

Effects of computer-based multimedia testing on social studies undergraduates' academic achievement and retention in environmental education

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Abstract

The study investigated the effects of computer multimedia testing on Social Studies undergraduates' academic achievement and retention in Environmental Education. The study was carried in federal universities in South-East, Nigeria. Post test only quasi experimental research design was adopted. The population for the study consisted of 327 200level Social Studies Education Students. Two intact classes were used consisting of 131 students. Environmental Education Achievement Test was used to collect data for the study. Data collected were analyzed mean and standard deviation while ANCOVA was used to test the null hypotheses at 0.05 level of significance. The study revealed that students exposed to Computer Multimedia Testing (CMT) had significant higher achievement and retention than those exposed to conventional computer-based test. Based on the findings, institutions should replace conventional computer-based tests with CMT to boost student achievement; Environmental Education courses should embed multimedia testing tools into their instructional design; Education policymakers should fund and mandate CMT infrastructure in Nigerian federal universities.

Keywords: Achievement; Computer multimedia test; Environmental education; Retention; Social studies

1. Introduction

Assessing environmental education content through traditional methods can be abstract, making it challenging for students to comprehend the material. Environmental education necessitates visualization and critical thinking, which can be difficult to express and evaluate through conventional assessment techniques. Computer multimedia testing presents a solution by delivering an interactive and engaging assessment experience that can more effectively evaluate students' understanding and application of environmental education principles; therefore, this study aims to determine the impact of Computer Multimedia Testing [CMT] on undergraduate academic success and retention in environmental education content.

Environmental education is recognized as a process of integrating environmental content into the educational system to raise awareness of environmental issues across all educational levels. Environmental education [EE] encompasses organized efforts to educate individuals about how natural environments operate, and specifically, how people can manage their behaviors and ecosystems to live sustainably (Fokides & Arvaniti, 2020). It is a multidisciplinary area combining fields such as Biology, Chemistry, Physics, Ecology, Earth Science, Atmospheric Science, Mathematics, and Geography (Major, 2018). Additionally, environmental education consists of educational materials that boost individuals' understanding of the environment, their awareness of related issues, their problem-solving abilities, and their attitudes, motivations, and commitments to making informed choices and acting responsibly (United Nations Educational, Scientific and Cultural Organization, 2014). Consequently, EE is now offered as a distinct course at the university level, incorporating recurring and emerging topics such as pollution, global warming, climate change, environmental hazards, environmental degradation, and conservation, among others (Ezeudu et al., 2014).

It is crucial that EE is delivered using appropriate instructional and assessment methods. There

is no doubt that technology has introduced significant innovative changes in the education sector across the board. Based on this premise, various techniques beyond teacher-centered instruction have emerged and are achieving substantial breakthroughs in secondary education. As a result, the teaching-learning process is significantly enhanced through innovative instructional strategies such as animation (Ogar, 2024). Thus, it is insufficient to use animations for teaching students while assessing them through traditional means. There is a need for assessment methods that incorporate multimedia elements.

Empirical evidence supports the researchers' assertion that students' current understanding of environmentally sustainable practices does not accurately reflect what has been taught in the classroom. For example, Eneji et al. (2019) found that undergraduate students exhibited negative waste management behavior, with disposal methods including a "throw away mentality," burning, and dumping waste into gutters and drains. This may stem from their lack of visual guidance regarding appropriate waste disposal or the consequences of such actions. Ekwesaranna et al. (2025) reported that while undergraduate students engaged in behaviors such as energy conservation and sustainable transportation, their involvement in organized environmental initiatives, such as recycling and group participation, remained limited. Furthermore, Ekwesaranna et al. (2025) noted that despite students in EE courses achieving higher ratings in environmentally sustainable behavior, merely being enrolled did not significantly predict pro-environmental actions. Arimiyau et al. (2023) revealed that undergraduates generally lack knowledge about environmental health-related issues. Elechi and Eleki (2025) indicated that only 32.3% of surveyed undergraduates in public universities in Rivers State demonstrated good knowledge of environmental sanitation practices. Although technology has been integrated into the teaching process to enable the use of animations (Ogar, 2024) in environmental education content, appropriate environmental behavior remains limited or insufficient, suggesting that utilizing technology for teaching is not enough without incorporating it into the assessment. This study therefore proposes to ascertain the efficacy of computer multimedia test assessment mode on students' achievement and retention in environmental education courses.

