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Enhancing Senior Secondary School Biology Students' Academic Achievement using Static and Animated Infographics Platforms in Niger State, Nigeria

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Abstract

The study enhanced senior secondary school Biology students' academic achievement using static and animated infographics platforms in Niger state, Nigeria. A pretest posttest quasi-experimental research design was adopted in which two research questions and two null hypotheses guided the study. The sample consisted of 119 (54 males and 65 females) Biology students as intact class of SS II of the four (4) selected secondary schools using a cluster-sampling technique. Two schools were assigned into experimental group I and two schools assigned as experimental group II. Forty (40) multiple-choice questions were used for data collection at pretest and posttest, the instrument were validated by experts and subjected to pilot testing. Coefficient of 0.99 for Static Infographics of the Human Digestive System (SIHDS) and 0.86 for Animated Infographics of the Human Digestive System (AIHDS) as determined through Pearson's correlation coefficient indicating a strong correlation between the two sets. The data was analysed using mean and standard deviation for the research questions and t-test was used for testing the null hypotheses at 0.05 level of significance. Findings revealed that there was

a significant difference t=-47.06, df=118, p-value=0.001 at p<0.05, in the achievement scores. Findings also revealed that significant difference does not exist t-value (t=-0.35, df=1, p-value=0.776 at p>0.05, in the achievement scores of male and female Biology students after exposure to static and animated infographics on the human digestive system. It was recommended among others that Biology teachers should adopt and utilise infographics in their instructional practices.

Keywords: ICT, Achievement, Biology, Infographics, Gender

Introduction

Information and Communication Technology (ICT) has tremendously affected every facet of human endeavour, which is crucial in shaping our modern world. This is particularly important due to the significant changes in the pedagogies of the 21st Century, which are dependent on the effectiveness and efficiency provided by Information and Communication Technology (ICT) tools such as Web 2.0, smartphones, digital technologies in education (Mynbayeva, *et al.,* 2018). The field encompasses using digital tools and technologies to acquire, process, store, and distribute information broadly and dynamically. ICT has revolutionised industries, education, healthcare, and communication by changing how we live, work, and interact with each other. The internet, mobile devices, and social media to artificial intelligence, cloud computing, and big data analytics have brought about a new era of unprecedented innovation, connectivity, instant global communication, and collaboration by building bridges between geographical and cultural divides.

ICT has revolutionised education by reshaping the way students learn and educators teach. According to Prendes *et al.,* (2021) a set of technologies that facilitates content comprehension and fosters skills development by creating a real-world experience through digital devices is virtual and augmented reality. The teaching and learning experience is enriched with its array of tools and resources, such as computers, tablets, interactive whiteboards, and educational software. ICT fosters personalised learning, allowing students to access a wealth of information and educational materials

online, catering to diverse learning styles and paces. Through ICT a wider audience are been able to benefit from educational instruction on various platforms made available on electronic devices like social media. In addition, ICT gives teachers the ability to create interactive and engaging lessons, monitor student progress, and collaborate with peers worldwide. The integration of ICT in education not only improves the quality of teaching and learning but also equips students with essential digital skills for the demands of the modern workforce. ICT also allow students to be responsible for their learning, make informed decisions about the dimensions of their learning process, and perform self-regulation. In this reign, teachers become facilitators of learning. In addition, modern methods allow seamless integration of ICT tools and other digital technologies, which further enhance their effectiveness in improving students' learning outcomes (Ogunsola, *et al.,* 2021).

Infographics have been used to swiftly communicate a message, make enormous volumes of data easier to understand, show data patterns and linkages, and track changes in variables over time (Basco, 2020). Infographics are designed to convey information quickly and effectively, making them a popular tool for representing statistics, facts, summaries, or comparisons. The World Health Organisation (WHO), the United States Centers for Disease Control (CDC) and other public health organisations worldwide turned to infographics to quickly and clearly convey complex information using textual and visual elements (Dalen, 2021; Yecora-Santos, 2022). As graphic tools, they are intended to help students learn and retain the information acquired through visual representations, perceive the relationship between selected pieces of information in graphic format, and connect abstract concepts and principles to concrete representation. The attraction of infographics seems to be inherent within their nature, since people are drawn to the visualisations, colours, and images of the infographics itself. An infographic can transfer knowledge about a topic faster and more effectively than pure text; however, this condition depends on the quality and presentation of the infographics. Feldman, *et al.,* (2022) added that infographics facilitate the association and creation of mental representations of words that help improve learning and memory performance in both children and adults.

