



BRAIN-BASED VIRTUAL LEARNING: IT'S EFFECT ON PROMOTING THE PERFORMANCE OF SECONDARY SCHOOL STUDENTS IN BIOLOGY

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ABSTRACT

This work focused on Brain-Based virtual learning: it's Effect on promoting the Performance of Secondary School Students in Biology. The objectives of this work include examine the difference between the mean interest and achievement scores of students taught Biology using the brain-based virtual learning strategy and those taught using the conventional teaching method and; to ascertain the difference between the mean interest and achievement scores of male and female students taught Biology using the brain-based virtual learning strategy. The pretest-posttest control group quasi-experimental research design was employed among students of Government Science Technical Colleges in Abuja Municipal Area Council and Abaji Area Council. Related articles were reviewed and it was discovered none of them use interest scale to evaluate the efficiency of their test results. Collection of data was made using Biology Interest Scale and, Biology Achievement Test with reliability indexes of 0.81 and 0.85 respectively. The descriptive and independent sample t-test statistics were used for data analysis. Results revealed significant statistical difference in the scores in both Biology Achievement Test and Biology Interest Scale in favour of participants exposed to the brain-based virtual learning strategy.

Keywords: Brain-Based, Virtual Learning, Secondary School Students, Performance, Biology.

INTRODUCTION

Brain-based learning (BBL) is all about creating an environment that is engaging and stimulating, one that fosters curiosity, creativity, and critical thinking which makes learning more efficiently and afford students to retain information better and apply

information learned more effectively in real-life situations (Saheed, 2022). Amjad, Habib and Saeed (2022) described BBL as an instructional approach that addresses students' achievement and learning goals from the perspective of the human brain. It entails specialized learning procedures centred on how human memory, attention, motivation, and conceptual cognitive learning. Proponents of brain-based instructional strategy include relaxed alertness which consists of low threat and high challenge to bring the brain to a state of optimal learning; orchestrated immersion – to eliminate fear in learners, while maintaining a highly challenging environment; and active processing - allows the learners to consolidate and internalize information by actively processing it (Caine & Caine, and Jensen cited in Olaoluwa & Ayantoye, 2016; Jazuli, Solihatin & Syahrial, 2019). These made brain-based instructional strategy brain-friendly and non-threatening to maximize knowledge; helps learners to learn from personal experiences and develop insightful ideas; and fosters cooperation, teamwork, and dedication, which enables pupils to draw lessons from their experiences in life, which is advantageous to both educators and learner (Duncan and Ali et al., cited in Mohammed & Daif-Allah, 2023). Undoubtedly, students' interest could be enhanced with the use of brain-based virtual learning strategy.

Education: A process of learning

Education is a process of receiving instructions especially in schools where individuals interact and gain skills and acquire knowledge and experiences which facilitates learning. Education is not just about memorizing facts; it is about fostering critical thinking, problem-solving and creativity. It aims to prepare individuals for various aspects of life, including future careers and personal development (Wei, Chen & Chen, 2020). Moreover, education is a lifelong journey which continues throughout life, and individuals adapt and acquire new knowledge and skills based on their experiences and changing circumstances (Jablon, 2017; Ye, Mi & Bi, 2021). In Nigeria, education is an essential tool for creating well-informed citizens who can actively participate in democratic processes, make informed decisions, and contribute to the betterment of society. Also, it is an instrument for fostering social cohesion, instills values and promotes harmony among individuals from diverse backgrounds and tribes for unity of the country (Oyelade & Abolade, 2018). Hence, education in Nigeria allows individuals to improve their socio-economic status, access better job prospects and lead fulfilling lives. This is due to the attention given to branches of education including science across levels of education in the country.

Students' Learning Interests

Interest is a multifaceted construct that involves individual student's curiosity, liking, or attraction toward a particular subject, activity, or topic (Adekunle & Femi-Adeoye, 2016). It is a dynamic aspect of the learning experience that plays a crucial role in motivation, engagement, and academic success (Nkok, 2022). Obviously, students' interests are influenced by internal and external factors which contribute to shaping their curiosity, motivation, and engagement (Adeniyi, 2021). Recognizing and addressing these factors can contribute to creating a supportive and engaging learning environment that enhances students' interest in a subject or activity (Adeniyi, 2021; Nkok, 2022). It requires a holistic approach that considers individual differences, promotes positive teacher-student and peer relationships, and emphasizes the real-world relevance of the learning experience (Adekunle & Femi-Adeoye, 2016). Therefore, understanding and nurturing students' interest is fundamental in educational settings which enhance students' academic achievement.

