Unizik Journal of
STM Education Volume 8 Issue 2
(Maiden Conference Edition) ISSN: 1597 - 8249

COMPARATIVE EFFECTS OF ANIMATED AND NON-ANIMATED COMPUTER ASSISTED INSTRUCTIONS ON STUDENTS' ACHIEVEMENT IN BIOLOGY IN AWKA SOUTH LGA OF ANAMBRA STATE

Regina Ijeamasi Enebechi (Ph.D) [*1], Amobi, Uchenna Vivian[2], Azike, Chinemelum P[3].
ri.enebechi@unizik.edu.ng[1]**uv.amobi@unizik.edu.ng[2] perpetuachinemelum7@gmail.com[3]**
[1]Orchid Id: https://orcid.org/0009-0004-2986-2744
[1,2&3] Department of Science Education, Nnamdi Azikiwe University, Awka

[*]**Corresponding author**: ri.enebechi@unizik.edu.ng[1]

Abstract

This study investigated the comparative effects of animated and non-animated computer-assisted instructions (CAI) on students' achievement in Biology in Awka South Local Government Area of Anambra State, Nigeria. The research aimed to determine whether the use of animated CAI, which incorporates dynamic visual and interactive elements, yields better academic outcomes compared to non-animated CAI, which relies on static visuals and text. A quasi-experimental design was employed, involving a sample of senior secondary school students divided into two groups: one exposed to animated CAI and the other to non-animated CAI. Pre-test and post-test assessments were conducted to measure students' achievement levels before and after the intervention. Our pretest-posttest control group design was non-randomized. The study was guided by two research questions two hypotheses. The population of the students consist 2,036 senior secondary school one (1) Biology students (1,006 males and 1,030 females) in the 17 public secondary schools in Awka South Local Government Area. Participants in the study included 120 SS I Biology students from two public secondary schools in Awka South Local Government area. The instrument used for data collection was Biology Achievement Test (BAT). The tool was verified. Kuder-Richardson Formula 20 (KR-20) was used to determine the instrument's reliability, and the results showed a reliability coefficient of 0.84. The research questions were answered using mean and standard deviation, and the research hypotheses were tested using Analysis of Covariance (ANCOVA). The findings revealed that students taught with animated CAI achieved significantly higher scores in Biology than those taught with non-animated CAI. The study concludes that animated CAI is more effective in enhancing students' understanding and retention of Biological concepts, likely due to its engaging and interactive nature. Recommendations include the integration of animated CAI into the Biology curriculum and the provision of training for teachers to effectively utilize such technologies in the classroom. This research contributes to the growing body of knowledge on the impact of instructional technologies on science education in Nigeria.

Keywords: **Achievement, Animation, Biology, Computer Assisted Instruction, Non-Animation**,

Introduction

Biology is one of the science subjects at the senior secondary school level which plays a critical role in equipping learners with the knowledge and skills necessary for understanding life processes and pursuing careers in medicine, biotechnology, environmental science, and related fields. However, the teaching and learning of Biology in Nigerian secondary schools particularly in areas like Awka South Local Government Area of Anambra State have continued to suffer setbacks due to poor instructional delivery, abstractness of concepts, and

lack of student motivation (Enebechi 2017). Traditional chalk-and-talk methods dominate classroom practice, resulting in rote learning, shallow comprehension, and low academic achievement in Biology.

In response to these challenges, educators have increasingly turned to Computer-Assisted Instruction (CAI) to transform the way science is taught. CAI refers to the use of computer-based platforms to deliver instructional content through text, visuals, sound, and interactive features. Computer Animated Instruction in Biology refers to the use of computer-generated dynamic visual media such as moving graphics, simulations, and interactive animations to teach and explain biological concepts and processes. These animations are especially effective in illustrating abstract, microscopic, or complex biological phenomena, such as cell division, molecular transport, or ecological systems, in a way that is visually engaging and easier to comprehend (Adegoke, 2011; Moreno & Mayer, 2007).