Biology is one of the major science subjects required by secondary school students to model them with appropriate knowledge to be able to study several courses at an advanced level of education. Fati *et al.,* (2020) opined that the importance of

Biology is underlined by the fact that it is a compulsory subject and a basic requirement for admission into tertiary institutions for science students. According to Okwo and Tawtigyas (2012), is a science that encompasses the scientific study of living entities and their interactions with one another and with their environment. Biology, as a life science, is concerned with the characteristics of living things, their forms, functions, reproduction, evolution, and relationships with one another and with their environment. Certain topics in Biology, like Pollution, aspects of Ecology, Genetics, and Central Nervous System, cannot be effectively taught in class without taking the students on a field trip to the learning site or bringing the object to the students for proper observation and demonstration. Brooks *et al.,* (2021) stated that learning about biological concepts and processes are not visible to the naked eye. In many situations, these topics are not taught effectively in a way that students can profoundly benefit from the process, hence students get discouraged. Timothy (2021) reports that the achievement of students and attitudes toward Biology has been a great concern for researchers because learning outcomes over the years have not been satisfactory.

The measurable and demonstrable outcomes or results of students' educational efforts and performance are referred to as their achievement. It encompasses a broad range of factors, including academic success, skills acquisition, personal growth, and achieving learning objectives. Achievements can be displayed in various ways, such as grades, test scores, certificates, diplomas, or the capacity to apply knowledge and skills in real-world scenarios. The achievement of students is a fundamental indicator of the effectiveness of educational programs and instructional methods, providing insights into the progress and development of learners. It is crucial to evaluate the overall quality of education systems and individual schools, which aids educators and policymakers in making informed decisions to enhance the educational experience and ensure that students reach their full potential. According to Kristiyanto *et al*., (2020), quality of education can be known and measured by students' learning outcomes that are manifested in the values obtained by students. It is to this effect that the quality of teachers and method of teaching be adequately considered and improved to enable students to acquire the required academic goals. Academic achievement is a direct representation of learning effectiveness and a valid indicator to evaluate the effectiveness of teaching and education as well as the overall development of students. This development is observed in attitude, vocational performance, and overall behavior within and outside school. Cao *et. al.,* (2018) argue that academic

achievement is not only about students' academic performance in school, but should also include all aspects of their knowledge, competence, and literacy development and how many concepts the students can retain.

In education, societal and cultural factors can affect how students of different genders perceive education and their abilities. Gender disparity in achievement has also being a major concern to the educators, scholars and researchers, many studies revealed no significant difference between male and female, while others observed a significant difference between the two sexes (Kuta *et al.,* 2024). Stereotypes and expectations associated with gender can influence students' self-esteem, interests, and career choices, which in turn affect their learning experiences and achievement. It is crucial to foster an inclusive and equitable learning environment that encourages all students, regardless of their gender, to explore their full potential. Recognizing and challenging gender biases, offering diverse role models, and tailoring teaching methods to individual learning styles can contribute to better educational outcomes for all students, regardless of their gender. A study conducted by Humble (2020), strongly opined that there is a relationship between gender differences, and academic performance of students, and student attitude to learning. Gender and other factors positively affect self-confidence, learning experiences, satisfaction, and learning outcomes. Previous studies reported that females are lagging in the use of modern technologies (Ukwoma *et al.,* 2021). For this study, a due consideration is given to gender in the use of technology because of the attraction it has received from previous research.

Statement of the Research Problem

Despite the importance of infographics to transform contents into images to make students understand difficult concepts easily, their use remains underutilised in the study area. As a result, secondary school Biology students continue to struggle with understanding the Human Digestive System. In recent years, there has been a persistent decline in students' interest and performance in Biology, as highlighted by the performance of students in Senior Secondary Certificate Examination (SSCE) conducted by West African Examination Council (WAEC), National Examination Council (NECO) and National Business and Technical Examinations Board (NABTEB). According to the records of National Examination Council (NECO) results of 2020 to 2023, the percentage pass in Biology has not been satisfactory. A detailed record of results analyses of NECO (2020-2023) showed the percentage distinction pass in different subjects, Biology had 11.93% of its

candidate with distinction pass: Mathematics had 26.79% of candidates with distinction pass; Chemistry had 28.18% of its candidate with distinction pass and Physics with 29.82% distinction pass. From the analysis above, the percentage distinction pass in Biology is the lowest, again, the WAEC Chief Examiner's Report (2020-2022) had repeatedly shown the poor achievement of Biology students in the concepts of Digestive System. This could be due to the complex nature of the concepts in addition to the methods of teaching by most Biology teachers and if the trend continues, it will affect Biology-related fields. However, different methods and approaches were used by different researchers such as the use of an interactive whiteboard, concept map, and peer-led guided instruction to solve the problem, but it has persisted therefore, the study intends to enhance Senior Secondary School Biology Students' learning achievement using Static and Animated infographics platforms in Minna, Niger State Nigeria.