The advent of Information and Communication Technology [ICT] in educational settings has shifted the assessment of students from traditional pen-and-paper methods to computer-based approaches. This transition aims to address the limitations of conventional assessment techniques while also meeting the demand for timely feedback. The computer plays a pivotal role in the innovative web-based technologies that have revolutionized contemporary educational testing. Computer-based assessment [CBA] involves utilizing computers to deliver, manage, and evaluate assessments, offering a digital substitute for the traditional paper format (Kuku, 2016). These assessments afford instant feedback and can support diverse question types, such as multiple-choice, simulations, and interactive tasks, thereby improving learning outcomes. For the scope of this study, computer assessment is defined as the evaluation of students' knowledge and skills through the use of digital devices, including computers, tablets, and smartphones.

There are several advantages linked to employing computers in student evaluations. According to Daniels and Gierl (2017), computer-based assessment can serve as a platform for both national assessments as well as daily and semester exams. Online testing offers benefits such as enabling teachers to generate higher quality test materials, standardizing the test administration process, and allowing for better tracking of students' achievements and knowledge retention. Other advantages of computer-based assessment, as highlighted by Dong et al. (2020), include the provision of immediate feedback to students, which keeps the assessment and results closely linked. This is in contrast to traditional feedback on essays and reports that is often delayed, making it seem disconnected to students who typically concentrate on the grade received. Furthermore, it offers immediate insights into student performance—lessons learned can be quickly applied to subsequent assignments, problems in learning can be diagnosed right away, and educators can modify their teaching methods accordingly. It is also a significant factor in motivating students, as they prefer to know their performance as quickly as possible.

Computer-based testing can help minimize examination fraud by diminishing the reliance on

human intervention, which has historically created opportunities for malpractice. Due to these enhanced security features, the use of computer-delivered examinations has been increasingly adopted (Kuku, 2016). Abosalem (2016) identified various computer assessment methods, including Randomized Computer-based Testing, Computer Adaptive Testing [CAT], Computer-Based Tests [CBT], and Computer Multimedia Testing [CMT]. Randomized Computer-based Testing [RCBT] entails administering a set of fixed items, where all multiple-choice components are completed on the computer and students are timed to encourage prompt submission, with immediate results available. On the other hand, Computer Adaptive Testing creates individualized assessments tailored to each candidate based on their demonstrated abilities and knowledge level. For this study, comparisons were made between Computer-Based Tests and Computer Multimedia Tests.

Computer-Based Testing is a specific type of computer assessment method utilized for student evaluation due to its learning algorithm's focus on performing a singular task—assessing students. Knowledge gained from this task does not necessarily carry over to other tasks or educational activities. Numerous studies have confirmed the effectiveness of CBT in enhancing students' academic performance and retention. Studies have shown that students generally report favorable experiences with computer-based testing and perceive it as an effective mode of assessment (Terzis & Economides, 2011). Kamoru and Solomon (2020) also found that CBT significantly enhanced students' outcomes. Conversely, Tachia (2021) stated that CBT did not have a significant impact on the academic performance of undergraduate students. Additionally, Christian et al. (2024) discovered that students who took the computer-based test had lower mean retention scores following the posttest. These differing empirical findings indicate a necessity for computer-assisted assessments that extend beyond CBT, prompting the researcher to propose the Computer Multimedia Test to evaluate its effectiveness.

The Computer Multimedia Test comprises administering a predetermined set of items that incorporate various media, thereby making assessments more enjoyable, precise, and accessible for students who may struggle with traditional testing methods. According to Mayer and Fiorella (2023), CMT can be understood as the evaluation of students using both textual and visual elements aimed at enhancing learning outcomes. The images can be either static, such as illustrations, graphs, charts, photos, or maps, or dynamic, including animations, videos, or interactive visuals. In practice, computer multimedia tests are digital assessments that feature a range of media components, including text, images, audio, video, and interactive simulations, to create engaging and interactive evaluations.