This instructional approach enhances students' conceptual understanding by allowing them to visualize processes that cannot be directly observed, thereby improving learning outcomes and promoting active engagement (Mayer, 2009; Adewale & Ajadi, 2014). For example, animated instruction can demonstrate how enzymes catalyze biochemical reactions or how photosynthesis occurs at the cellular level, providing a clearer and more memorable representation than static textbook images. By making learning more dynamic and interesting, technology integration particularly CAI is revolutionizing education. Two major forms of CAI are animated and non-animated instruction. Animated CAI integrates motion graphics and simulations that visualize biological processes dynamically making them easier to understand and retain (Mayer, 2009; Adegoke, 2011). For example, animations showing mitosis or photosynthesis allow learners to visualize sequences, movement of particles, and interactions within cells. In contrast, non-animated CAI presents still diagrams, textual explanations, and images in static formats, which may not fully capture the dynamic nature of biological phenomena (Adewale & Ajadi, 2014).

The significance of animation lies in its potential to foster conceptual understanding by bridging the gap between theoretical knowledge and mental visualization. Research suggests that animated instruction enhances cognitive engagement and learning outcomes, especially in science subjects that require understanding of time-based or abstract processes (Moreno & Mayer, 2007; Ekwueme & Igwe, 2018). Despite the growing body of literature supporting the effectiveness of CAI, there is limited empirical evidence comparing the impact of animated versus non-animated.

CAI on students' academic achievement in Biology within the Nigerian context, particularly in Awka South LGA of Anambra State. Despite the significance of Biology and widespread appeal among students, the recorded performance of students in the subject in external examinations over the years has remained unsatisfactory and inconsistent according to West African Examination Council's Chief Examiners Report (2017-2023). In 2017, for aggregate of A1-C6, a percentage pass of 55.57% was recorded, 55.10% in 2018, 55.63% in 2019, 63.23% in 2020, 58.09% in 2021, 64.16% in 2022 and 54.69 in 2023 showing that students' academic achievement in the subject over the years fluctuates and inconsistent, with the exception of the year 2020 and 2022 in which students demonstrated good academic achievement. Considering the recent WAEC performance data, it becomes evident that students' academic achievement not only mirrors their academic standings but also significantly influences their overall readiness for future educational advancement. The persistent poor performance and inconsistency results of students in Biology as reported in WAEC Chief Examiners' reports (WAEC, 2017-2023), and the underutilization of multimedia tools in classrooms despite increased computer access, there is a pressing need to investigate which mode of CAI animated or non-animated is more effective in improving students' academic achievement in Biology. This study is therefore motivated by the need to provide empirical evidence to guide teachers, curriculum developers, and policymakers in adopting the most effective digital instructional strategy that aligns with 21st-century educational reforms.

From the researchers' point of view academic achievement refers to the actual outcome or attainment a student gets after schooling. It is said to be ''the amount of knowledge derived from learning in educational institution. Academic achievement in this study is regarded as the measurable outcomes and accomplishments attained by students in educational settings. This includes their performance in various subjects, mastery of skills and knowledge, grades, test scores, and overall success in meeting academic goals. It is the quality of knowledge acquired by students as a result of exposure to classroom experiences. The level of success a student receives on educational tests is referred to as academic achievement (Enebechi 2024). Students' motivation, sense of self-worth, and involvement in school can all be adversely affected by persistently low achievement, which may result in school dropout (Okebukola, 2020). This highlights the pressing need for creative teaching methods that can raise student performance in important subjects like Biology.

According to Ikwuka et. al. (2021), academic achievement represents the outcome of education or learning, typically assessed through examinations or continuous assessment. It is

