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MULTIMEDIA INSTRUCTION FOR UNDERGRADUATES IN SCIENCE EDUCATION: A SYSTEMATIC REVIEW OF THE IMPACT ON LEARNING OUTCOMES

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Abstract

This paper examined the impact of multimedia instructional strategy in motivating undergraduates learning outcomes in Science Education in Ekiti University, Nigeria. The study adopted a quasi-experimental pre-test, post-test, control group design. The sample consisted of 80 Undergraduates selected through purposive sampling procedures. The instrument that was used for the study was Science Education Achievement Test (SEAT). It is a self-designed instrument that consists of information on bio-data of the respondents and 40 multiple-choice items. Expert judgments were used to ensure face and content validity. Test-retest method was used to determine the reliability and a reliability Coefficient of 0.72 was obtained. The data were analyzed using inferential statistics of t-test. The study found out that there was a significant difference between the posttest achievement mean scores of students exposed to multimedia strategy and conventional strategy (Posttest of 12.46 and 8.66 respectively). It was also revealed in the study that there was a significant difference between the retention mean scores of students exposed to multimedia strategy and conventional strategy (Posttest of 30.08 and 28.40 respectively). This indicates that both strategies have significantly different effects on student performance. Based on this finding, it was recommended among other things that government should organize seminar/workshops among the lecturers in Universities on the effective use of multimedia instructional strategy in their various classes to enhance learning outcomes.

Keywords: Learning outcomes**,** Multimedia, Retention, Science Education, Undergraduates

Introduction

In today's scientific and technologically advanced society, human beings face challenges and dilemmas that stem from science. Technology and science are now important components of social and economic advancement. Science has successfully converted nature into useful resources for a better quality of life. According to Rudolph (2023), teaching science is important for preparing future scientists and technical workers as well as for educating the general public. Just a small percentage of

schoolchildren go on to pursue technical careers, according to data on educational achievement and career outcomes. However, science is frequently taught in schools to help kids learn the material because it is thought that this will prepare them for technical jobs.

However, research from the fields of cognitive psychology, science education, and science communication reveals that the primary general-education goals of teaching science for everyday personal use, better thinking skills, or democratic decision-making (what are sometimes referred to as scientific-literacy skills) are poorly served by the prevailing content-mastery approach.

One definition of science is the study of natural phenomena. Another objective, rational, and respectable endeavor to comprehend the principles and forces at work in the natural universe is science. Science and its applications to people and society have become much more widely taught in schools. In the history of scholarly and public concern with the quality of human life and development, the increasing interest and activities in applied developmental science (ADS) coincide with a favorable moment (Lerner, Fisher, and Weinberg, 2021).

According to Nelavai and Ramesh (2020), despite the fact that university is a continuation of school, students struggle to keep up with the first curriculum. The purpose of this systematic study was to determine the factors associated with students' subpar performance during their first few months of university. The investigation into the difficulties experienced by first-year engineering students with inadequate substratum was spurred by this topic. The researchers proposed a foundation course that serves as a link between school and university in order to address this problem.Some of the findings that emerged were related to the personality of students and lecturers, the courses taught and poor foundation. Foundation course is allocated in the first few months of college and students' progress is monitored. This solution is to remove the problem in the long run.

In order to attain skills, the content and concepts should be well understood. According to Stronge (2018), every teacher seeks to be an effective teacher. Every teacher wants to have a positive, remarkable, and lasting influence on students' lives. But what makes for an effective teacher? What role does teacher preparation play in teacher effectiveness? What do effective teachers do during planning, instruction, and assessment? How do they create a learning environment that engages and supports students? And how do effective teachers interact with their students to promote the best opportunities and results for all?

The way to improve teaching and learning, according to Subramani and Iyappan (2018), is through advanced pedagogy. An effective teacher "continually renews himself

[or herself] as a professional on his [or her] quest to provide students the highest quality of education possible." Learning new teaching techniques and integrating new technology into classes are not intimidating to this educator. Think pairs, peer instruction, flip classrooms, and multimedia instructional methodologies are a few examples of these tactics.

