

Effects of Instructional Materials on Biology Students' Academic Achievements in Gwagwalada, Abuja

Precious Duru¹, Favour Oluwadamilare Durojaye², Duru Confidence³, Miracle Ebere Ejiako⁴, Charity Duru⁵, Zainab Ahmad Albarkawa⁶, Abubakar Abdul-Aziz⁷, Mary Stephen⁸, Onoji Cleopatra Agwuye⁹

^{1,2}Faculty of Education, Department of Science and Environmental Education, University of Abuja, Abuja, Nigeria

³Faculty of Veterinary Medicine, University of Abuja, Abuja, Nigeria

⁴Department of Cooperative Economics and Management, Federal Polytechnic Nekede, Owerri, Imo State, Nigeria.

⁵Department of Business Administration and Management, Isa Mustapha Agwai I Polytechnic, Lafia, Nasarawa State, Nigeria

⁶Faculty of Education, Department of Science Education, Federal University Gusau, Zamfara State, Nigeria.

⁷Faculty of Education, Department of Science and Vocational Education, Usman Danfodiyo University, Sokoto, Nigeria

⁸Faculty of Education, Department of Educational Foundation, University of Abuja, Abuja, Nigeria

⁹Faculty of Social Sciences, Department of Sociology, University of Abuja, Abuja, Nigeria

³The Louis DC Carson Foundation, Abuja, Nigeria

Abstract— Instructional materials (IMs) make or unmake teaching and learning. There is no single best strategy for teaching that ensures learners fully understand what is being taught. The main objective of this study was to determine the effects of flash cards (an instructional material) on research methods on the academic achievement of senior secondary students within Gwagwalada Area Council, Abuja, Nigeria. Two different schools named A and B were non-randomly sampled utilising the quasi-experimental research design. Participants from school A were taught with flash cards. In contrast, participants from school B were taught without flash cards, after which a researcher-designed Achievement Test in Biology (ATB) were administered to the participants of both schools. The test scores were recorded and both descriptively and inferentially analysed and presented using SPSS statistical software.

Keywords—Academic achievement, Biology, flash cards, Gwagwalada, students

I. INTRODUCTION

1.1 Background

Education is commonly perceived as a tool for fostering successful national progress. Within the framework of the instructional process, the objectives of education in Nigeria encompass the establishment of a unified, robust, and self-sufficient nation, the promotion of a society that values freedom and democracy, the creation of a just and egalitarian social order, the cultivation of a thriving and dynamic economy, and the provision of abundant opportunities for all citizens, as acknowledged by the Federal Government of Nigeria (FGN, 2004). Consequently, education functions as an integrative force within the fabric of society.

Biology is a science education senior secondary school subject that aims to provide students with a comprehensive grasp of biological concepts, principles, theories, and laws (Bello, Alabi, Ahmed, Sulaiman, Bello, 2020). It encompasses the examination of living organisms, ranging from minute cellular molecules to the entire biosphere, including ecosystems and the Earth's surface. The global significance of biology is considerable, with pivotal contributions in diverse fields such as microbiology, biotechnology, genetics, botany, medicine, zoology, and bioinformatics (Kulak & Newton, 2015). Acquiring a thorough understanding of biological concepts is essential for students to grasp the intricacies of the living world from an academic perspective. The study of biology allows students to delve into various facets such as the structures and functions of organisms, interactions within ecosystems, evolutionary processes, genetics, and practical applications in health, agriculture, and the environment. A proficient grasp of biology equips students to actively contribute to environmental sustainability, participate in scientific research endeavours, and make well-informed decisions within the increasingly complex realm of biology (Neji & Ntibi, 2019a). Nevertheless, owing to its abstract nature and intricate relationships, the teaching and learning of biology are often perceived as challenging (Cimer, 2012).

The process of learning is ongoing, encompassing the acquisition of novel knowledge, ideas, skills, values, and experiences, resulting in behavioural changes (Hale & Mauzerall, 2004). Effectively conveying educational concepts entails tapping into the diverse interests and abilities of students, progressing from familiar concepts to fewer familiar ones, and promoting active engagement within the classroom.



Teachers should consider their teaching goals achieved only when they observe the intended changes in student behaviour. Educational materials play a crucial role as useful instruments facilitating the learning process and enhancing students' understanding of the subject matter.

Instructional materials serve as supportive tools, enhancing the effectiveness of teaching methods and contributing value to the educational process. These materials exist in various formats, including visual aids, hands-on tools, multimedia displays, and technological assets. When educators integrate suitable instructional materials into their teaching strategies, they promote active participation and interaction among students, especially when students can actively engage with and manipulate these materials, as emphasised by Abidoye et al. in 2022. Instructional materials function as indispensable teaching aids, effectively conveying essential concepts and supporting learners in their educational journeys. By incorporating appropriate teaching resources, teachers can elevate students' understanding and academic achievement in the field of biology, creating a dynamic and interactive classroom environment.