These assessments can boost student participation, enhance comprehension of intricate concepts, and evaluate various skills and knowledge. Computer multimedia is particularly advantageous and effective in education due to its interactive nature, flexibility, and the amalgamation of diverse media that accommodate individual learner differences and bolster motivation. Research indicates notable connections between computer multimedia tests and students' academic success. Teo et al. (2020) affirm the impact of multimedia in enhancing students' academic performance. Bello and Abdulkaram (2023) also reported that students instructed through interactive multimedia methods outperformed those educated via conventional lecture formats. Muhammad-Thani and Abdulrahman (2024) demonstrated that students taught Computer Science using multimedia instructional techniques achieved superior results compared to their peers who received no instructional strategies. Similarly, Incedayi (2018) noted a significant correlation between students' utilization of animation technology and their success in geography courses. However, a gap remains as none of these studies were conducted in South-East Federal Universities, particularly regarding academic achievement and retention in environmental education courses that necessitate substantial multimedia exposure. This context led to the foundation of this study. The following research questions directed the investigation;

RQ 1) What are the differences in mean achievement scores of students assessed using CBT and CMT?

RQ 2) What are the differences in mean retention scores of students assessed using CBT and

CMT?

2. Method

2.1. Research Design

This research employed a posttest-only quasi-experimental design. The post-test approach was chosen because the students had already received instruction from their lecturers, making it unnecessary for the researcher to take part in classroom teaching, and thus a relevant pretest assessment could not be implemented. Within this framework, there was one experimental group, CMT, and one control group, CBT. In this setup, participants in the first group (E) underwent treatment with CMT, while participants in the second group (C) experienced CBT, allowing for a comparison of academic achievement and retention between the two groups.

2.2. Participants

The study was carried in South-East, Nigeria. The population for the study consisted of 327 200level Social Studies Education Students. Two intact classes were used consisting of 131 students. Simple random sampling involving balloting without replacement was used to assign the control and experimental group status to the two selected classes.

2.3. Instrumentation

The data collection tool used was an Achievement Test called the Environmental Education Achievement Test [EEAT]. This test included 35 questions made up of objective items. Each question offered four choices, consisting of one correct answer and three incorrect options; a correct answer earns 2 points, resulting in a maximum score of 70 points. The researcher developed the test items based on the Environmental Education curriculum from the second semester course. The items in the EEAT were randomized for the retention assessment. The drafts of the EEAT underwent face validity assessment. Three experts evaluated the validity: two from the Department of Social Science Education and one from the Department of Science Education (Measurement and Evaluation Unit), all affiliated with the University of Nigeria. The experts were asked to review the test items for their suitability for the learners' level, their effectiveness in measuring the intended content, and whether to add or remove items to enhance the instrument's quality, accuracy of responses, and believability of distractors. Their feedback shaped the final version of the instrument. For content validity, the researcher created the test items using a table of specifications, which outlines the item distribution according to Bloom's educational taxonomies. The experts were required to evaluate whether the instrument's items sufficiently covered the content areas of the curriculum and to suggest any additional items they deemed relevant that might have been inadvertently omitted. The proposed adjustments were incorporated into the instrument, making it suitable for the study. To ensure reliability, the instrument was trial-tested with 20 respondents, including students from the University of Nigeria, who were not part of the study group. To determine the internal consistency of the test items, the scores obtained from their responses were analyzed using the Kuder-Richardson formula 20 (K-R 20). The K-R 20 formula was chosen due to the dichotomous scoring of the items and their varying difficulty levels. Additionally, each item of the instrument had a designated correct answer. The calculated internal consistency reliability coefficient for the EEAT was found to be .725.

2.4. Experimental Procedure

The experiment was conducted in the CBT centers of the two universities. Before starting the experiment, the researchers set up the computer equipment to administer the EEAT-CMT to the experimental group, while the control group continued with the EEAT-CBT as usual. After three weeks, a retention test was given to both groups that had been formed earlier. However, to prevent students from being familiar with the questions, the items for the CBT were rearranged. The results obtained after the experiment were collected from both the CBT and CMT systems. Participants' responses from the retention test were scored, and these results were compared to

their post-test scores. The effects of the treatment on the participants was inferred from the results when analyzed statistically.

2.5. Institutional Review Board Statement

Ethical approval for the research was requested and granted by the Department of Social Science Education, Faculty of Education Research Ethics and Publication Committee at the University of Nigeria. Additionally, permission was obtained from the heads of both departments involved in the study. Participants were also asked to provide written consent through a consent form. Each individual received the form to review and sign after the study's aims were clarified, and they were assured that their information would remain confidential.

