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EFFECT OF AUDIO-VIDEO TEACHING STRATEGY ON STUDENTS' ACHIEVEMENT IN CHEMISTRY

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Abstract
The nature of chemistry demands for a mode of instruction that can appeal to different learning channels and widen the horizon of learners' learning experience for more understanding. Thus, this study investigated the effect of audio-video teaching strategy, a multimedia strategy on students' achievement in chemistry. A quasi experimental, pretest-posttest, non-equivalent control group design research was adopted for the study. A sample of 610 participants were used for the study. The instrument used was Chemistry Achievement Test (CAT). The internal consistency of the test items was estimated to be 0.88 using Kuder- Richardson formula 20 (K-R-20) method. Results showed that there was a significant improvement on students' achievement when taught chemistry using audio-video teaching strategy. Based on the result, it was recommended that teachers should adopt audio-video teaching strategy in teaching chemistry and attend workshops/seminars on the use of audio-video teaching strategy.

Keywords: Achievement, Audio-video, Chemistry, Quasi-experiment, Teaching Strategy.

Introduction

Chemistry is included in school curricula by many nations with the expectations that exposition of the young citizens to chemistry instructions would help to boost economy, and high level of development attained (Federal Ministry of Education, 2007) and Umesh & David, 2013). The Nigerian chemistry curriculum objectives stressed that learning chemistry at the senior secondary school should equip the young citizenry to acquire the knowledge and skills including competence in ICT applications required for employment and wealth generation (FM E, 2007). The Nigerian chemistry curriculum objectives conform to the Royal Society of Chemistry's vision for 11-19 chemistry education which maintains that the vision of chemistry education curriculum in the United Kingdom at the national level includes, to ensure a sustainable supply of young citizens with the curiosity, knowledge and skills required to engender growth and productivity. The extent to which teaching and learning exercises geared towards realization of the expectations of society could be determined through students' academic achievement (Igboanugo, 2011; Njoku, 2023).

Observed persistent poor academic achievement in chemistry has remained a great concern to researchers (WAEC, 2018-2022; Rossett, 2013). Some of the factors responsible for students' poor academic achievement in chemistry are nature of chemistry, misconceptions, lack of students' interest. Others include insufficient teaching resources, poor teachers' quality and poor teaching methods adopted by the teacher (Taber, 2023).

Most chemistry contents are abstract (Njoku, 2023). Therefore, the nature of chemistry makes its teaching and learning difficult. Chemistry attempts to explain or trace the causes of phenomena using abstract concepts, principles, rules, theories and laws. The basic concepts in school chemistry which include electron, orbital, ion, molecule, mole, bonding, energy are abstract. Chemistry principles, rules, theories and laws such as the Aufbau principle, Hund's rule, principles and laws of electrolysis, Le Chatelier's principle, laws of chemical combination and the ionic theory lack tangibility. Abstraction in chemistry leads to misconception, misunderstanding and misinterpretations of chemistry concepts, ideas and principles (Taber, 2019 and Riddle, & Lo-Fan-Hin, 2023). Furthermore, chemistry language is symbolic and mathematical. This is as expressed in chemical, ionic and nuclear equations. Students find it difficult to understand, use and write chemistry language (Weisman, 1995; Taber, 2013 and Njoku, & Attah, 2018). The learner needs an extraordinary power of conception to understand chemistry. The nature of chemistry contents demands for a special teaching method that would appeal to different senses of the learner (Atma, Azahra, Mustadi & Adina, 2020). Some students seem to learn better when information is presented through words (verbal presentation) whereas others seem to learn better when it is presented in the form of pictures (visual presentation) (Numgwo, Emmanuel, Owudunni & Ekpe, 2020). Using traditional method such as the lecture method not aided with technology is limited in appealing to different senses and does not allow active participation of the learner during instruction (Taber, 2023) therefore it is not efficacious enough to lend the learner the extraordinary power of conception required in learning and understanding chemistry which is dominated by abstraction (Kumar, Gangwar & Mehrotra, 2023,Riddle, & Lo-Fan-Hin, 2023).