A study conducted to investigate the influence of instructional materials on students' academic achievement in Biology within Surulere Local Government Area, Lagos, suggests a significant impact of instructional materials on the pedagogy of Biology. Furthermore, the use of instructional materials has a substantial effect on knowledge acquisition in biology, as highlighted by Ali et al. in 2014. This study aims to explore the correlation between instructional materials and students' academic success in Biology within senior secondary schools in Gwagwalada Area Council, Abuja, Nigeria. The findings indicate that students who were exposed to instructional materials performed better than those who were not, as reported by Awolaju in 2016.

Furthermore, the presence of sufficient teaching and learning resources within educational institutions positively impacts students' performance in Biology examinations (Osamor & Odebisi, 2019). Instructional resources are vital for delivering high-quality education (Oakes & Saunders, 2002). These resources aid teachers in effectively conveying knowledge, enhancing the effectiveness of learning by facilitating knowledge acquisition. They promote active engagement, particularly when students are allowed to interact with and utilise these materials. The availability of instructional materials enhances the teaching and learning experience for primary science teachers, making it enjoyable.

Instructional materials play a pivotal role in education by stimulating students' interests, addressing physical constraints, and improving the presentation of subject matter. Research conducted in senior secondary schools in Osun State investigated the relationship between the use of instructional materials and students' academic performance in Biology, indicating that students taught with instructional materials outperformed those taught without them. This underscores the importance of instructional resources in fostering effective teaching and learning experiences.

The inherent complexity of science subjects, including Biology, often presents challenges for educators, underscoring the necessity of instructional materials to improve students' understanding and engagement (Neji & Ntibi, 2019b). Insufficient availability and inadequate utilisation of instructional materials are recognised as significant factors contributing to the inefficiency of the school system and students' subpar performance. Instructional materials encompass visual aids that appeal to the sense of sight, audio resources that engage the sense of hearing, and audio-visual materials that combine visual and auditory elements. Effectively utilising instructional materials involves several crucial steps, such as previewing the materials, setting up the learning environment, and ensuring the audience's attention, motivation, and comprehension. Private schools generally have more abundant material resources compared to public schools, leading to improved academic performance in external examinations. It has been demonstrated that larger class sizes have a negative impact on students' academic achievement (Timilehin & Ogbomida, 2012).

Moreover, effectively managing class sizes is essential for optimal learning, as an increase in class sizes has demonstrated adverse effects on students' academic performance (Garrett, 2014). Previous research has delved into the correlation between class size and academic achievement, indicating that schools with smaller class sizes tend to produce higher-quality outcomes compared to larger ones (Owoeye & Yara, 2011). Studies have also established a significant difference in output quality in secondary schools based on average class sizes, with schools having 35 students or fewer per class performing better than those with larger class sizes (Adeyemi, 2005). Investigations into the impact of class size on the academic performance of Biology students in senior secondary schools in Lagos State revealed that larger class sizes detrimentally affected students' academic achievement (Ehebha & Adeyinka, 2022).



The research also identified no significant influence of class size on gender differences but noted its impact on students' proficiency levels in Biology.

Recognising the significance of instructional materials in Biology education, this study aims to assess the impact of Biology instructional materials (specifically, flashcards) on students' academic achievement in senior secondary schools within Gwagwalada Area Council, Abuja, Nigeria. By examining the relationship between instructional materials and students' academic success, this research contributes valuable insights to our understanding of effective teaching strategies in Biology education.

Cognisant of the pivotal role those instructional materials play in shaping the academic landscape, particularly within the context of biology education in senior secondary schools, this research aims to delve deeply into the effect of instructional materials on the academic achievement of biology students living within Gwagwalada Area Council, Abuja, Nigeria. The problem at hand revolves around the need to comprehensively understand how various types of instructional materials, including flash cards, textbooks, digital resources, visual aids and hands-on tools, impact students' learning outcomes in the field of biology. While the significance of instructional materials is widely acknowledged, there is a gap in the literature regarding the specific ways these different types of instructional materials contribute to or hinder the academic achievements of senior secondary school biology students. This research therefore seeks to address this gap by examining the effect of flash cards; being an instructional material, on the academic achievement of students. Ultimately, the elaborated problem statement underscores the need for empirical evidence and insights that can help inform educational policymakers, curriculum developers, teachers, and educational material publishers about the best practices for integrating instructional materials into biology education at the senior secondary school level. By addressing these research questions, this study aims to contribute to the enhancement of teaching strategies, curriculum design, and the overall academic experience of biology students within Gwagwalada Area Council.

1.2 Objectives Of The Study

This study is aimed at evaluating the possible effects of instructional materials (flashcards) on biology students' academic achievements in Gwagwalada Area Council, Abuja, Nigeria. Specifically, the study aimed to:

- Examine the effects of instructional materials (flashcards) on students' academic achievements in biology in Gwagwalada Area Council, Abuja, Nigeria.
- Determine if there is a difference in the academic achievement of students taught using instructional materials (flashcards) and those taught using conventional instruction.