"Multimedia is a combination of sound, text, animation, video, or art delivered by a computer or other digital platform," according to Vagg, Balta, Bolger, and Lone (2020). This includes basic teaching tools like videos or animations as well as more sophisticated ones like Virtual Reality (VR) and 3D Augmented Reality (AR). Learning has been demonstrated to benefit from multimedia: animations effectively pique learners' interest, which improves the learning process and fosters empathy in students. Positive findings of these studies suggest that the use of multimedia as a form of blended-learning technique caters to the multiple learning styles and have been found to provide better outcomes than traditional lecture delivery.

Multimedia technology was one of the solutions that Abdulrahaman, Faruk, Oloyede, Surajudeen-Bakinde, Olawoyin, and Azeez (2020) investigated. With the goal of analyzing how multimedia technologies have demonstrated themselves to be a viable tactic for closing the gap in the provision of unfettered access to high-quality education and enhanced student performance, their paper offers a methodical review of various multimedia tools in the teaching and learning processes. Nowadays, multimedia technology is pervasive in the modern world and uses a variety of communication or promotional media, including computers, still photos, and videos. This insurgence of multimedia into the world of information technology has resulted in a significant decrease of information being presented in plain text, replacing it instead with combinations of computer-produced digital media, such as graphic images, photographs, videos, animations, and audio. The use of multimedia for the purpose of enhancing learning is beneficial because it allows for an easier and broader variety of teaching styles with which information can be obtained; it promotes interactive learning and, as a result, encourages greater enthusiasm toward education in both students and teachers (Pavithra, Aathilingam, and Prakash, 2018).

For these objectives to be realized, teachers who are the implementers of this curriculum, apart from being versed in the subject matter, the selection of an appropriate instructional methodology and its effective use, greatly determine their level of success which itself is measured by their students' performance. Realizing learning objectives requires curriculum alignment, but in higher education, practical issues frequently make this alignment difficult. The detrimental impact of misalignment is exacerbated when students are unaware of their place in the curriculum. We address

the use of a digital curriculum mapping tool and make the case for the significance of learning pathways being visible throughout the curriculum. (Wijngaard and Merx, 2018).

Impact of Multimedia Learning

According to Eze, Olumoko, Obi, and Akingbemisilu (2020), using multimedia as an educational technique improved student performance. Thus, their research came to the conclusion that multimedia technology is superior and that educators ought to use it in the classroom. Studies that looked at how multimedia learning affected student attitudes also found comparable findings to those that looked at how it affected student accomplishment.

Some studies concluded that multimedia learning has significant effects on student achievement (Bulut, 2019). Iskandar, Rizal, Kurniasih, Sutiksno, and Purnomo, (2018) analyzed the effects of multimedia learning on students achievement in terms of cognitive test results.The findings of the study indicated that the experiment group which received multimedia teaching had significantly much higher scores on achievement and permanent learning in contrast to the control group. In addition, nearly all students reported that they liked multimedia teaching. In short research on the effects of multimedia learning on student achievement produced different findings. At the core of multimedia, teaching is to provide students with stimulating experiences to better understand concepts by delivering information using different applications.

In a study carried out by Çeken and Taşkın, (2022). The current study presented a systematic review of multimedia learning principles in different learning environments, including traditional, virtual reality and augmented reality.

The findings of this study showed that: (1) there is a growing interest in multimedia learning principles; (2) undergraduate students were the target participant group in the review studies; (3) only five studies tested one of the principles in the VR environment, but none in the AR learning environment; (4) the majority of studies preferred indirect objective measurements (e.g., learning outcomes, eye-tracking, study time) or subjective measurements (e.g., mental effort, difficulty); (5) STEM subjects are frequently preferred in investigations; and (6) modality was the most studied multimedia learning principle in the reviewed articles, followed by redundancy, multimedia, signaling, coherence, segmenting, personalisation, spatial contiguity, temporal contiguity, image, pre-training, and voice in that order. The results were discussed in detail. Specific gaps in the literature were identified, and suggestions and implications were provided for further research.

