(1;144) = 50.939$ ;  $P\text{-value} < 0.05$ ]. Since  $P\text{-value} < 0.05$ , the  $H_0$  is therefore rejected. This implies when students taught with the use of standardized instructional materials outperformed their counterparts that were not exposed to the same teaching instruction.

Table 4: Summary of 3-ways interactions Analysis of Covariance (ANCOVA) on the Post-test Achievement Scores in Biology According to Teaching Strategies and Gender

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
3-Ways interactions					
Corrected Model	27259.231a	14	1947.088	13.655	0.000
Intercept	295206.132	1	295206.132	2070.342	0.000
Standardized * Improved * Conventional	230.801	1	230.801	11.619	0.000
Improved * Conventional * Gender	56.753	1	56.753	0.398	0.529
Standardized * Conventional * Gender	37.540	1	37.540	0.263	0.609
Standardized * Improved * Gender	88.365	1	88.365	0.620	0.433
Error	18108.685	134	142.588		
Total	438332.000	149			
Corrected Total	45367.915	148			
a. R Squared = 0.601 (Adjusted R Squared = 0.557)					

Source: Field Survey Report, 2024

H03: There will be no significant interaction effect of conventional method, improvised instructional materials and standardized instructional materials on academic achievement of Senior Secondary School Biology students in respiratory system topics in Oyo Metropolis.

From table 4.4 above, the 3-ways ANOVA results shows that there was significant interactive effect of conventional method, improvised instructional materials and standardized instructional materials on academic achievement of Senior Secondary School Biology students in respiratory system topics in Oyo Metropolis: [ $F(1;134) = 11.619$ ;  $P\text{-value} < 0.05$ ], the  $H_0$  is therefore rejected. This implies that conventional method, improvised instructional materials and standardized instructional materials will enhance students' academic achievement in Biology.

## DISCUSSION

The finding of the study showed that there was a significant interactive effect between standardized and improvised instructional materials on the academic achievement of Senior Secondary School Biology students in respiratory system topics in Oyo Metropolis. This finding showed that the combined use of standardized and improvised materials may produce a synergistic effect, enhancing students' learning outcomes more effectively than either approach alone. The interaction indicates that integrating the structured format of standardized materials with the contextual adaptability of improvised resources can enrich the instructional experience, catering to diverse learning preferences and facilitating a deeper understanding of complex biological concepts.

## DISCUSSION OF THE FINDINGS

This research investigates the impact of different teaching strategies specifically conventional methods, standardized instructional materials, and improvised instructional materials on the academic achievement of Senior Secondary School Biology students, particularly regarding the respiratory system. The study demonstrates that a combination of standardized and improvised instructional materials leads to improved academic performance, suggesting that these strategies effectively enhance student learning. The use of improvised instructional materials, combined with conventional methods, is shown to be beneficial for student understanding and performance, encouraging educators to adopt more innovative teaching practices.

Based on the findings of this study, the following conclusions were drawn: the use of improvised and standardized instructional materials enhance students' academic achievement. Also gender has no influence in academic achievement of students when taught Biology with improvised and standardized instructional materials.

## RECOMMENDATIONS

Biology teacher should adopt a blended approach that incorporates both standardized and improvised instructional materials in teaching Biology.

Educators should continue to employ gender-neutral teaching strategies. To ensure that both male and female students receive equitable educational opportunities and support their academic success in Biology.

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