1.3 Research Questions

The following research questions were raised to guide the study:

- What is the effect of teaching biological science with instructional materials (flashcards) in terms of students' academic achievement compared to those taught using the traditional method?
- Is there any difference in the academic achievement of students taught using instructional materials (flashcards) and those taught using conventional instruction?

II. CONCEPTUAL FRAMEWORK

Academic achievement is a complex concept that encompasses an individual's performance in educational settings. It holds significant importance in the field of education, as comprehending the factors influencing academic achievement can pave the way for the development of effective strategies to improve students' learning outcomes. Yusuf (2012) defined academic achievement as the knowledge and skills that students have mastered in a subject or course, essentially reflecting how well they have performed in assessments based on educational criteria set by professional educators. It serves as a measure of students' success in meeting their learning objectives. The evaluation of academic achievement often involves examinations or continuous assessments (Academic Achievement Definition and Meaning | Top Hat, 2020). Several factors have been studied in relation to academic achievement, including objectives. The evaluation of academic achievement often involves examinations or continuous assessments (Academic Achievement Definition and Meaning | Top Hat, 2020). Various factors have been studied in relation to academic achievement, including:

2.1 Teaching Methods

The selection of teaching methods and instructional strategies holds considerable sway over academic success.

Research in this field has explored diverse pedagogical approaches, such as traditional lectures, active learning, project-based learning, and technology-assisted instruction. Pedagogical methods play a pivotal role in shaping academic achievement. Studies indicate that active learning and project-based teaching approaches can improve student outcomes (Freeman et al., 2014). Effective teaching methods take into account individual learning styles, engage students, and provide opportunities for active participation. Furthermore, the calibre of teachers, encompassing their content knowledge and teaching skills, is identified as a crucial factor influencing academic achievement.

2.2 Socioeconomic Status

This has long been acknowledged as a significant indicator of academic success (Smith, 2007). Numerous studies have validated the presence of an achievement disparity between students from lower socioeconomic (SES) backgrounds and their more economically advantaged counterparts (Jones & Brown, 2014). Research consistently demonstrates that students with lower SES tend to exhibit lower academic performance compared to their wealthier peers. The existence of this achievement gap is frequently attributed to discrepancies in access to educational resources, including high-quality schools, educational materials, and extracurricular opportunities. The impact of SES on academic achievement can have enduring implications, influencing individuals' future career prospects and overall well-being.

2.3 Parental Involvement

The active participation of parents in a child's educational journey significantly influences academic success. Research consistently indicates that parental involvement in education has a positive effect on academic achievement (Henderson & Mapp, 2002). Numerous studies have shown that students with actively engaged parents tend to excel in their academic endeavours. Parental involvement manifests in various ways, such as assisting with homework, participating in parent-teacher conferences, and creating a supportive learning atmosphere at home. Positive parental engagement can boost a student's motivation, self-esteem, and sense of responsibility for their academic success (Johnson et al., 2018).

2.4 Student Motivation

Student motivation stands as a crucial factor in determining academic success. Engaged and motivated students are more inclined to actively participate in learning and persevere through challenges.

The concept of self-efficacy, introduced by Bandura (1997), holds significance in understanding student motivation and academic accomplishment. Motivation can stem from intrinsic sources (personal interest and a sense of autonomy) or extrinsic influences (external rewards or pressures). Educators can boost student motivation by cultivating a supportive and dynamic learning environment, setting realistic goals, and providing constructive feedback. Furthermore, belief in one's own abilities (self-efficacy) and the importance assigned to academic goals (task value) are pivotal aspects of motivation.

Academic achievement, therefore, emerges as a complex outcome influenced by diverse factors, including socioeconomic status, parental involvement, teaching methods, and student motivation (Hattie, 2009). These factors are interconnected and mutually reinforcing. For example, effective teaching methods can enhance student motivation, and motivated students are more likely to seek parental support and achieve academic success. To foster academic achievement, it is essential to address these factors comprehensively and implement interventions that recognise their interplay.

2.5 Instructional Materials

Instructional materials are defined as the designated contents of courses designed to impart essential knowledge or skills to students, facilitating the acquisition of factual ideas and the development of professional careers (Edessa, 2016). These materials have a historical origin dating back to the introduction of slates as supplements to books and teaching. The evolution led to the widespread use of chalkboards in Nigeria's educational institutions, and from there, a plethora of tools and devices became integral to the teaching and learning process. Examples of instructional materials include pictures, chalkboards, radios, computers, typewriters, charts, models, television sets, maps, graphs, among others (Carmo, 2020). Instructional materials function as teaching aids, illustrating the teaching process and enhancing comprehension for learners. According to Franzer, Okebukola, and Jegede (1992), even a professionally qualified science teacher, no matter how well-trained, would struggle to implement ideas without the necessary equipment and materials in the school setting.