determined by students' performance, as reflected in their scores on tests and examinations. Enoch and Asogwa (2021) described academic achievement as the comprehensive attainment of students, manifesting in various aspects of their educational journey. Academic achievement holds significant importance as a foundational benchmark for assessing teaching and learning endeavors. It remains a focal point of concern for parents, educators, society, and researchers, especially given the perceived decline in the academic performance of secondary school students. Research results have shown that despite the importance attached to Biology, students' academic achievement in the subject at the secondary level has been dwindling over the years (Adebanjo, 2020). Hence, it is imperative to prioritize efforts aimed at addressing the issue of students' underperformance in the subject. To this end, researchers have identified numerous factors contributing to the consistent low academic achievement in Biology, particularly at the Senior Secondary Certificate Examinations. Arslan and Akin (2014) as cited in Samuel and Okonkwo (2021) have attributed this unsatisfactory achievement to many factors among which include teacher factor, environmental factor, student factor, and psychological factors. Research also conducted by Gana (2022) and Ojo (2022) demonstrated how well CAI makes learning more dynamic to increase students' interest, focus, and performance in science subjects. In a similar vein, Owolabi and Oginni (2022) reported that animation enhances learning and facilitates students' understanding of difficult material. Though the general efficacy of CAI in science education has been the subject of numerous studies, few studies have examined its comparative effects, particularly in Biology, specifically in Awka South.

Another factor that is often connected to academic success is gender. According to Obikezie et. al. (2025), gender identity is a deeply personal aspect that may align with a person's sex assigned at birth or differ from it, as seen in transgender individuals. The understanding of gender has evolved, recognizing that it exists beyond a binary system and can include non-binary and gender queer identities. It is a socio-cultural construct that assigns roles, attitudes and values considered appropriate for each sex. While some studies find variations depending on the type of cognitive task (Godspower-Echie & Ihenko, 2019). Hence, gender is merely a designation assigned to individuals based on their biological characteristics. The impact of gender on students' achievement in Biology has been inconsistent and inconclusive over the years. While some researchers (Enebechi et al., 2025) have found no statically significant difference in AI use between male and female students. (Pat-Anyaeji & Okeke, 2019; Egwu & Okigbo, 2021) have reported that male students outperformed female students

in Biology. Overall, there is conflicting evidence regarding gender differences in science performance, which emphasizes the need for more research, especially in the area of CAI. The effect of CAI on students' achievement in various subjects and geographical areas has been the subject of numerous studies. For example, Egbutu and Okeke (2021) discovered that students' critical thinking skills in Chemistry were greatly enhanced by animated instruction. Multimedia-animated techniques improved students' interest, performance, and retention in basic science, according to Samuel and Nurudeen (2019). According to Ukaigwe and Goi-Tanen (2022), CAI had a more beneficial effect on mathematics than conventional approaches. However, few studies have directly compared animated and non-animated CAI in Biology education, particularly in the context of Awka South, despite these positive findings. It is still unclear how teaching style, student gender, and academic results interact specifically in this local setting.

Investigating novel teaching techniques is essential given the country's emphasis on science education and the ongoing underachievement in Biology, particularly in areas like Awka South. Therefore, the purpose of this study is to compare how well animated and non-animated CAI improves academic achievement among Biology students. Additionally, it aims to comprehend how gender may moderate the efficacy of these teaching strategies.

Statement of the problem

Despite the crucial role of Biology in preparing students for careers in medicine, biotechnology, and other life sciences, students in Awka South LGA continue to perform poorly in the subject, as reflected in recurring low achievement in both internal and external examinations. This underachievement is largely attributed to the abstract nature of many biological concepts and the continued reliance on teacher-centered, non-interactive instructional approaches. While computer-assisted instruction (CAI) offers a promising alternative, there is limited empirical evidence on which form animated or non-animated is more effective in enhancing students' understanding and academic achievement in Biology. The lack of such evidence creates a gap in informed instructional decision-making. This study therefore seeks to determine the comparative effects of animated and non-animated CAI on students' achievement in Biology in Awka South LGA.

Purpose of the Study

The purpose of the study was to investigate comparative effects of animated and non-animated computer assisted instructions on student's achievement in Biology. Specifically, the study ought to determine the:

1. Mean achievement scores of students taught Biology using animated and non-animated computer assisted Instructional strategies?
2. Mean achievement scores of male and female students taught Biology using animated and non-animated computer assisted Instructional strategy

Research Questions

The following research questions guided the study:

1. What are the mean achievement scores of students taught Biology using animated and non-animated computer assisted instructional strategies?
2. What are the mean achievement scores of male and female students taught Biology using animated and non-animated computer assisted Instructional strategy?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance in the study:

Ho1 There is no significant difference in the mean achievement scores of students taught Biology using animated and non-animated computer assisted Instructional strategies.