Research Questions

The following research questions guided the study:

1. Is there any mean effect of static and animated infographics on the academic achievement scores of Senior Secondary School Biology students in Minna, Niger State?
2. Does gender affect the academic achievement scores of Senior Secondary School Biology students when taught using static and animated infographics in Minna, Niger State?

Research Hypotheses

The following null hypotheses will be tested in this study at 0.05 level of significance

1. **HO_1**: There is no significant difference in the achievement scores of Biology students exposed to static and animated infographics on the human digestive system concept in Biology in Senior Secondary Schools in Niger State.
2. **HO_2**: There is no significant difference in the achievement scores of male and female Biology students exposed to static and animated infographics on the human digestive system concept in Biology in Senior Secondary Schools in Niger State.

Methodology

A quasi-experimental research design was adopted in which two research questions and two null hypotheses guided the study. The population of the study comprised

of 5935 students offering Biology as a subject in public Secondary Schools in Minna, Niger state, Nigeria. The target population was 1911 SS II Biology students, the sample comprised of 119 (54 males and 65 females) Biology students as intact class of SS II of four (4) selected secondary schools using a cluster-sampling technique. Two schools were assigned into experimental group I and two schools assigned as experimental group II. A reliability Coefficient of 0.99 for Static Infographics of the Human Digestive System (SIHDS) and 0.86 for Animated Infographics of the Human Digestive System (AIHDS) as determined through Pearson's correlation coefficient was obtained in a pilot test.

The instruments are:

1. Static Infographics of the Human Digestive System (SIHDS)
2. Animated Infographics of the Human Digestive System (AIHDS)
3. Biology Achievement Test (BAT)

1. Static infographic of human digestive system (SIHDS) and animated infographic of human digestive system (AIHDS)

   The structure was meticulously developed according ADDIE model, which stands for Analysis, Design, Development, Implementation, and Evaluation. The first step involved identifying the learning goals, and then the structure was meticulously crafted according to the specific guidelines laid out in the SS II curriculum. Next, the design phase involved planning the visual and textual content for each infographic. For animated infographics, writing a clear and engaging script was necessary. Static infographic (SIHDS) is an unmovable visual representation about the various components and processes involved in the digestion of food within the human body. The final phase, evaluation, involved summative assessments.

2. Biology achievement test (BAT)

   This involves selecting the appropriate question format of multiple-choice based on predetermined criteria, such as class, educational background, or specific research objectives. Forty (40) multiple-choice questions were used for data collection at pretest and posttest. Test conditions were standardised to minimise external influences on performance.

Results

Mean and Standard Deviation were used to answer research questions and t-test was used for testing the null hypotheses at 0.05 level of significance.

Research question 1: Is there any mean effect of static and animated infographics on the academic achievement scores of Senior Secondary School Biology students in Minna, Niger State?

Table 1: Mean scores and standard deviation of experimental groups at pre-test and post-test

Group	N	Pre-test ($\bar{x}$)	SD	Post-test ($\bar{x}$)	SD	Mean Gain
Experimental Group I	57	28.25	7.14	64.38	11.39	36.13
Experimental Group II	62	25.66	7.80	59.26	10.83	33.60

Table 1 reveals that students in experimental group I (those exposed to Static Infographics) had a mean score of 28.25 and a standard deviation of 7.14 at the pre-test, and a mean score of 64.38 and a standard deviation of 11.39 at the post-test. Table 1 further reveals that students in experimental group II (those exposed to Animated infographics) had a mean score of 25.66 and a standard deviation of 7.80 at the pre-test, and a mean score of 59.26 and a standard deviation of 10.83 at the post-test. The mean gain scores of 36.13 and 33.60 recorded for experimental groups I and II respectively, reveal that differences exist in the mean achievement of the two groups.

Research question 2: Does gender affect the academic achievement scores of Senior Secondary School Biology students when taught using static and animated infographics in Minna, Niger State?