To achieve the set goals of education and ensure students benefit from the teaching experience, the use of instructional materials is crucial. They encompass various materials or facilities used in the teaching and learning process, ranging from books, government documents, artefacts, instructional sheets, computers, and radios to television sets, social media, and magazines (Janovsky & Brooks, 2015).

These materials find application across primary, secondary, and tertiary levels of education. In the teaching of Biology, the use of instructional materials is particularly significant, tailored to different concepts within the subject (Yusuf, Maina, & Dare, 2013). However, there is a noted deficiency in adequate and appropriate instructional materials for effective teaching and learning in secondary schools (Yusuf, Maina, & Dare, 2013).

Instructional materials play a vital role in stimulating student participation, increasing knowledge, and influencing the achievement of biology students. The use of inappropriate teaching materials, such as incorrectly labelled charts, can lead to various academic issues, ranging from mass failure or underachievement in public examinations to a gradual deterioration in educational institutions at all levels (Josiah & Okaoboh, 2001). These materials are viewed as an improvement and significant relief for teachers in imparting knowledge, making the message clearer, more interesting, and more accessible. In secondary schools, instructional materials enhance and improve teachers' competence, presenting real-life experiences and materials for learners to assimilate, thus making learning more meaningful (Eze, 2020). Abdullahi (2010) describes the use of instructional materials as the art of designing a replica of something to make it function or play the role of the real thing for effective teaching and learning.

Utilising instructional materials can capture individual attention by creating interest and goals that aid learners in achieving direct effort (Effiong & Igiri, 2015). The teacher's motivation challenge primarily revolves around organising situations with instructional materials in which the learner can envision attainable goals. Brown et al. (2005) succinctly outlined the functions of teaching aids as follows:

- Facilitating meaningful communication and effective learning.
- Ensuring better retention, thereby enhancing the permanence of learning.
- Overcoming the limitations of the classroom by making inaccessible content accessible.
- Providing a shared experience upon which subsequent learning can be built.
- Encouraging participation, especially when students are allowed to interact with the materials.

According to Osuala (2010), instructional materials not only serve to motivate and spark interest in students but also contribute to a heightened respect for the teacher's subject knowledge.

Described as concrete and tangible to the sense organs during teaching (Aginna-Obu, 2000), instructional materials play a crucial role in any learning and teaching environment. Their use and significance cannot be overstated, as they are essential for effective teaching (Effiong & Igiri, 2015b). Furthermore, equipment and other instructional materials somewhat dictate the teaching method employed by the teacher in biology instruction, which may include demonstration, experimental approaches, discussions, and more.

III. THEORETICAL FRAMEWORK

3.1 *Biology as a Subject*

Biology is a natural science dedicated to the examination of life and living entities. Contemporary biology spans numerous specialised disciplines that investigate the structure, function, growth, distribution, evolution, and other characteristics of living organisms. It is recognised as a branch of knowledge dealing with living organisms and their essential processes.

Biology has consistently held a foundational role in education, providing profound insights into the intricate mechanisms governing life on Earth. Delving into the importance of biology as an academic field, its influence on diverse facets of society, and the current challenges it confronts in education reveals the following:

- **Role in Science Education:** Within science education, Biology holds a central position, acting as a pathway to comprehend the natural world and forming the foundation for various scientific fields like genetics, ecology, and microbiology. Through the exploration of biological concepts, students cultivate critical thinking abilities and scientific literacy (Smith & Johnson, 2018). Furthermore, the significance of biology goes beyond the confines of the classroom, offering valuable insights into areas such as health, environmental conservation, and advancements in biotechnology (Miller & Levine, 2020).
- **Interdisciplinary Nature of Biology:** One of the notable characteristics of biology is its interdisciplinary character, where it converges with disciplines such as chemistry, physics, and mathematics, giving rise to fields like biochemistry, biophysics, and computational biology. This interdisciplinary perspective has been a driving force behind scientific breakthroughs and technological progress (Alberts et al., 2018). Furthermore, biology has played a pivotal role in significant advancements in medicine, agriculture, and environmental science, underscoring its extensive societal influence.

- **Challenges in Teaching and Learning Biology:** Despite its importance, instructing and grasping the concepts of biology present challenges. The intricate and profound nature of the subject can be daunting for students, resulting in challenges in understanding (Smith et al., 2019). Educators encounter the responsibility of rendering biology comprehensible and captivating, utilising successful teaching techniques and inventive technologies (Herron & Freeman, 2021). Additionally, it is crucial to tackle concerns related to fairness and diversity in biology education to guarantee equal access to educational opportunities for all students (Johnson, 2017).
- **Research and Advancements in Biology:** The field of biology is dynamic, marked by ongoing research and progress. Emerging areas of study like genomics, synthetic biology, and biotechnology offer hope for tackling global challenges such as disease management, food security, and environmental sustainability (Venter et al., 2021). Researchers in biology contribute to expanding our understanding of life processes and discovering practical applications to enhance the quality of life. Biology remains a pivotal subject in education, laying the groundwork for scientific comprehension and influencing various aspects of society. Its interdisciplinary nature and capacity to drive scientific progress underscore its importance. Despite persistent challenges in teaching and learning biology, continuous efforts are essential to make the subject accessible and inclusive. With ongoing research and progress, biology remains a thriving field with considerable potential to address some of the world's most pressing issues.