Academic achievement

Academic achievement refers to the successful completion of educational goals indicating students' level of knowledge, skills, and competencies in a particular subject or field. It is often measured by grades, test scores, and other performance indicators (Irungu, Nyagah & Mercy, 2019). It is a significant aspect of a student's educational journey and is influenced by various factors such as individual, educational, and environmental factors (Atsumbe, Raymond & Ajunwa, 2015). It serves as a foundation for future educational and career opportunities and reflects a students' abilities to acquire and apply knowledge and skills in their academic pursuits (Suleiman, 2017). Recently, studies look as gender as moderating factors in relation to academic achievement.

The Analysis of Science Education

Science education is vital for the development of any nation. Science education is a specialized branch of education that focuses on teaching and learning scientific concepts, principles and methods (Ye, Mi & Bi, 2021). It plays a crucial role in developing scientific literacy, critical thinking skills and an understanding of the natural world (Jablon, 2017). Also, science education is essential for nurturing a scientifically literate and informed citizenry, fostering innovation and addressing global challenges. It empowers individuals to understand and contribute to the advancements and

applications of science in society (Musasia, Abacha & Biyoyo, 2012). Globally, levels of science education are three **primary science education, secondary science education, and higher education in science** (Oliveira & Bonito, 2023). **Among the secondary science education is biology.** Biology is the scientific study of living organisms and their interactions with each other and their environments. It is a diverse and rapidly evolving field that spans various levels of biological organization, from molecules and cells to ecosystems and the entire biosphere (Cimer, 2012). As a dynamic and interdisciplinary field that continues to advance human understanding of life on earth, biology is applicable to numerous aspects of human endeavours including medicine and healthcare, biotechnology, agriculture, environment, and research among others (Apochi, Umoru, & Onah, 2018). As a subject at the senior secondary school level in Nigeria like other countries of the world, biology enjoyed popularity and patronage among students compared to other science subjects. The popularity stems from the fact that students consider it to be easy and to be more relevant to everyday life (Etobro & Fabinu, 2017; Apochi, Umoru, & Onah, 2018). The objectives of biology in secondary schools encompass a range of goals aimed at providing students with a fundamental understanding of living organisms, their interactions, and the underlying principles of biological systems (Cimer, 2012). Also, to equip students with a comprehensive understanding of the living world and the skills necessary to engage with biological concepts critically and responsibly (Ugwu, Jatau & Gwamna, 2020). These objectives contribute to the development of scientific literacy and critical thinking skills (Cimer, 2012). Indubitably, students-centered and stimulating instructional strategies are essential towards achieving objectives of biology in senior secondary schools (Namasaka, Mondoh & Wasike, 2017; Ugwu, Jatau & Gwamna, 2020). In this regard, brain-based virtual learning strategy cannot be overemphasized.

LITERATURE REVIEW

Adeniyi (2021) explored the effect of audio-visual materials on students' interest and academic achievement in physics in senior secondary schools in Gwagwalada Area Council, Abuja. The quasi-experimental research design was adopted for the study. Targeted population of the study was 3,964 physics students in the Area Council. Sixty (60) students made-up the sample size of the study. Data of the study were gathered through two instruments – physics performance test, and physics interest assessment scale. The descriptive and t-test statistics were employed for data analysis. The study

revealed significant effect of audio-visual materials on students' interest and performance in physics with insignificant gender-related difference. It was recommended that adequate audio-visual materials should be provided to schools to enhance its usage for teaching and learning of physics, and that teachers should be trained on effective use of audio-visual materials.

Amjad, Habib and Saeed (2022) investigated the effect of BBL approach on elementary students' academic performance in mathematics in Pakistan. The study employed a single subject A-B-A research design. Population of the study comprised elementary students enrolled during the academic year 2021-2022 in the public schools of the district of Kasur, Punjab. The participants of the study were 39 8th graders in an intact class of a public school. Data of the study were collected times using one-tier MCQs based tests. The data were analysed using visual analysis and one-way repeated measure ANOVA. Results revealed that BBL significantly affects students' academic performance without gender boundary. It was recommended that teachers should utilize BBL principles-based activities for instructional delivery of mathematics.