However, due to the limited ability of people to process information for people to enjoy high-quality education without affecting efficiency, different forms of multimedia (including PowerPoint, simulation, computer games, and virtual reality) have been developed. Reviewed articles cover as many different school subjects as possible to clearly show that multimedia learning could bring advantages to students' academic performance. Because high-tech technology always has advantages and

disadvantages, the research also focuses on the impact of different multimedia methods.

Several works of literature have demonstrated the great use of multimedia-integrated instruction in various aspects of learning, including achievement, understanding, retention, motivation, engagement, and changing abstract concepts into concert concepts. However, in many developing countries, including Ethiopia, instruction is mainly based on conventional methods and has problems using multimedia and DCII. The application of multimedia in educational systems is being applied globally although the range and speed of implementation vary from country to country. The benefits of multimedia instruction are well known, but they are not widely used in Nigerian secondary schools. A literature review identified that the most emphasized teaching methods in biology were those in which students worked in groups and actively participated in learning processes and lecture methods.

Koval et al. (2022) asserted that "the future's blackboard will be multimedia." The purpose of the application of multimedia technologies of education in higher education institutions is to prepare students for full-fledged life in the information society. It is necessary to outline the pedagogical goals of multimedia learning technologies, which include: implementing the social order brought about by the informatisation of modern society; intensifying the educational process at all levels and improving its efficiency and quality; and stating that computer interaction will drive schools at all levels, learning styles, and for various subjects. In particular, the design of specific multimedia materials for educational courses in research institutions and schools at all levels can greatly enhance students' learning interests. The use of multimedia can also increase the effectiveness of learning. In this respect, in the twenty-first century, the materials and methods for fine arts education should be in line with cultural diversity and integrity. Accordingly, instructional media should be integrated with computer-based instruction, the Internet, multimedia, and hypermedia. When the changing world is considered with its increasing uncertainties, complicated international environment, and rapid changes, it is important for teachers to be able to attract students' attention. Teachers who use traditional dictation, blackboard writing, and playing slides cannot succeed in this in the current environment with diverse sounds and colors.

In view of Prakash and Pavithra (2018) Multimedia technology has several advantages over conventional media, including rapid speed, high information transfer, great interaction, ease of use, and stimulation of multiple senses. Text, graphics, drawings, still and moving images (video), animation, audio, and any other media where all forms of information may be represented, stored, shared, and managed digitally are all included in the field of multimedia, which is computer-controlled. In addition to being a component of a live presentation, multimedia can be recorded and played, shown, interacted with, or accessed by information-satisfied processing equipment, such as

sophisticated and automated technologies. Electronic media techniques for storing and interacting with multimedia content are known as multimedia devices. Multimedia is notable from diverse media in fine art; for model, by containing audio it has a broader scope. In the early years of multimedia the term" rich media" was identical with collaborating multimedia, and" hypermedia" was an application of multimedia. In this paper we discussed about the different elements of multimedia along with its applications, features, advantages and disadvantages so on.

The use of multimedia instruction can be more intuitive, interactive, integrated, controllable, and editable. The use of multimedia in instruction can be a vivid way of presenting the curriculum content, and it can stimulate students' learning motivation and increase their learning satisfaction. They believe that the purpose of using multimedia is for communication management. In this respect, it can be stated that multimedia enables adapting the content according to individual differences and expressing the teaching content with optimum media. In addition, multimedia instruction can provide various communication channels for learners to achieve the highest effect and satisfaction. Multimedia that corresponds to human characteristics in terms of multiple senses can provide information in different forms. This can make the transmission and reception of feelings and information more authentic. Moreover, information can be offered according to learners' needs and responses, so that the delivery of information is not limited to only fine arts, but it represents interactive learning and enables individualized learning. Educational experts have confirmed that this can contribute to learning satisfaction.