IV. EMPIRICAL STUDIES

Azi and Dajan (2022) conducted a study to explore the impact of instructional materials on the academic performance of senior secondary school students in biology in Jos-North Local Government Area of Plateau State. The experimental design involved two schools, one public and one private, selected from a total of 22 public schools and 97 private schools in the area. The study included 87 participants, with 44 and 43 students from SS 2 Biology in the experimental and control groups, respectively. Descriptive statistics such as mean, standard deviation, and standard error of the mean were employed to analyse two research questions. The research instrument, Biology Students' Achievement Test (BSAT), consisted of a 20-item multiple-choice test, which demonstrated reliability through trial testing.

Results indicated that the experimental group, exposed to instructional materials, outperformed the control group, suggesting the effectiveness of using instructional materials in teaching Biology at the secondary school level. Recommendations from the study emphasised the need for teacher training and retraining through workshops, seminars, and conferences to enhance their skills in utilising instructional materials for Biology education.

Effiong and Igiri (2015) undertook a study to assess the impact of instructional materials on the teaching and learning of Biology by SS II students in Yakurr Local Government Area of Cross River State. The research employed four research questions and a descriptive statistical method to determine the impact of teacher effectiveness. Five comparable secondary schools were selected, and data analysis, using simple percentages, revealed positive achievements in students taught by highly qualified biology teachers using instructional materials. The study recommended that the government make basic instructional materials available to schools to enhance effective teaching and learning processes.

Akpan and Onoh (2017) aimed to investigate the effect of instructional materials on the academic performance of primary school pupils in Ikwuano Local Government Area of Abia State, Nigeria. The study involved all students from public and private primary schools in the area, with a sample size of 300 pupils selected using simple random sampling. Data collection instruments included a questionnaire and post-test results, and analysis involved simple mean and percentage. The findings indicated that students taught with instructional materials performed better than those without. Recommendations included seasonal training for teachers, efforts towards improvisation of instructional materials, establishing an instructional material bank for teachers' easy access, and exploring a broader range of materials, including overhead projectors, slides, and web-based instruction.

Abidoye et al. (2023) examined the impact of Biology instructional materials on the academic achievement of senior secondary school students in Ilorin West LGA, Kwara State, Nigeria. Employing a descriptive survey research design, the study targeted Biology students in senior secondary schools, with 120 students selected through random sampling. Data collection involved a questionnaire, and analysis employed various statistical methods. Results revealed a significant positive effect of Biology instructional materials on students' academic achievement. However, no significant differences were found based on gender and class size.

The study emphasised the importance of school type in influencing academic performance and recommended measures such as providing instructional materials by the Ministry of Education, incorporating them in lessons, government support for public schools, and enhancing infrastructure in schools.

V. RESEARCH DESIGN AND METHODS

This chapter delineates the researcher's approach and outlines all the elements essential for carrying out this study, including the research design, study population, and research instruments. Furthermore, it offers a comprehensive elucidation of the chosen analytical approach and the methodology for collecting data.

5.1 Research Design

This study adopts a quantitative research approach, which, as defined by Watson (2015), employs various techniques for systematically examining social phenomena through the use of statistical or numerical data. This approach emphasises measurement and assumes that the phenomena under investigation are quantifiable. Williams (2017) describes quantitative research methodology as characterised by its reliance on a numeric or statistical approach in research design, indicating a focus on quantifying data. To elaborate further, Bacon-Shone (2015) explains that the quantitative research method involves collecting data through structured instruments like questionnaires, surveys, experiments, or polls, with the analysis based on results from a representative sample drawn from the overall population. The chosen technique for data collection in this study is experimental studies, a primary method involving the manipulation of variables to observe their impact on the outcome. Researchers control conditions and collect data to conclude cause-and-effect relationships.

5.2 Population Of Study

Population typically refers to a group of individuals or subjects that forms the central focus of a scientific inquiry. Asemah (2012) provides a definition, stating that a population includes all individuals within a clearly defined group of people, events, or subjects, encompassing every possible element or observation associated with a specific phenomenon that captures the researcher's interest. The research population used for this study is 86, which consists of SS1 students from two senior secondary schools in Gwagwalada Area Council.

Gender	School A	School B
Female	22	29
Male	24	11
Total	46	40

5.3 Sample Size And Sampling Procedure

Sampling involves the process of picking a specific segment or subset of the population to gather data that can be used to make broader conclusions about the entire population. It's crucial that the selected subset adequately represents all the various attributes present within the larger population.

The sampling procedure which the study adopted is the Non-random (Nonprobability) sampling technique, and two schools named School A and B were sampled for the study. Through this procedure, selection is done based on convenience or other criteria, allowing one to easily collect data. The sample was based on the quota drawn from one of the most populated areas within Gwagwalada Area Council.