Bada and Jita (2023) investigated the effect of brain-based teaching method on students' retention and self-efficacy in physics in Ondo State. The pre-test post-test control group quasi experimental design was adopted. Participants of the study were 99 students selected from two schools using random sampling technique. A researcher designed data collection tool "heat energy test" was used for data collection. Both descriptive and inferential (t-test and ANCOVA) statistics were used for data analysis. It was revealed that brain-based teaching method significantly improved the retention of students in physics (heat energy) and self-efficacy did not influence physics students' retention in physics (heat energy). It was concluded that brain-based teaching method enhanced the retention of physics (heat energy) thus breaking the limitation posed by differences in the characteristics of the students. It was recommended that brain-based teaching method should be prudently used by teachers for effective instructional delivery.

Kyado, Achor and Gbadamosi (2021) investigated the effect of brain-based learning strategy on students' attitude towards physics in Taraba State. Quasi-experimental design, involving non-equivalent pretest, posttest and control group design was used for the study. The population consisted of 2115 secondary school II students that offer Physics from 25 public secondary schools in Jalingo Local Government Area of the State. The sample size for the study was 88 Physics students of secondary school II drawn from two public science oriented secondary schools. Instrument of the study

was physics attitude scale. The descriptive statistics and ANCOVA were used for data analysis. Findings revealed statistical significant difference between the mean attitude scores of students taught physics using brain-based learning strategy and those taught using conventional learning strategy. Also, it was revealed that no statistical significant difference in the mean attitude scores of male and female students taught physics using brain-based learning strategy.

Mohammed and Daif-Allah (2023) compared the impacts of the interaction between brain-based learning strategies and patterns of infographics in e-learning environments and its impact on the development of informational concepts among cybersecurity students in Saudi Arabia. The quasi-experimental research design was adopted. 80 students in Qassim University participated in the study. Data were collected by means of information concept test. The independent sample t-test was used for data analysis. Findings revealed that the repetition of information at increasing intervals of time using the infographics is effective to learning concepts in an organized manner and to improving short memory; and the mental model's strategy also helped to retain information. The study recommended the use of brain-based learning strategies and patterns of infographics (static/animated) in e-learning environments.

Nkok (2022) investigated the interaction effect of gender on students' interest and academic achievement using teaching methods in Niger State. The research designed used in the study was quasi-experimental design. The population of the study was all senior secondary Biology students in Education zone B of the State. The sample size of the study was 178 students. Instruments of the study were plant reproduction interest inventory and plant reproduction achievement test. Data of the study were analyzed using analysis of covariance. The findings of the study revealed that there is no significant interaction effect of computer simulation strategy and conventional teaching method and gender on students' interest, no significant interaction effect of gender and teaching Method on students' achievements, and there was no difference in the interaction effect of both sexes with teaching strategies on students' retention score. It was concluded that gender has no influence on students' interest and academic achievement. It was recommended that computer simulation teaching strategy should be employed in teaching biology in secondary schools in Niger state.

Şahin, Ökmen, and Kılıç (2023) evaluated the effectiveness of the brain-based learning strategy cycle on students' attitudes towards cooperative learning, teacher self-efficacy beliefs, and metacognitive thinking skills in Turkey. A pre-test and post-test quasi-experimental design without a control group was used in the study. Population of the

study comprised 111 sophomore (2nd year) students studying at Duzce University Faculty of Education, Psychological Counseling and Guidance Department in the fall semester of the 2020–2021 academic year. Sample size of the study was 90 students. Data of the study were collected using the "Attitude Scale Towards Cooperative Learning", the "Teacher Self-Efficacy Scale", the "Metacognition Thinking Skill Scale" and the "Student Letters". Data obtained were analyzed using the Wilcoxon Signed Ranks Test and the content analysis. It was revealed that students had positive attitudes towards the model of the study. It was concluded that the model created a significant difference in students' attitudes towards cooperative learning, teacher self-efficacy beliefs, and metacognitive thinking skills.