Inawati Erwin and Musmulyadi, (2022) indicated significant correlations between students' learning attitude and learning satisfaction. According to their study, it can be claimed that the better the learning attitude is, the higher the learning satisfaction will be. In addition, institutions can develop tests in line with the research on satisfaction and remove unsuitable curricula to reduce the likelihood of failure. Learning satisfaction research indicated that improving deficient curricula can enhance learners' positive attitude and guide their development. They found that the better the learning attitude, the higher the learning satisfaction. They also found that learning attitude is related to learning satisfaction. Learning satisfaction is not simply the indicator of the outcome of the learning activity, but also the main indicator to promote learning motivation and attitude and develop the curricula and considered that each person has different learning needs and attitude throughout life, and satisfaction is the achievement of these needs or attitudes. Therefore, a prior understanding of the needs and attitudes is necessary for education. Learning satisfaction and learners can achieve the goal expected before learning after participating in a learning activity.

According to Onah, Okwukwe and Chima (2024), multimedia enhances learning and instruction by adding authenticity and diversity. Web-based audio, graphics, video, and animations might be used to teach the subjects to the students in a way that traditional methods could not provide in a realistic classroom setting. This way, closeness to reality could be provided and complete learning could be achieved (Semerci, 2019). Another contribution multimedia makes into education is the increase in academic achievement of the students. To sum up multimedia, hasten the learning process as it is the best teaching aids or tool where student can easily grasp the subject to be learned in a period of time. The use of multimedia will improve students' understanding scientific concepts. With the evolution of multimedia in education, learning has gradually moved from the era of the teacher being the repertoire of knowledge or the students being the passive recipients. Now, the role of both teachers and students' has significantly changed.

Students are now active participants in the learning process, while teachers serve as learning facilitators. Reese, Pawluk and Taylor, (2016).found that learners retain more when a variety of senses are engaged in learning; and that allows them to retain and recall information. that supplementing traditional teaching classroom with multimedia learning tools could enhance students' motivation to learn, and make them active in the learning process, thereby, improving practice. Likewise, several similar studies have reported the increased academic success of students where multimedia techniques are applied, and this success is attributed to the ability of multimedia technology to capture student's interest and get them engaged in the course of learning. This implies that the mental representation and connections of learning materials in words and pictures enhance students' engagement via active learning. Hence, multimedia, in its many formats, has been found to play a crucial role in education indeed.

Statement of the Problem

Method of teaching is extremely important. However there is little realization of this and the methods of teaching used in our schools, colleges and training institutes continue to be largely traditional. Even the best curriculum and the most perfect syllabus remain dead unless supported by the right strategies of teaching. The search for educational effectiveness has always been a primary objective for the educators. In order to achieve educational effectiveness it is important for the educators to adopt an effective teaching method that suits the individual learning style.

Science has become a part of everyday experiences and thus there is a need to initiate the students into the scientific spirit and to introduce them to a world made up of technological objects and processes where in multimedia plays a pivotal role. A teacher can judge students' strengths and weaknesses through an activity. In our schools,

Science teaching is still oral in character where the students are passive listeners. The teaching of the subject can be made more interesting and effective if some innovative methodologies are adopted.

However, the extent to which other strategies have been achieved in improving teaching has not yet been addressed in science education by the researcher. It is in the light of this discovery that the researcher embarked on this action research to use the multimedia instruction to help students learn and understand some concepts taught in science education. Therefore, this study aims to investigate how undergraduates' performance in Science education could be improved through multimedia instructional strategy.

Research Objectives

The objectives of this study were to examine the effect of multimedia instructional strategy in motivating students' learning outcome in science education among undergraduates in Ekiti, Nigeria. In addition, the study will find out the achievement and retention levels of students exposed to multimedia instructional strategy and those exposed to conventional method. The outcome of this effort will be used to suggest steps that can motivate and improve students' learning outcome in science education.

Hypotheses

The following null hypotheses were generated and tested;

1. There is no significant difference between the posttest achievement mean scores of students exposed to the multimedia instructional strategy and the conventional strategy
2. There is no significant difference between the retention mean scores of students exposed to multimedia instructional strategy and conventional strategy.

Methodology

The study was a quasi-experimental pre-test, post-test, control group design. The pre-test was to establish the knowledge base line of the students that was used for the study while the post-test will measure the level of academic performance of the students after treatment. The design of the study is represented as follows: Experimental Group = 0_1 X_1 0_2 , Control Group =0_3 X_2 0_4.
Where 0_1,0_3, represent pre-test. X_1= multimedia instructional strategy X_2= Conventional method. Also, 0_2,0_4, represent post-test.