2.6. Data Analysis

Data collected from the post-test and retention assessments were coded and entered for analysis. Descriptive statistics (mean and standard deviation) were used to answer the research questions by summarizing participants' performance in the experimental and control groups. To test the null hypotheses at the .05 level of significance, Analysis of Covariance [ANCOVA] was employed to examine whether there were statistically significant differences between groups. Where applicable, the retention scores were compared with post-test scores to determine the extent to which learning was sustained over time. All statistical analyses were conducted using appropriate statistical software.

3. Results

Table 1 shows the mean scores and standard deviation of differences in mean achievement scores of students assessed using Computer Multimedia Testing and Computer Based Testing.

Table1

Descriptive Statistics of Achievement Scores by Testing Strategy (CMT vs. CBT)

	Strategy	N	Mean	SD	SE Mean	Skewness	Kurtosis
Achievement	CMT	73	50.63	6.52	.76	0.526	0.054
	CBT	58	43.56	9.39	1.23	0.409	0.011

Results in Table 1 show that students exposed to computer multimedia testing obtained a mean achievement score of 50.63, whereas those in the control computer-based testing group recorded a mean score of 43.56. This indicates a mean difference of 7.07 in favour of the CMT (multimedia) group.

Table 2 presents the ANCOVA summary comparing the mean achievement scores of students assessed using Computer Multimedia Testing and Computer-Based Testing.

Table 2

ANCOVA Summary of Achievement Scores by Testing Strategy (CMT vs. CBT)

Source	Type III Sum of Squares	df	Mean Square	F	p
Corrected Model	1647.528 ^a	3	549.176	8.665	<.001
Intercept	279560.277	1	279560.277	4410.882	<.001
Strategy	1600.707	1	1600.707	25.256	<.001
Error	8049.220	127	63.380		
Total	305313.000	131			
Corrected Total	9696.748	130			

a. R Squared = .170 (Adjusted R Squared = .150)

Note. Dependent variable: Achievement

The results in Table 2 show that the *p*-value associated with the testing strategies is <.001, which is below the .05 level of significance. This indicates that the null hypothesis of no significant difference is rejected. Therefore, there is a statistically significant difference in the mean achievement scores of students assessed using CBT and CMT, in favour of the CMT group.

Table 3 presents the mean scores and standard deviations of students' retention scores by testing strategy (CMT vs. CBT).

Table 3

Mean and SD of Students' Retention Scores (CBT vs. CMT)

	Strategy	N	Mean	SD	SE Mean	Skewness	Kurtosis
Achievement	CMT	73	60.72	4.22	.494	0.287	0.366
	CBT	58	44.01	12.44	1.634	0.391	-0.425

Results in Table 3 show that students exposed to computer multimedia testing obtained a mean retention score of 60.72, whereas those in the control computer-based testing group recorded a mean score of 44.01. This indicates a mean difference of 16.71 in favour of the CMT (multimedia) group.

Table 4 presents the ANCOVA summary comparing the mean retention scores of students assessed using CMT and CBT.

Table 4

ANCOVA Summary of Retention Scores by Testing Strategy (CBT vs. CMT)

Source	Type III Sum of Squares	df	Mean Square	F	p
Corrected Model	13411.113 ^a	3	4470.371	99.259	<.001
Intercept	358039.944	1	358039.944	7949.805	<.001
Strategy	6979.671	1	6979.671	154.974	<.001
Error	5719.772	127	45.038		
Total	391682.000	131			
Corrected Total	19130.885	130			

a. R Squared = .701 (Adjusted R Squared = .694)

Note. Dependent variable: Retention

The results in Table 4 show that the *p*-value associated with the testing strategies is <.001, which is below the .05 level of significance. This indicates that the null hypothesis of no significant difference is rejected. Therefore, there is a statistically significant difference in the mean retention scores of students assessed using CBT and CMT, in favour of the CMT group.