Ugwu, Jatau and Gwamna (2020) investigated the impact of discussion method on performance and retention in biology among senior secondary students in Katsina Education Zone, Katsina State, and adopted gender as a moderating variable. Quasi-experimental design was employed for the study. The targeted populations are all the 1,176 second year senior secondary biology students. The sample size is 214 SS II students selected from the population using simple random technique. The research design was quasi-experimental design involving pretest, posttest, experimental and control groups. The instrument used was Biology Performance Test (BPT). Descriptive statistics of mean and standard deviation were used to answer research questions while the independent sampled t-test was used to test the hypotheses. The major findings showed that significant difference exists between the academic performance and retention of students taught biology using discussion method and that taught using lecture method without gender difference. On the basis of these findings, it was recommended that biology teachers should be trained on the use and importance of discussion method in teaching biology concepts.

METHODOLOGY

The methodology adopted in this work is to review related works on Brain-Based virtual learning: its Effect on promoting the Performance of Secondary School Students in Biology. We analyze the importance of Brain-Based virtual learning in improving the learning ability of secondary school students in Biology. It evaluates the need to improve learning with the integration of brain-based learning strategy. The effectiveness of brain-based learning strategy in this era of information technology was observed. It was discovered that that students learning interest increased with the use of brain-based learning strategy. The research examines how secondary schools can

deploy brain-based virtual learning strategy. The study evaluate the difference between the mean interest and achievement scores of students taught Biology using the brain-based virtual learning strategy and those taught using the conventional teaching method and; to ascertain the difference between the mean interest and achievement scores of male and female students taught Biology using the brain-based virtual learning strategy. The pretest-posttest control group quasi-experimental research design was employed. Population of the study composed of 5,760 students in Government Science Technical Colleges in Abuja Municipal Area Council and Abaji Area Council. Participants of the study were 114 students from two intact classes (one from each of the sampled schools). Data of the study were collected using Biology Interest Scale and, Biology Achievement Test with reliability indexes of 0.81 and 0.85 respectively. The descriptive and independent sample t-test statistics were used for data analysis. Results revealed significant statistical difference in the scores in both Biology Achievement Test and Biology Interest Scale in favour of participants exposed to the brain-based virtual learning strategy without gender bias. The work observed that the Brain-Based Virtual Learning Strategy is an effective strategy for enhancement of students' interest and achievement in Biology in senior secondary schools.

The Concept of Brain-Based Structured

The concept of brain-based structure outlines and organizes the key attributess, variables, and relationships involved in a research study (Ugwu, Jatau & Gwamna, 2020). It provides a foundation for understanding, interpreting, and conducting research within a specific context. A well-defined conceptual framework enhances communication among researchers and readers, allowing for a common understanding of the study's structure (Musasia, Abacha & Biyoyo, 2012). Hence, the conceptual framework for this study is presented thus:

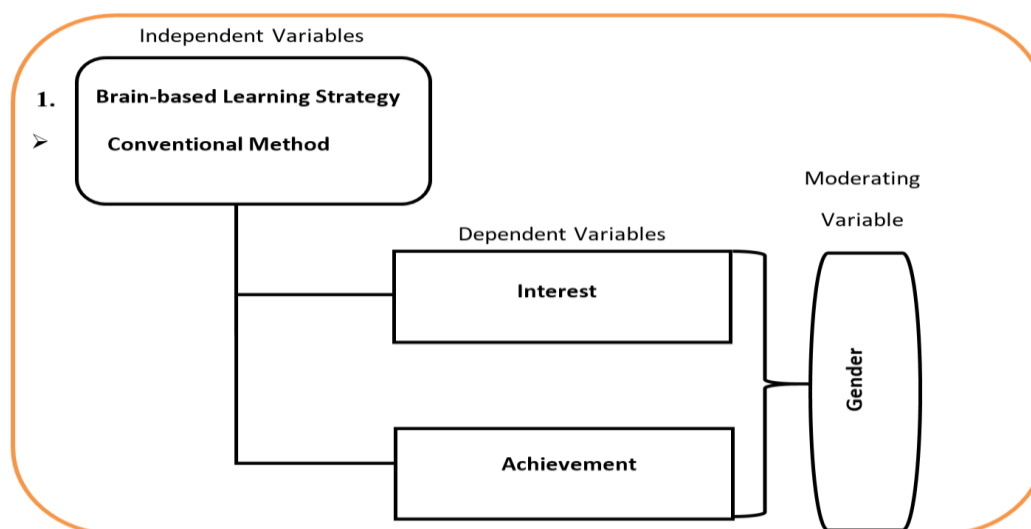


Figure 1: The Concept of Brain-Based Structure **Source:** Researcher (2023)