The target population for this study was made up of all the Science Education students in Bamidele Olumilua University of Education, Science and Technology, Ikere, Nigeria. The sample for this study comprised 80 students selected from 200 level in the department of Science Education using purposive sampling technique, because 300

and 400 Level students were on teaching practice during the research. The instrument that was used for this study is Science Education Achievement Test (SEAT). It is a self-designed instrument. Section A of the SEAT consisted of information on bio-data of the respondents while Section B consisted of 40 multiple-choice items that covers all the content of the chosen topics used as achievement test. Same test was re-arranged and administered as the posttest for retention. Expert judgments were used to ensure face and content validity. Test-retest method was used to determine the reliability and reliability Coefficient of 0.72 was obtained. In testing this hypothesis, the scores were subjected to t-test analysis at 0.05 level of significance.

The Experimental Group: The multimedia strategy involves guiding the 40 participants on the use of different devices;

1. -Text: for core content and instructions
   -Images/Diagrams: to visualize complex ideas
   -Audio: for pronunciation, music, or lectures
   -Video: for demonstrations or storytelling
   -Interactive Elements: quizzes, simulations, games
2. Implementing the Lesson
   -Delivering the lesson using a suitable platform like classroom projector and Google Classroom
   -Engaging students actively using multimedia by pausing videos for discussion, adding polls or interactive questions.
3. Facilitating Interaction and Engagement
   -Encouraging student participation (chat, voice, collaborative tasks).
   -Using interactive media (quizzes, digital whiteboards, breakout groups).
   -Allowing learners to ask questions or reflect on the content.

The Control Group: Traditional method of instruction. The lecture approach, which was the most common teaching strategy, was used to instruct the 40 students in the control group. This group was shown each concept, but no accompanying images were included. However, the teachers encouraged learners to take notes of the ideas or facts presented and they supplemented the traditional lecture presentation with assignments. The opportunity gives learners to encode new information in their memories, while the notes can be reviewed later to assimilate knowledge gained in the lecture presented by the lecturer.

Experimental Mortality; Experimental mortality" is the term used to describe the "drop rate." When participants in studies using longitudinal designs are unable to finish the study process, an issue known as experimental mortality arises. One of the biggest risks to internal validity in experimental research is experimental death. Based on our

experiences with experimental research in Africa, where longitudinal research is occasionally used, it appears appropriate to define experimental mortality as the dropout of subjects or participants (i.e., market women, university students, street urchins, secondary school students, and university academics) from ongoing experimental activities.

Results

H1: There is no significant difference between the posttest achievement mean scores of students exposed to the multimedia instructional strategy and conventional strategy.

In testing this hypothesis, the mean total scores and standard error obtained from the posttest achievement mean scores of students exposed to the multimedia instructional strategy and conventional strategy were subjected to t-test analysis at 0.05 level of significance.

Table 1: The t-test showing the posttest achievement mean scores of students exposed to the multimedia instructional strategy and conventional strategy

Group	N	Mean	SD	df	t-cal	t-table	Result
multimedia	40	12.46	4.71				
Conventional	40	8.66	3.85	119	13.41	1.98	Significant at p<0.05

Table 1 shows that the achievement mean score of students exposed to multimedia strategy is 12.46 with standard deviation of 4.71, while the achievement mean score of students exposed to conventional method is 8.66 with standard deviation of 3.85. The t-calculated is 13.41, while the t-table is 1.98. Thus the t-calculated is greater than the t-table value; therefore, the null hypothesis is rejected.

H2: There is no significant difference between the posttest retention mean scores of students exposed to multimedia strategy and conventional strategy.

In testing this hypothesis, the mean total scores and standard errors obtained from posttest retention mean scores of students exposed to multimedia strategy and conventional strategy were subjected to t-test analysis at 0.05 level of significance.