5.4 Instrumentation

A research instrument is a tool used to collect, measure, and analyse data related to a research work. They are most commonly used in health, social sciences, and education to assess clients, students, teachers, staff, etc. The research instrument is usually determined by the researcher, and it is tied to the study methodology.

For this study, the research instruments used were a researcher-designed Achievement Test in Biology (ATB), flash cards, researcher-developed lesson note, and the collected data were analysed using the IBM SPSS statistical computer package version 27.0.1.

5.5 Validation Of Research Instrument

The test items were carefully drawn to ensure that the items fell within the scope of the SS1 syllabus as guided by the prepared lesson note and the specific area that has been selected for the purpose of the study. The test items were referred to experts in science education for criticisms, and their observations influenced modifications to the instrument.

5.6 Procedure For Data Collection

The instruments used in this study were an adequately prepared instructional material (flash cards) and a researcher-designed Achievement Test in Biology (ATB).

The Achievement Test in Biology (ATB) contained 50 items 4 option multiple choice objective test developed by the researcher on the units used in the study. The students were made to select the correct answer from four options. The test in Biology was used to measure the academic achievement of the students in School A and B.

5.7 Method Of Data Analysis

The method used for the analysis of the data generated from the study involved both descriptive and inferential approach which involves drawing conclusions or making predictions about a population based on a sample. The mean, standard deviation and t-test analysis were used. Scores of the different groups were computed and used in testing the hypothesis. This method was found adequate because of the kind of instruments used to gather the data for the study. The level of significance adopted for the analysis was ($P < 0.05$). This level of significance formed the basis for rejecting or accepting the hypothesis. Unpaired T-test analysis was done using the IBM SPSS statistical computer package version 27.0.1, and data were recorded as mean $\pm$ S.D (Standard Deviation).

VI. DATA ANALYSIS AND INTERPRETATION

This chapter presents the results obtained from the analysis of data collected through the administration of the researcher-designed achievement test in Biology (ATB) to students in both School A and School B. To enhance clarity, tables, pie charts, means, and standard deviations were employed to succinctly represent these results.

Research question 1: What is the effect of teaching biological science using instructional materials (flashcards) on students' academic achievement compared to those taught using the traditional method?

Table 1: Mean $\pm$ S.D values of the test results of students in School A and School B

School A (Control group)		School B (Experimental group)	
Mean	S.D	Mean	S.D
43	10.84	67	8.79

Table 1 above shows that the control group (School A) has a mean achievement score of 43 and a standard deviation (S.D) of 10.84, while the experimental group (School B) has a mean achievement score of 67 and a standard deviation (S.D) of 8.79.

The pie chart below, as seen in Fig. 1, shows the Percentage of the total number of students who scored above 60 in the researcher-designed achievement test in biology (ATB) from both School A and B. The pie chart shows that School B had about 72.5 per cent of students who scored above 60% in the administered while School A had 6.5%. The mean result, standard deviation and the pie chart results go on to explain that students in School B had an impressive academic achievement score. Therefore, the effect of teaching biological science with instructional material (flash cards) in terms of students' academic achievement is that students taught with it would have better academic achievement when compared to those taught using the traditional method.

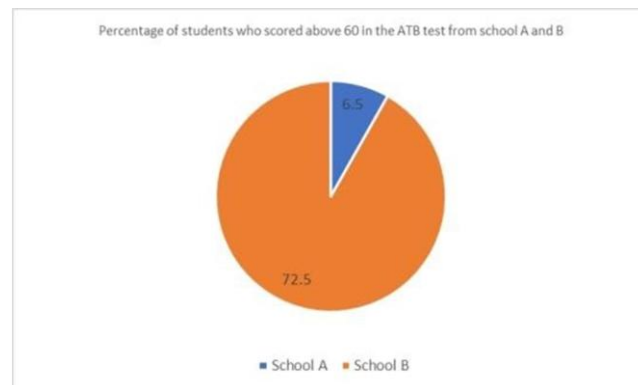


Fig 1. Percentage of Students Scores

Fig 1: Percentage of students who scored above 60 on the researcher-designed achievement test in biology (ATB) from both schools A and B.

Research question 2: Is there any difference in the academic achievement of students taught using instructional material (flash cards) and those taught using conventional instruction?

Table 2: showing the level of significance (P-value) and the degrees of freedom (df) of both School A and B

	Degree of freedom (df)	Level of significance (P-Value)
School A	45	<0.001
School B	39	<0.001

Above, Table 2 shows the significant difference in academic achievements between students from both School A and School B in Gwagwalada Area Council at a 95% confidence level.

A P-value of <0.001 was obtained, indicating a significant difference in mean scores between School A and School B. Therefore, in response to Research Question 2, this finding suggests a notable difference in the academic achievement of students taught using instructional materials (flashcards) compared to those taught using conventional instruction.