Ho2 There is no significant difference in the mean achievement scores of male and female students taught Biology using animated and non-animated computer assisted Instructional strategy.

Methods

This study employed a quasi-experimental research design. Specifically, non-equivalent pretest and posttest were used in a non-randomized experimental group design. A quasi-experimental design is one in which participants are not able to be assigned at random to either the experimental or control groups (Nworgu, 2015). Both experimental groups were included in this design since student randomization would not have been suitable. Before the main experiment, we conducted a baseline analysis (pretest) to determine whether there were any notable differences between the groups. We were unable to locate any, though, indicating that the groups were uniform and roughly equal. The Awka South Local Government Area in Anambra State served as the study's area. The Awka South Local Government is part of the Awka Education Zone in Anambra State. It is bordered by Awka North, Dunukofia, Anaocha, and Ekwusigo Local Government Area. The Awka South Local Government Area has 17 public schools, 16 of which are coeducational and one of which is a single-sex school. Awka South Local Government Area was chosen for the investigation because it would pique the interest of a significant number of students at the end of the study. 2,036 senior secondary school Biology students 1,006 males and 1,030 females from the 17 public secondary schools

in the Awka South Local Government Area made up the study's population, according to the Post Primary Schools Service Commission (PPSSC) statistics and records section of the 2023–2024.

Public schools employ more qualified teachers with a range of years of experience, as opposed to private schools that use part-time teachers with little experience. SS1 was chosen because this group of students is just beginning senior secondary school. The ecological concept (population) and reproductive system are also used in the SS1 scheme of work, which students find difficult to comprehend. 120 SS1 students from two schools in the Awka South Local Government Area made up the study's sample. Purposive and simple random sampling random techniques were used. Firstly, two schools were purposively chosen for the study because they had historically had poor Biology achievement. Secondly, the schools were coeducational because one of the moderating factors under investigation is gender. Thirdly, the schools were picked because they had better ICT infrastructure than other nearby schools. In the second stage, simple random sampling was used to divide the two schools into experimental groups. Simple random sampling was used to assign the two schools to the experimental groups. In the end, the non-animated computer-assisted instruction group consisted of sixty-six (66) students, twenty-four (24) males and forty-two (42) females, while the animated computer-assisted instruction group consisted of fifty-four (54) students, twenty (20) males and thirty-four (34) females.

The data was gathered using the Biology Achievement Test (BAT). There were fifty (50) multiple-choice biology achievement test items that were based on the topics and content that was covered in class. There are fifty multiple-choice questions with four possible answers (A–D), and each correctly answered question was worth two marks. No mark was awarded for an incorrect response. The BAT was based on the subjects that were taught and was adapted from earlier WEAC and JAMB questions. The BAT was used for both the pre-test and the post-test, albeit with a different arrangement. The BAT was subjected to both content and faces validation. Three specialists from the faculty of education at Nnamdi Azikiwe University in Awka carried out the validation: two from the department of science education and one from the educational foundation. Using the Test blueprint, the content validation of the BAT items was carried out based on the content of the two selected topics in the SS1 scheme of work. Their input led to changes in the questions. To ascertain the instruments' dependability, trail testing was conducted. (20) Students from SS1 Biology who were not from the study area participated in the pilot study. BAT's reliability co-efficient, as determined by Kuder-

Richardson formula 20, was 0.87. The Kuder-Richardson 20 formula was used because BAT responses were dichotomously scored, meaning they included right or wrong answers. The BAT was administered to the students prior to the experimental treatment. This served as a pre-test for the study. At the end of the study, the instrument was rearranged and administered to the students once more as a post-test. To prevent the students from realizing that they had already responded to the same question, this was done. The mean and standard deviation were used to analyze the data in order to answer the research questions, and the Analysis of Covariance (ANCOVA) was used to test the hypotheses at an alpha level of 0.05. Given that a p value of less than 0.05 is considered significant, this implies that the hypothesis was rejected. Since the hypothesis was not disproved, a p-value of 0.05 or greater is not regarded as significant.