In the conceptual framework presented in the diagram above, the independent variables are the instructional strategies - brain-based virtual learning strategy and conventional method. Students' interest and achievement represent the dependent variables. Arrows indicate the hypothesized relationships between the independent and dependent variables. Gender, the moderating variable, positioned as a separate variable at the same level as student interest and achievement. The arrow connecting gender to student achievement and interest indicates that gender is a moderating variable influencing the relationships between brain-based virtual learning strategy and both student interest and achievement. The graphical representation informed that the nexus among the variables in the study.

Teaching and Learning in the 21st Century

Teaching and learning in the 21st century is characterized by a dynamic and evolving educational landscape that responds to technological advancements, globalization, and the changing needs of students. The traditional model of education is being reshaped to incorporate innovative teaching strategies, technology integration, and a focus on developing 21st-century skills (Wolfenden, Buckler, Santos & Mittelmeier, 2018). Also, teaching and learning in the 21st century is characterized by a shift towards student-centered, technology-enhanced, and globally connected educational experiences (Twining, Rix & Sheehy, 2016). The focus is on preparing students not only with content knowledge but also with the skills and dispositions necessary for success in the rapidly evolving 21st-century landscape (Erstad & Voogt, 2018).

Learning has been defined by the educational psychologists in different ways and meanings. It has been explained as a quantitative increase in knowledge, memorizing of facts, skills, and methods that can be retained and used as necessary. It is also viewed as making sense or abstracting meaning, relating parts of the subject matter to each other and to the real world, interpreting and understanding reality and comprehending the world by reinterpreting knowledge (Behlol & Dad, 2010).

The main characteristics of 21st century teaching and learning including the following (compiled from Twining, Rix & Sheehy, 2016; Jablon, 2017; Tabatha, 2018; Wei, Chen & Chen, 2020; Ye, Mi & Bi, 2021):

- i. **Technology Integration.** Technology tools and platforms are to be leveraged to enhance instructional delivery. This includes the use of smart boards, online resources, educational apps, and collaborative platforms that promote interactive learning. Perhaps, learning materials are presented in various formats, including text, audio, video, and interactive simulations.
- ii. **Personalized Learning.** The shift toward personalized learning recognizes the diverse learning needs and preferences of students. Adaptive learning platforms, differentiated instruction, and project-based approaches cater to individual student strengths and challenges.
- iii. **Global Perspectives.** Education embraces a global perspective, exposing students to diverse cultures, languages, and global issues. Virtual collaborations, online projects, and international partnerships broaden students' understanding of the world.
- iv. **Critical Thinking and Problem-Solving.** Emphasis is placed on developing critical thinking and problem-solving skills. Teachers design activities and projects that require students to analyze information, think creatively, and apply their knowledge to real-world situations.
- v. **Collaborative Learning.** Collaboration is a key component of 21st-century teaching. Group projects, peer learning, and collaborative activities prepare students for teamwork and communication skills essential in professional settings.
- vi. **Continuous Professional Development.** Teachers engage in continuous professional development to stay abreast of emerging educational trends, technologies, and pedagogical approaches. Lifelong learning is a cornerstone of effective teaching in the 21st century.

- vii. **Student-Centered Approaches.** Student-centered teaching shifts the focus from the teacher as a sole source of knowledge to students as active participants in their learning. Teachers serve as guides, facilitating learning experiences based on students' interests and needs. Likewise, Students are encouraged to take responsibility for their learning.
- viii. **Digital and Information Literacy.** Students develop digital literacy skills to navigate and critically evaluate information on the internet. They learn to use digital tools for research, collaboration, and communication. Information literacy is emphasized, teaching students how to evaluate sources, discern credible information, and synthesize knowledge from various platforms.
- ix. **Emphasis on Soft Skills and Lifelong Learning Mindset.** Alongside academic skills, there is an increased emphasis on soft skills such as communication, empathy, and resilience, which are considered vital for success in both academic and professional settings.