4. Discussion

The research indicated that students who experienced computer multimedia testing demonstrated greater achievement compared to those who underwent conventional computer-based testing in Environmental Education. Additional analysis employing ANCOVA showed that this variance in average achievement scores for students assessed through CBT and CMT was statistically meaningful. This observation may be due to the increased engagement and interactive characteristics of multimedia components. CMT probably included visual and auditory supports, animations, and simulations that helped students grasp intricate ideas more effectively. This engaging method may have allowed students to better conceptualize and relate to the content, contributing to enhanced understanding and performance. The statistically significant difference in average achievement scores between CBT and CMT, as indicated by ANCOVA, implies that the multimedia-enhanced testing format considerably influenced student performance. Supporting this study's findings, Muhammad-Thani and Abdulrahman (2024) indicated that students taught Computer Science using multimedia instructional methods performed better than those who were not taught with these strategies. Similarly, Teo et al. (2020) established that multimedia learning was effective in improving academic achievement in science subjects, further reinforcing the potency of multimedia-enhanced assessments in boosting student performance. Likewise, Incedayi (2018) found a significant correlation between students' use of animation technology and their success in geography courses. Umar et al. (2020) equally found that students taught basic science and technology through multimedia instructional strategies achieved at higher levels than their counterparts taught without such strategies, further corroborating the superiority of multimedia-

enhanced approaches. Furthermore, Mayer and Fiorella (2021) theoretically reinforced these findings by establishing that graphics and multimedia presentations significantly enhance learning outcomes by simultaneously engaging both visual and auditory cognitive channels. Conversely, Okoli et al. (2023) observed that participants in the CBT group outperformed those in the CMT group in English Language and Mathematics Achievement Tests. This contradictory finding may be attributed to subject-specific differences, as Environmental Education's visual and conceptual nature may make it more responsive to multimedia enhancement than language and mathematics subjects.

The research also revealed that students who experienced computer multimedia testing had superior retention scores compared to those who took conventional computer-based tests in Environmental Education. Further examination using ANCOVA indicated that the observed difference in average retention scores for students assessed through CBT and CMT was statistically significant. This result may stem from the multimedia format's capacity to improve information encoding and retrieval. The interactive and engaging features of CMT likely promoted deeper learning, enabling students to retain information more effectively over a longer period. The multimedia components, including visuals, animations, and audio, could have aided students in forming more vivid mental images, which made recalling information simpler. This enhanced retention aligns with the cognitive theory of multimedia learning, which posits that multimedia presentations can boost educational outcomes by engaging both visual and auditory processing. The statistically significant difference in average retention scores between CBT and CMT underscores the prospective long-term advantages of integrating multimedia features into assessments, resulting in more efficient learning and retention. This enhanced retention aligns with the cognitive theory of multimedia learning, which posits that multimedia presentations can boost educational outcomes by engaging both visual and auditory processing simultaneously (Mayer & Fiorella, 2021). The statistically significant difference in average retention scores between CBT and CMT underscores the prospective long-term advantages of integrating multimedia features into assessments, resulting in more efficient learning and retention. In support of these findings, Tadesse and Dereje (2023) reported that a technology-integrated formative assessment strategy effectively improved retention scores among secondary school students. Additionally, Bello and Abdulkaram (2023) discovered that students instructed in Introduction to Computer Studies through interactive multimedia outperformed those taught via traditional lecture methods. Similarly, Anusiuba et al. (2019) demonstrated that computer-assisted tutorial instruction significantly enhanced students' achievement and retention in computer studies compared to conventional instructional methods. In a related context, Umar et al. (2015) revealed that multimedia instruction was superior in boosting students' achievement and retention in auto-mechanics compared to traditional methods. Consistent with this study's results, Umar et al. (2020) found that students taught basic science and technology through multimedia instructional strategies achieved and retained knowledge at higher levels than their counterparts taught without such strategies.

5. Conclusion

Based on the results, it can be inferred that computer multimedia testing is a more effective method of assessment compared to traditional computer-based testing regarding student achievement and retention. The statistically significant differences in average achievement and retention scores between the two groups indicate that incorporating multimedia components into assessments can improve student learning outcomes. These findings suggest that educators and policymakers should think about integrating multimedia-enhanced assessments in educational environments to boost student performance and retention.

6. Recommendations

Based on the results, the study suggests several important implications for educational practice. Educators and assessment developers should integrate multimedia components, such as videos,

animations, and interactive simulations, into assessments to enhance student engagement and improve academic performance. Additionally, educators should receive adequate training and support to effectively design and implement multimedia-enhanced assessments, ensuring they possess the necessary technological knowledge to maximize their benefits. Educational institutions are also encouraged to invest in upgrading technological infrastructure, including reliable internet access, modern hardware, and compatible software, to support the effective implementation of multimedia-based assessments. Furthermore, curriculum developers should review and revise existing assessment frameworks to incorporate multimedia-enhanced evaluation methods that align with learning objectives while addressing diverse learning styles and students' needs.

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