Experimental Procedure

In order to conduct the study with the SS1 Biology students, the researcher went to the study schools and asked the principals for permission. Six weeks were allotted for the study; the first week was spent administering the pre-test, and the remaining four weeks were spent on the actual study. The BAT (post-test) was administered during the sixth week. Two ordinary biology teachers were approached by the researcher. For one of the experimental groups, one of the biology teachers is proficient in computer operation. The instructor who used animation to instruct experimental group A was trained in the method's logistics of implementation. The teacher assistant in the second experimental group B was not trained, but instead received scripted lessons that followed direct instruction without the use of animation. The lessons were prepared and stored on CD Rom, and they were presented in the following order: biology concepts with pictorial illustrations, followed by student activities and evaluation questions. Each student was instructed to complete the activities in the computer program supervised by the teacher. Even though the teachers were briefed on how to implement the programs prior to the actual classroom implementation, the researcher made sure the research assistants followed the implementation plan by conducting frequent review sessions with the teachers to find out how well they performed in putting the intervention programs into practice. Finding any issues that might confuse the implementation fidelity was the main goal of these sessions. According to the two teachers in the two intervention programs, there were no implementation issues during the session, and the students were paying attention in class. For every intervention program, the researcher made two arbitrary observations. They all agreed that they adhered to the lesson scripts that were provided to them, and a qualitative assessment was given through

the random observations as the researcher met and discussed their observations. Lesson plans based on each of the instructional techniques were given to the research assistants in the two groups to adhere to during the intervention.

Results

Research Question one

What are the mean achievement scores of students taught Biology using animated and non-animated computer assisted instructional strategies?

Table 1: Mean and standard deviation of pretest and posttest achievement scores of students taught Biology using animated and non-animated computer assisted instructional strategies

Strategies		Pre-test		Post-test		
	N	Mean	SD	Mean	SD	Mean Gain
ACAIS	54	51.48	6.21	88.52	5.65	37.04
NACAIS	66	49.18	8.02	67.94	4.34	18.76

Table 1 show that students who received Biology instruction using the animated computer-assisted instructional strategy (ACAIS) scored 51.48 on the pretest with a standard deviation (SD) of 6.21 and 88.52 on the posttest with an SD of 5.65. Additionally, the students who were taught Biology using ACAIS achieved a mean gain of 37.04. Conversely, the students who received Biology instruction through the non-animated computer assisted instructional strategy (NACAIS) scored 49.18 on the pretest with an SD of 8.02 and 67.94 on the posttest with an SD of 4.34. Students who received Biology instruction using NACAIS saw an average gain of 18.76. Additionally, compared to students taught using ACAIS, the NACAIS posttest mean achievement score (4.34) shows a low score variation (5.65). This suggests that Biology students who received instruction using animated computer-assisted instruction (ACAIS) outperformed those who received instruction using non-animated computer-assisted instruction (NACAIS). Therefore, compared to the non-animated computer-assisted instructional strategy (ACAIS), the animated ACAIS is more effective at raising Biology students' achievement.

Research Question 2:

What is the mean achievement scores of male and female students taught Biology using animated and non-animated computer assisted instructional strategies?

Table 2: Mean and standard deviation of pre-test and post-test mean achievement scores of male and female students taught Biology using animated and non-animated computer assisted instructional strategies

Strategies		Pre-test			Post-test	
	N	Mean	SD	Mean	SD	Mean Gain
Male	44	49.95	7.39	77.59	11.16	27.64
Female	76	50.37	7.32	76.97	11.62	26.60

Male students who received Biology instruction using both animated and non-animated computer-assisted instructional strategies had a pretest mean achievement score of 49.95 with a standard deviation of 7.39, and a posttest mean achievement score of 77.59 with a standard deviation of 11.16, according to the results in Table 2. In contrast, the female students who received Biology instruction through computer-assisted instructional strategies, both animated and non-animated, achieved a mean achievement score of 50.37 on the pretest with a standard deviation of 7.32, and a mean achievement score of 76.97 with a standard deviation of 11.62 on the posttest. Male students' scores (11.16) and female students' scores (11.62) varied more when computer-assisted instructional strategies, both animated and non-animated, were used. The mean gains for teaching biology to male and female students using computer-assisted instructional strategies that were animated and those that were not were 27.64 and 26.60, respectively. This implies that male Biology students who were taught using computer-assisted instructional strategies, both animated and non-animated, performed marginally better than their female peers.