VII. SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

7.1 Summary Of Findings

This study investigated the effects of instructional materials (flashcards) on biology students' academic achievement. The literature review revealed that instructional materials are flashcards used to teach biology in the educational process of senior secondary school students to enhance teaching and learning. Achievement in an academic context is defined as the successful completion of educational goals. Effect is seen as a result or consequence of an action or other cause, and Biology is the scientific study of living organisms and their interactions with each other and their environment. To guide the study, five research questions were posed.

The literature review in this study was organised under a conceptual framework, theoretical framework, review of related empirical studies and summary of literature review. The study was carried out in Gwagwalada Area Council, Abuja, Nigeria. The sample size of the study comprised 86 subjects (46 students from School A and 40 students from School B) in Gwagwalada Area Council, and the non-random (non-probability) sampling method was used. The students in School B were taught using instructional material (flash cards), while the students in School A were taught without the use of instructional material. By the administration of a researcher-designed achievement test in Biology (ATB) containing 50 items 4 option multiple choice objective test which was developed by the researcher, the students were made to select the correct answer from four options, and the scores gotten were recorded. This test was used to measure the academic achievement of the students.

Research question number one which seeks to ascertain the effect of teaching biological science with instructional material (flash cards) in terms of students' academic achievement compared to those taught using traditional method was answered using means, standard deviations (S.D) and percentages of the ATB test scores gotten from school A and B.

While research question number two which tries to find out if there is any difference in the academic achievement of students taught using instructional material (flash cards) and those taught using conventional instruction was answered using inferential statistics: unpaired t-test analysis; which result showed that there is a statistical significant difference ($P<0.05$) between the scores gotten from students in school A and B. The findings of the study revealed that students in School B, who were taught with the flash cards, performed much better than students in School A, which were taught without flash cards in the ATB test administered.

7.2 Conclusion

From the results gotten from this study, the Null hypothesis, which states that there is no statistically significant difference in the academic achievement of students taught using instructional materials (flash cards) from those taught using conventional instruction, was therefore rejected. The result of this study also highlights the importance of flash cards as an instructional material in the academic achievements of students, which is in line with Eze (2020), who buttresses those instructional materials are teaching aids that help in the communication of knowledge to a group, and it involves the general distribution of additional information that aids in the grasping of the idea or knowledge being communicated.

7.3 Recommendations

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

- Government, stakeholders of education, and professional associations should organise regular in-service training for teachers on how to adequately and effectively design and use instructional materials for their teaching purposes
- With knowledge of the importance of instructional materials to the academic achievement of students, the government should enforce and mandate that teachers make use of instructional materials in their teaching process.
- Regular supervision should be arranged to ensure that teachers are adhering to this instruction.
- The government should ensure that the basic materials needed for the appropriate use of these teaching aids are provided and adequately distributed.
- Adequate funds should be provided for professional training of teachers.
- Institutions, colleges of education and universities should ensure that they adhere to the instructions given.