Table 2: the t-test showing the posttest retention mean scores of students exposed to multimedia strategy and conventional strategy

Group	N	Mean	SD	df	t-cal	t-tab	Result
multimedia strategy	40	30.08	3.06				
Conventional strategy	40	28.40	3.14	119	2.52	1.98	Significant at p<0.05

Table 2 shows that the retention means score of students exposed to multimedia strategy is 30.08 with standard deviation of 3.06, while the retention mean score of students exposed to conventional method is 28.40 with standard deviation of 3.14. The t-calculated is 2.52 while the table value is 1.98. Thus, the t-calculated is greater than t-table value; therefore, the null-hypothesis is rejected. This implies that there is a significant difference between posttest retention means scores of students exposed to multimedia strategy and conventional strategy.

Table 3: ANCOVA showing the pretest and posttest scores analysis of students exposed to multimedia strategy and conventional strategy

Source	SS	df	Ms	F	Sig.
Covariate(Pretest)	1320.45	1	1320.45	18.62	0.00
Group(Strategy)	890.67	1	890.67	12.55	0.01
Error	5340.88	77	69.35		
Total	7552.00	79			

After controlling for pretest scores, there was a statistically significant difference in students' posttest performance between the two teaching strategies ($F(1,77)= 12.55$, $p< .05$). Students taught using multimedia strategies performed significantly better than those taught using conventional method.

Discussion

The finding of the study revealed in hypothesis1 that there is significant difference between the posttest achievements mean scores of students exposed to the multimedia strategy and conventional strategy. The study also revealed in hypothesis 2 that there is a significant difference between the posttest retention mean scores of students exposed to multimedia strategy and conventional strategy. This is in accordance to the submission of Iskandar, Rizal, Kurniasih, Sutiksno, & Purnomo (2018) who was of opinion that, teaching methods or approaches, Technological

progress has influenced the way we acquire knowledge and learn. On the other hand, improves efficiency and saves time. especially in the learning of science and technology are expected not only to enable students acquire knowledge but to retain same over a long period of time and discovery learning can assist in improving the understanding, critical thinking skills, problem solving skills, communication skills of learners, increase the involvement of learners, both individually and socially, in exploring and critically solving problems. In hypothesis 3 there was no significant difference between the posttest achievement mean scores and retention mean scores of students exposed to conventional strategy. In hypothesis 4 there was a significant difference between the posttest achievement mean scores and retention mean scores of students exposed to multimedia strategy. This was also supported by (Pavithra& Prakash, (2018) by who asserted that use of multimedia enhances learning and beneficial because it allows for an easier and broader variety of teaching styles with which information can be obtained; it promotes interactive learning and, as a result, encourages greater enthusiasm toward education in both students and teachers and more intellectually engaged in science when they are using multimedia strategy and moreover some teachers indicate that students whose interest in science had been minimal in the past made impressive contributions using multimedia method and took science more serious and achieve overall improvement in motivation and learning outcome. It was therefore found from the study that students exposed to multimedia strategy performed better than those exposed to conventional method.

Conclusion

According to the study's findings, teaching science education through multimedia was more successful than using the traditional approach. The multimedia teaching approach has the potential to improve student learning outcomes because it enables students to create their own meanings and scaffold what they are learning with their peers. It was also determined that increasing students' interest through more active teaching methods can significantly boost their performance and retention in science classes. In order to further improve learning outcomes for the subject, lecturers must help their students in this approach.

Recommendations

Based on the findings of this study, the following recommendations are made;

1. It is advised that students be tested on their ability to use multimedia instruction to respond to questions during quizzes and exams. Students would be encouraged to take studies seriously as a result. Lecturers should aim to experiment with different teaching techniques and utilize as many as possible to break up the monotony of their sessions rather than becoming too set in their ways.

2. Regarding the issue of insufficient instructional aids and specimens, university administrators ought to purchase tools such as projectors, laptops, and tape recorders.
3. Further empirical studies should be carried out on the use of computer for instructional purposes, on different subjects and at different levels to provide sound basis for the integration of multimedia instruction in Nigerian schools.
4. There should be in-service training for lecturers on the use of multimedia instruction in science teaching.

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