Hypothesis One

There is no significant difference in the mean achievement scores of students taught Biology using animated and non-animated computer assisted instructional strategies.

Table 3: Analysis of covariance (ANCOVA) of the significant difference in the mean achievement scores of students taught Biology by strategies and gender

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	12605.045[a]	4	3151.261	125.563	.000	.814
Intercept	13621.784	1	13621.784	542.765	.000	.825
PretestBAT	11.000	1	11.000	.438	.509	.004
Strategies	11281.712	1	11281.712	449.524	.000	.796
Gender	5.328	1	5.328	.212	.646	.002

Strategies * Gender	6.753	1	6.753	.269	.605	.002
Error	2886.155	115	25.097			
Total	730672.000	120				
Corrected Total	15491.200	119				

An F-ratio value of 449.524 was obtained with a probability value of.00, which is less than the 0.05 level of significance (p <.05), for the effect of animated and non-animated computer-assisted instructional strategies on students' mean achievement scores in Biology, according to the results in Table 3. The null hypothesis was thus disproved. Therefore, it can be concluded that students who were taught Biology using animated computer-assisted instructional strategies (ACAIS) had significantly higher mean achievement scores than students who were taught biology using non-animated computer-assisted instructional strategies (NACAIS).Regarding effect size, Table 3 demonstrates that the treatment is responsible for a Partial Eta Squared.796 (79.6%) in students' achievement scores, which is sufficiently large to be effective.

Hypothesis Two

There is no significant difference in the mean achievement scores of male and female students taught Biology using animated and non-animated computer assisted instructional strategies. According to the findings of the study the impact of both animated and non-animated computer-assisted teaching strategies on the mean Biology achievement scores of male and female students was found to have an F-ratio value of.212 with a probability value of.646, which is higher than the 0.05 level of significance (p >.05). As a result, the null hypothesis was accepted. Therefore, it can be concluded that there is no discernible difference between the mean achievement scores of male and female Biology students who were taught the subject using computer-assisted instructional strategies that were animated and those that were not. Regarding effect size, Table 3 also demonstrates that the effect of gender accounts for Partial Eta Squared.002 (0.02%) of biology students' achievement scores.

Discussion of the Findings

Mean achievement scores of students taught Biology using animated and non-animated computer assisted instructional strategies

The findings of the study show that students who received Biology instruction using animated computer-assisted instructional strategies (ACAIS) outperformed their counterparts who received instruction using non-animated computer-assisted instructional strategies (NACAIS) in terms of achievement. Additionally, students who were taught Biology using animated computer-assisted instructional strategies (ACAIS) had significantly higher mean

achievement scores than students who were taught Biology using non-animated computer-assisted instructional strategies (NACAIS). Therefore, compared to the non-animated computer-assisted instructional strategy (ACAIS), the animated ACAIS is more successful in raising Biology students' achievement.

Additionally, a large effect size indicates that the treatment is responsible for 79.6% of the achievement scores of Biology students. This might be as a result of the fact that ACAIS g8uarantees improved visualization of difficult concepts and improves comprehension, problem-solving abilities, and student engagement all of which are prerequisites for students to succeed. Because it lessens learning challenges brought on by a lack of conceptualization and visualization of events at the submicroscopic level, this is consistent with Samuel and Nurudeen's (2019) findings that there is a significant difference in the interest, achievement, and retention of upper basic III students taught basic science concepts using multimedia animated instructional strategies. Additionally, the results supported the findings of Asubiojo (2023), Godspower-Echie, and Ihenko (2017), who found that students taught using computer-assisted strategies significantly outperformed students taught using lecture methods in terms of their achievement in basic science and technology. This result is also in line with that of Egbutu and Okeke (2021), who found that CAI significantly improved students' chemistry performance. According to Ukaigwe and Goi Taren (2022), students who were exposed to multimedia instruction performed significantly better than those who were taught using traditional methods.