Concept of Brain- Based Learning

The Brain-based learning emerged in the 1980s with several researches in neuroscience on the functionality of the brain and its relevance to learning. One of the first researchers to establish the connection between the brain functions and conventional educational practices was Hart (1983) in the book “Human Brain and Human Learning”. Hart observed that with several outstanding researches in neuropsychology and education over the years, there is no modern knowledge of the brain (Degen, 2011). In the 1990s, brain-based learning gained widespread acceptance, and neuroscience and education were definitively linked with the publication of the peer-reviewed journal “Mind, Brain, and Education”. Caine and Caine; and Jensen cited Amjad, Habib and Saeed (2022) used neurological findings to develop brain- based learning strategy, in order to promote learning in accordance with the way the brain is naturally designed to learn. Brain- based learning as an instructional approach is based on the notion that, if the brain is functioning properly and is able to carry out its normal processes, learning will occur naturally (Bada, 2022).

Concept of Academic Achievement

Academic achievement refers to the successful completion of educational goals, indicating a student's level of knowledge, skills, and competencies in a particular

subject or field. It serves as a foundation for future educational and career opportunities and reflects a student's ability to acquire and apply knowledge and skills in their academic pursuits (Ugwu, Jatau & Gwamna, 2020). As a complex and multifaceted concept, academic achievement influenced by a combination of individual, educational, and environmental factors. It is often measured by grades, test scores, and other performance indicators. Academic achievement is a significant aspect of a student's educational journey and is influenced by various factors (Atsumbe, Raymond & Ajunwa, 2015). Here are key points related to academic achievement as deduced from studies of Atsumbe, Raymond and Ajunwa (2015); Jazuli, Solihatin and Syahrial (2019); Adnan (2020):

- i. **Grades and Assessments:** Grades and assessments are commonly used to measure academic achievement. They provide a quantitative representation of a student's performance in coursework, exams, projects, and assignments.
- ii. **GPA (Grade Point Average):** GPA is a cumulative measure of academic performance, calculated by averaging a student's grades. It is often used for college admissions and scholarships.
- iii. **Subject Mastery:** Academic achievement reflects a student's mastery of subject matter, which may include knowledge, problem-solving skills, critical thinking, and analytical abilities.
- iv. **High School Graduation:** Graduating from high school is a significant academic achievement and is often a prerequisite for pursuing higher education or entering the workforce.
- v. **Teacher Quality:** Effective teaching and instructional methods can impact student performance and academic achievement. High-quality educators can inspire and support students in their learning journey.
- vi. **Parental Involvement:** Support and involvement from parents or caregivers, such as providing a conducive learning environment and encouragement, can positively affect academic achievement.
- vii. **Peer Influence:** Peer relationships and interactions with classmates can impact academic achievement. Positive peer relationships can encourage learning, while negative influences may hinder it.

Concept of Students' Interest

Interest is a dynamic and multidimensional construct that involves emotional engagement, intrinsic motivation, and a genuine desire to explore and learn. It is a powerful motivational process that energizes learning, guides academic and career trajectories, and essential to academic success (Thoman, Smith & Silvia, 2011). Interest is both a psychological state of attention and affect toward a particular object or topic, and an enduring predisposition to reengage over time. Students' interest in the teaching and learning activities has been of concern to scholars, researchers, parents, educators, government and other stakeholders in the education sector (Harackiewicz, Smith & Priniski, 2016).

Synopsis of Biology and State of Biology Secondary Schools in Nigeria

Biology is a crucial scientific discipline that plays a fundamental role in our understanding of life and the natural world. Its importance extends across various aspects of human life, scientific research, and societal advancements (Cimer, 2012). Importance of biology, generally, including the following (Etobro & Fabinu. 2017; Apochi, Umoru, & Onah, 2018; Ugwu, Jatau & Gwamna, 2020): Understanding Life and Educational Foundation. Biology is the study of life, encompassing all living organisms, from microscopic bacteria to complex multicellular organisms. It provides insights into the mechanisms and processes that characterize living beings, including their structure, function, growth, evolution, and interactions. In addition, biology is a fundamental component of science education, providing students with a foundational understanding of scientific principles. It cultivates scientific literacy, which is essential for informed decision-making in a technologically advanced society.

Test of Hypothesis

Results from analysis of data related o formulated hypotheses were presented herein. All tests were carried out at 0.05 level of significance using the independent sample t-test statistics.