Table 2: Mean scores and standard deviation of male and female students in experimental groups at pre-test and post-test

Group	N	Pre-test ($\bar{x}$)	SD	Post-test ($\bar{x}$)	SD	Mean Gain
Experimental Group I						
Male	27	27.42	6.95	61.77	12.40	34.35
Female	30	28.97	7.35	66.63	10.10	37.66
Experimental Group II						
Male	27	26.78	8.94	60.44	11.78	33.66
Female	35	24.80	6.81	58.34	10.33	33.54

Table 2 reveals that male students in experimental group I (those exposed to static infographics) had mean scores of 27.42 with a standard deviation of 6.95 at the

pre-test, and mean scores of 61.77 with a standard deviation of 12.40 at the post-test. Table 2 further reveals that female students had a mean score of 28.97 with a standard deviation of 7.35 at the pre-test and mean scores of 66.63 with a standard deviation of 10.10 at the post-test. The table reveals that male students in experimental group II (those exposed to animated infographics) had mean scores of 26.78 with a standard deviation of 8.94 at the pre-test, and mean scores of 60.44 with standard deviation of 11.78 at post-test. Table 2 further reveals that female students had mean scores of 24.80 with standard deviation of 6.81 at pre-test, and mean scores of 58.34 with standard deviation of 10.33 at post-test. The mean difference of 34.35 and 37.66 recorded for male and female groups respectively, this reveals that difference exists in gender for experimental group I while the mean difference of 33.66 and 33.54 recorded for male and female groups respectively, reveals that a slight difference exists in gender for experimental group II.

Table 3: t-test comparison of pre-test and post-test mean achievement scores of Biology students exposed to static and animated infographics

Group	N	Mean ($\bar{x}$)	SD	df	t-value	p-value
Pre-test	119	26.87	7.55			
Post-test	119	61.70	11.30	118	-47.06	0.001

NS: Significant @ p=0.05

Table 3 reveals that the calculated t-value (t=-47.06, df=118, p<0.05) is significant at the alpha level. Hence hypothesis one is rejected. This implies that a significant difference exists in the achievement scores of Biology students after exposure to static and animated infographics on the human digestive system.

Table 4: t-test comparison of achievement scores of male and female Biology students exposed to static and animated infographics

Group	N	Mean ($\bar{x}$)	SD	df	t	p-value
Male	54	61.11	1.02			
Female	65	62.49	5.82	1	-0.35	0.776

NS: Significant @ p=0.05

Table 4 reveals that the calculated t-value (t=-0.35, df=1, p>0.05) is insignificant at the alpha level. Hence hypothesis one is not rejected. This implies that a significant difference does not exist in the achievement scores of male and female

Biology students after exposure to static and animated infographics on the human digestive system.

Discussion of Results

Findings emanated from this study regarding enhancing senior secondary school Biology students' learning achievement using static and animated infographics platforms in Minna, Niger State, Nigeria reveal a distinct variation in the achievement scores of Biology students who were exposed to either static or animated infographics on the human digestive system. The data indicates a significant improvement in the students' achievement, emphasizing the effectiveness of infographics as a teaching tool. The finding agrees with Mohammed and Daif-Allah, (2023) a study highlighted that the combination of brain-based learning strategies with different infographic types (static vs. animated) significantly affected students' test scores in information concepts, suggesting that the effectiveness of each format can vary based on the instructional approach. Therefore, whether in static or animated form, the use of these visual aids significantly enhances students' understanding of complex biological concepts, underscoring their vital role in modern educational strategies.

The research indicates that there is no significant difference in the achievement scores between male and female Biology students after they were exposed to static and animated infographics on the human digestive system. This finding suggests that both genders benefit equally from these types of visual aids, demonstrating that the effectiveness of static and animated infographics in enhancing academic performance is consistent regardless of gender. Consequently, educators can confidently utilise these tools knowing that they support equitable learning outcomes among all students.

Conclusion

This research enhanced senior secondary school Biology students' learning achievement using static and animated infographics in Minna, Niger state, Nigeria. Achievement was variably affected by the administration of static and animated infographics on the human digestive system as it provided a significant learning outcome, which is a strong performance indicator for Biology students, using a more effective medium can improve their achievement in learning. Furthermore, based on these findings, instructional content disseminated through static and animated infographics on the human digestive system was attractive to Biology

students hence; it helps to improve their learning achievement. The lack of gender differences suggests that both male and female students can equally benefit from these visual learning tools. By integrating both static and animated infographics on the human digestive system into their teaching practices, educators can create a more dynamic and effective learning experience for their students.

Recommendations

1. Instructional content should be disseminated to students in the form of infographics, as this would enhance independent study and improve their academic achievement.
2. Secondary schools should provide a stable power supply, and information, and communication technology facilities, which will aid Biology students in accessing open electronic resources and materials for students and teachers.
3. Government and non-governmental bodies should make provisions for continuous sensitisation, training, and workshops for Biology teachers in secondary schools to embrace infographics.

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