REFERENCES

- [1] Abidoye, F. O., Abidoye, A. A., & Olaide, M. S. (2023). The Effect of Biology Teaching Materials on the Academic Achievement of Senior Secondary School Students in Ilorin West, Ilorin, Kwara State. *International Journal of Educational Innovation and Research*, 2(2). <https://doi.org/10.31949/ijer.v2i2.4625>
- [2] Abidoye, F. O., Aliyu, M. Z., Ahmed, A. R., & Oluwole, O. S. (2022). Instructional resources for teaching biology in secondary schools in Moro, Kwara State, Nigeria. *JPBI (Journal Pendidikan Biologi Indonesia)*, 8(2), 187–193. <https://doi.org/10.22219/jpbiv8i2.18093>
- [3] Adeyemi, T. O. (2005). The influence of class size on the quality of output in secondary schools in Ekiti State, Nigeria. *International Journal of Emotional Psychology and Sport Ethics*, 7, 1–13.
- [4] Akpan, V. I., & Onoh, U. A. (2017). Effects of the Utilization of Instructional Materials on the Academic Achievement of Senior Secondary School Students in Ikwuano Abia State. *International Journal of Scholarly and Educational Research in Africa*, 12(4).
- [5] Ali, A. R., Toriman, M. E., & Gasim, M. B. (2014). Academic achievement in biology with suggested solutions in selected secondary schools in Kano State, Nigeria. *International Journal of Education and Research*, 2(11), 215–224.
- [6] Awolaju, B. A. (2016). Instructional materials as correlates of students' academic performance in biology in senior secondary schools in Osun State. *International Journal of Information and Education Technology*, 6(9), 705–708.
- [7] Azi, A. S., & Dajan, H. J. (2022). Effects of Using Instructional Materials on the Academic Achievement of Secondary School Students in Economics in Jos-North Local Government Area of Plateau State. *Kashere Journal of Education*, 3(1). <https://doi.org/10.4314/kje.v3i1.1>
- [8] Bello, G., Alabi, H. I., Ahmed, A. R., Sulaiman, M. M. S., Bello, Z. A. B., & Bello, A. A. B. (2020). Biology education and bio entrepreneur opportunities in Nigeria. *Nigerian Online Journal of Educational Sciences and Technology*, 1(2), 1–17. *Biology students in senior secondary schools in Delta State. south eastern journal of research and sustainable development (sejrsd)*, 2(1), 214–227.
- [9] Brown, A., Lee, C., & Johnson, M. (2020). Enhancing Biology Education through Multimedia Instructional Materials. *Journal of Science Education and Technology*, 30 (2), 201-215.
- [10] Carmo, M. (2020). Education and New Developments. In *Science Press*.
- [11] Cimer, A. (2012). What makes biology learning difficult and effective: Students' views. *Educational Research and Reviews*, 7(3), 61.
- [12] Edessa, S. (2016). Impacts of insufficient instructional materials and higher education systems in teaching biology. *gamtamokslinis ugdymas / natural science education*, 13(3). <https://doi.org/10.48127/gu-nse/16.13.114>. *Educational achievements. International Journal of Innovative Science and Research Technology*, 7(7), 241–248.
- [13] Effiong, O. E., & Igiri, C. E. (2015). Impact of Instructional Materials in Teaching and Learning of Biology in Senior Secondary Schools in Yakurr LG A. *International Letters of Social and Humanistic Sciences*, 62. <https://doi.org/10.18052/www.scipress.com/ilshs.62.27>
- [14] Ehebha, G. A., & Adeyinka, O. L. (2022). A paper on the influence of classroom sizes on biology students' educational achievements. *International Journal of Innovative Science and Research Technology*, 7(7), 241–248. Federal Government of Nigeria (2004). National Policy on Education. NERDC Abuja.
- [15] Garrett, T. (2014). *Effective classroom management: The essentials*. Teachers College Press.
- [16] Hale, T. N., & Mauzerall, D. L. (2004). Thinking globally and acting locally: Can the Johannesburg partnerships coordinate action on sustainable development? *The Journal of Environment & Development*, 13(3), 220–239.
- [17] Janovsky, A. & Brooks, A. (2015). *Instructional materials: Definition, examples and evaluation*. Retrieved from <https://www.study.com>
- [18] Jeynes, W. H. (2002). The Impact of School, Family, and Community Connections on Student Achievement. *Urban Education*, 42(1).
- [19] Johnson, L. (2018). Effective Use of Instructional Materials in the High School Biology Classroom. *Journal of Educational Research*, 41(3), 301-312.
- [20] Kulak, V., & Newton, G. (2015). An Investigation of the Pedagogical Impact of Using Case- Based Learning in an Undergraduate Biochemistry Course. *International Journal of Higher Education*, 4(4), 13–24.
- [21] Neji, H. A., & Ntibi, J. E. E. (2019). Effect of E-learning devices on chemistry students' academic performance in Calabar Municipality, Cross River State. *Interdisciplinary Journal of Science Education*, 1(1), 170–178.
- [22] Oakes, J., & Saunders, M. (2002). Access to textbooks, instructional materials, equipment, and technology: Inadequacy and inequality in California's public schools.
- [23] Osamor, O. N. G., & Odebisi, P. (2019). Effect of instructional materials on the academic achievement of biology students in senior secondary schools in Delta State. *south eastern journal of research and sustainable development (sejrsd)*, 2(1), 214–227.
- [24] Owofe, J. S., & Yara, P. O. (2011). Class size and academic achievement of secondary school students in Ekiti State, *Research and Sustainable Development (sejrsd)*, 2(1), 214–227.
- [25] Si'ayah, S., Kumiawati, N. K., Velasufah, W., & Setiawan, A. R. (2019). A brief explanation of basic science education. *Journal of A Brief Explanation of Basic Science Education*, 1(1).
- [26] Smith, P., & Jones, Q. (2019). Cognitive Tools in High School Biology Education. *Biology Teaching Techniques*, 25(4), 512-525.
- [27] Timilehin, E. H., & Ogbomida, A. H. (2012). Human and material resources as correlates of academic performance of private and public secondary school students in Ondo State, Nigeria. *European Scientific Journal*, 8(10).
- [28] Wall, A. (2019). Promoting This We Believe and the AMLE Standards with Teacher Candidates. *Current Issues in Middle Level Education*, 24(1). <https://doi.org/10.20429/cimle.2019.240107>
- [29] Yusuf, A. F. (2012). Influence of principals' leadership styles on students' academic achievement in secondary schools. *Journal of Innovative Research in Management and Humanities*, 3(1), 113-121.
- [30] Yusuf, H. O., Maina, B., & Dare, M. O. (2013). Assessment Of the Availability, Utilization and Management of ICT Facilities in Teaching English Language In Secondary Schools In Kaduna State, Nigeria. *Advances in Language and Literary Studies*, 4(1). <https://doi.org/10.7575/aialc.all.v4n.1p.20>.