Hypothesis One: There is no significant difference between the mean interest scores of students taught Biology using the brain-based virtual learning strategy and those taught using the conventional teaching method.

Table 1: Summary of t-test for Hypothesis One

Group	N	Mean	SD	Df	t-cal.	t-tab	Decision
Control	53	2.56	0.68	112	7.86	1.66	Rejected

Experimental	61	3.45	0.61
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Data on Table 1 were summary of independent sample t-test result for hypothesis one. The result showed that t-cal (calculated t-test value) was 7.86 whereas the t-tab (t-test table value) at degree of freedom (df) of 112 was 1.66, hence, hypothesis one was rejected. Therefore, there is significant difference in the mean interest score of students taught Biology using the brain-based virtual learning strategy (mean = 3.45, SD = 0.61) and those taught using the conventional teaching method (mean = 2.56, SD = 0.68) in favour of experimental group.

Hypothesis Two: There is no significant difference between the mean achievement scores of students taught Biology using the brain-based virtual learning strategy and those taught using the conventional teaching method.

Table 2: Summary of t-test for Hypothesis Two

Group	N	Mean	SD	Df	t-cal.	t-tab	Decision
Control	53	58.11	3.95	112	20.93	1.66	Rejected
Experimental	61	73.48	3.88				

Data on Table 2 were summary of independent sample t-test result for hypothesis two. The result showed that t-cal (calculated t-test value) was 20.93 whereas the t-tab (t-test table value) at degree of freedom (df) of 112 was 1.66, hence, hypothesis two was rejected. Therefore, there was significant difference in the mean achievement scores of students taught Biology using the brain-based virtual learning strategy (mean = 58.11, SD = 3.95) and those taught using the conventional teaching method (mean = 73.48, SD = 3.88) favour the experimental group.

Summary of Findings

Results of the analysis of the study showed on Tables 1 and 2 are summarily presented as follows:

1. Brain-based virtual learning strategy enhances students' interest in Biology. This based on the results on Tables 1 and 2 which showed significant difference in the mean interest scores of students taught Biology using the brain-based virtual learning strategy and those taught using the conventional teaching method.
2. There is significant difference in the mean achievement scores of students taught Biology using the brain-based virtual learning strategy and those taught using the

conventional teaching method in favour of those taught using the brain-based virtual learning strategy as the experimental group achieved higher than the control group.

Discussion of Findings

This section focused on the discussion of findings of the present study using the results from research hypothesis one and two which are in line with objective of this study. The study revealed that there is statistical significant difference in the interest of students taught biology using the brain-based virtual learning strategy and those taught using the conventional teaching method. Hence, the brain-based virtual learning strategy boosts students' interest in biology.

Summary

This study investigated the effect of brain-based virtual learning strategy on senior secondary school students' interest and achievement in Biology in Abuja, Nigeria. Results revealed improvement in pretest and posttest scores of both groups informing effectiveness of the treatments accorded participants in both groups. Also, significant statistical difference in the scores in both Biology Achievement Test and Biology Interest Scale were recorded in favour of participants exposed to the brain-based virtual learning strategy. This is an indication that the brain-based virtual learning strategy has significant and positive effect on interest and achievement in Biology among senior secondary school students in the Abuja, Nigeria.

Conclusion

Based on the result outcomes of the study, the following conclusions were reached:

- i. The brain-based virtual learning strategy significantly increases students' interest in Biology compared to conventional teaching methods.
- ii. The brain-based virtual learning strategy is more effective in enhancing students' achievement in Biology.

Recommendation

In line with the results of the study and the above implications, the following recommendations were proffered:

- i. The curriculum planners should incorporate brain-based virtual learning strategy into teaching methods for Biology in senior secondary schools to enhance the interest and achievement of students.
- ii. Teachers should be encouraged to apply the brain-based virtual learning strategy to enhance students' interest and their academic achievement.
- iii. Workshops and seminars should be regularly provided for in-service teachers with emphasis on the instructional potentials of and effective integration and use of brain-based visual learning strategy in their teaching practices.
- iv. School administrators should create conducive environment for teachers in the schools, and provide visual learning resources and materials to encourage and support teachers in the use of brain-based visual learning strategy for effective instructional delivery of biology.

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