Mean achievement scores of male and female students taught Biology using animated and non-animated computer assisted instructional strategies

The study's conclusions demonstrated that male students who were taught Biology using both animated and non-animated computer-assisted instructional strategies outperformed their female counterparts by a small margin. However, additional research revealed that the mean achievement scores of male and female Biology students taught with and without animated computer-assisted instructional strategies did not differ significantly. This may be because both genders are given equal opportunities to improve their Biology achievement through the treatment, particularly ACAIS. The study's findings are consistent with those of Tambaya, et al., (2016) and Ibemenji et al., (2019), who found no discernible difference between male and female biology students' academic performance. Conversely, the results contradict those of Chikendu (2018) and Ogunleye and Ojekwu (2019), who found that gender significantly influences students' achievement in favor of female students.

Conclusion

The study concludes that animated computer-assisted instructional strategy (ACAIS) significantly enhances students' achievement in Biology more than the non-animated strategy (NACAIS). It is also gender-friendly, making it an effective tool for teaching both male and female students.

Recommendations

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

1. Teachers should be trained on how to use animated computer assisted instructional strategy (ACAIS) to improve students' achievement through seminars workshops and conferences.
2. School administrators and stakeholders should make provision for computers and other instructional materials that will enable teacher adopt and students to learn using ACAIS.
3. Animated computer assisted instructional strategy should be integrated into the teacher education syllabus by the curriculum developers during the pre-service training of Biology teachers.
4. Educational stakeholders and curriculum planners should also integrate ACAIS into the Biology curriculum, as it is effective and suitable for learners of all gender.

References

Adebanjo, A. A. (2020). Improving students' academic achievement in Biology using information and communication technology aided instruction. *Journal of Social Sciences*, 5(4), 317-326.

Adegoke, B. A. (2011). Effect of multimedia instruction on senior secondary school students' achievement in physics. European Journal of Educational Studies, 3(3), 537–541.

Adewale, O. S., & Ajadi, O. T. (2014). Effects of animated instructional package on secondary school students' achievement in Biology. *International Journal of Education and Development using ICT*, 10(3), 30–46.

Asubiojo, R. O. (2023). Effects of Computer Assisted Instruction (Cai) On Secondary School S8tudents' Achievement in Basic Science and Technology Ekiti State. *Shodh Sari-An International Multidisciplinary Journal*, 02(02), 88–98. https://doi.org/10.59231/SARI7576

Chikwendu, R. E. (2018). Effects of instructional Computer Animation on Secondary School Students Achievement and Interest in Chemistry. Unpublished Ph.D Dissertation, Nnamdi Azikiwe University Awka.

Egbutu, E. O., & Okeke, U. C. (2021). Effect of animated instructional materials on senior secondary school students' academic performance in Chemistry. *Journal of Science Education and Technology*, 30(2), 165–178.

Enebechi, R. I., Nwosu, K. C., Amobi, U.V. & Ogbaka L.C.(2025). Undergraduate students' use of artificial intelligence tools in their learning: Do gender and primary place of residence matter? *Journal of Educational Research on children, parents and teachers.* 6(2), 1-10. https://ercptjournal.org/

Enoch, J. U., & Asogwa, V. C. (2021). Teacher –student relationship and attitude as correlates of students' academic achievement in agricultural science in senior secondary schools. *African Educational Research Journal,* 9(2), 600-615.

Egwu, S.O., & Okigbo, E.C. (2021). Effect of field trip on secondary school students' academic achievement in ecology in Anambra state. South Eastern Journal of Research and Sustainable Development (SEJRSD), 4(1),140-156.

Ekwueme, C. O., & Igwe, B. U. (2018). Animation and academic performance of students in science. *Journal of Education and Practice*, 9(3), 54–62.

Gana, B. M. (2022). Gender differences in students' achievement in science subjects in Nigeria: A meta-analysis. *Nigerian Journal of Educational Research*, 24(3), 52–61.

Gana, C. S. (2022). Computer-assisted instruction: A tool for concretizing abstract concepts in secondary school subjects. *Journal of Educational Technology*, 5(2), 123-134.

Godspower-Echie, G., & Ihenko, S. I. (2017). Gender and academic achievement in science subjects in secondary schools. *International Journal of Innovative Education Research*, 5(4), 28–33.

Ibemenji, K. G., Etokeren, I. S., & Okwelle, P. C. (2019). Effect of cooperative learning strategy on biology students' academic performance in senior secondary school in Rivers State. *Journal of Scientific Research & Reports, 23(6)*, 1-11.

Ikwuka, O.1.,Okoye, C. C., Udenwa, V.C., Adigwe, J. H. E., Nkemjika, O., Uzoegbo, U.H., and Nwuba. O.P. (2021). ICT competencies needed by teachers for effective teaching of English language in secondary schools. *Journal of Advanced Educational Philosophy*. 5(8), 249-254

Mayer, R. E. (2009). *Multimedia learning* (2nd ed.). Cambridge University Press.

Moreno, R., & Mayer, R. E. (2007). Interactive multimodal learning environments: Special issue on interactive learning environments: Contemporary issues and trends. *Educational Psychology Review*, 19(3), 309–326.

Nworgu, B. G. (2015). Educational Research: Basic Issues and Methodology (3rd Ed.). Enugu: University Trust Publishers.

Obikezie M. C., Enebechi, R.I., Nwuba, S.I. & Eke,. J. A.(2025). School locations and gender moderated variables on teachers' quality as predictor of senior secondary school science students' academic achievement. *Journal Plus Education.* 37(1), 252-265. https://doi>10.24250/jpe/1/2025/OMC/ERI/NSI/EJA/</doi>

Ogunleye, B. O. and Ojekwu, I. N. (2019). Effects of mind mapping strategy and gender on students' basic science achievement in Eleme Local Government Area of Rivers State *Nigeria,Journal of Education, 12,* 193-204./Ojo, A. A. (2022). Animated

instructional strategies and achievement of secondary school students in Biology. *Journal of Educational Media and Technology*, 27(1), 45–54.

Okebukola, P. A. (2020). Rethinking science education in Nigeria: From curriculum to implementation. University of Lagos Press.

Owolabi, T. O., & Oginni, A. A. (2022). Enhancing interest and achievement through animation in science classrooms. *International Journal of Science Education*, 44(5), 715–729.

Pat-Anyaeji, V. N., & Okeke, S.O.C. (2019). Effect of scaffolding instruction strategy on secondary school students' achievement in Biology in Onitsha Education zone in Anambra State. *Unizik Journal of STM Education*, 3(1), 39-50.

Samuel, A. T., & Nurudeen, A. A. (2019). Multimedia and basic science instruction in junior secondary schools: Impacts and challenges. *Nigerian Journal of Science Education*, 11(3), 24–34.

Samuel, N. N., & Okonkwo, I. G. (2021). Relationship between metacognition, locus of control, and academic achievement in secondary school chemistry students in Anambra state, Nigeria. *Education research International*, 2021, 1-7. https://doi.org/10.1155/2021/6698808

Tambaya, S. I., Sabitu, A. & Matazu, Y. M. (2016). Comparative analysis of gender performances in biology, chemistry and physics among pre-degree students of Federal University, Dutsinma. *International Journal of Educational Benchmark, 5(1),* 108-118.

Ukaigwe, O. C., & Goi-Tanen, M. (2022). The effectiveness of computer-assisted instruction on Mathematics achievement of junior secondary students. *Journal of Educational Technology and Curriculum Development*, 6(2), 54–61.

West African Examination Council (WAEC), (2017-2023). The Chief Examiners Report on Students performance in Senior School Certificate Biology Examination. Lagos, 181-186