A lot of teaching strategies have been recommended by researchers for effective teaching and learning chemistry. Such strategies include cooperative learning, flipped classroom, think-pair, ICT based instructional strategies (Okebanam & Umate, 2023 and Uko & Babayemi, 2023). However, the trending teaching strategies are the ICT/digital teaching strategies (UNESCO, 2018). Due to the efficacious nature of the digital strategies in instruction, the UNESCO declared that all nations should embrace the digital technology in teaching and learning. To stress the importance of digital technology in teaching and learning, the American Disabilities Act (ADA) recommends that web materials should be made accessible to all students (Ibrahim, Abdullahi & Nasir, 2017). In line with the trending global digitalization, the F. M. E (2007) stressed the need for chemistry curriculum and its implementation to embrace digitalization. The digital teaching strategies include use of computers, web, satellites, internets, videos and animation. Digital video is an important aspect of the instructional web materials.

Audio-video teaching strategy is a teaching strategy that appeals to the senses of auditory and visual (Gqoli, 2022). Students learn in many ways through seeing, hearing, reflecting and reasoning (Felder, 1988). Audio-video teaching strategy allows teachers and learners to control the pace of teaching and learning exercise thereby taking care of different kinds of learners from different backgrounds (Kumar, Gangwar, & Mehrotra, 2023). Audio-video strategy, can allow the learner have an audio-video record of the classroom instruction using the android phone or the computer applications and rewind the instruction at his/her convenience and pace for a better understanding. This underscores individualized instruction and can also result to overlearning.

Use of audio-video strategy in instruction has advantages of facilitating thinking and problem solving, fostering mastering learning and support remote/online learning (Chotimah, Setyawarno, Rosana, 2023; Wang, Han, Gao & Liu, 2021). Other advantages include aspiring and engaging

students, helping in practical instruction and acquisition of science process skills, and breaking the barrier of distance in reaching learners (Schwarz & Kuonen, 2021; Obi, et al, 2022 and Rojas, 2023). A planned combination of sound and pictures as found in audio-video teaching strategy could enhance development of creativity, motor abilities, and cognitive skills in children, provide excitement for learners, educate young ones, and improve competing skills (Gqoli, 2022). Audio-video teaching strategy has some limitations such as: time-consuming, requires technical skills and costly equipment (Eya, & Okebanama, 2022). However, researchers such as (Rojas, 2023; Schwarz & Kuonen, 2021; Velázquez-Marcano, Williamson, Ashkenazi, Tasker & Williamson, 2004) recommended the use of audio-video strategy in chemistry instruction.

Hanell (2018) reported that digitalization in education is strongly linked to teachers' competence in using digital tools such as video which was found to be low and affected development of digital competence in the students. Gqoli (2022) discovered that teachers are interested in integrating technology into teaching and learning but for certain obstacles which include teachers' lack of confidence in their technical expertise, lack of technological equipment, physical environment restrictions, and infrastructure.

The theory of cognitive multimedia learning propounded by Richard Meyer (1977) gives the theoretical background to Audio-video teaching strategy. According to Meyer (2002), learning does not rely on text alone but takes place through both audio and visual senses. Meyer therefore propounded two channels of mental representations necessary to increase learners' memory for effective learning to include the use words and pictures. An assertion by Davis & Norman (2016) maintains that by the principles of the cognitive multimedia learning, learners become active in the learning process by identifying and choosing important materials, organizing the materials into visual and verbal models and integrating the new models with prior knowledge.

The audio-video teaching strategy is a combination of audio and visual mental channels of representation for instruction which is capable of maximizing learners' memory and understanding. The teacher presents learning experiences to the learner through audio-video. The auditory channel being stressed and confirmed by display of pictures/images through the visual channel (video). This strategy has the propensity to appeal to the learner's different senses to capture the learner's attention and interest. Audio-video teaching strategy by appealing to the learner's different senses, according to Meyer 2002 increases the learner's memory, gives the learner a better opportunity to actively have full interaction with the learning environment which instigates intellectual construction and reconstruction of knowledge for more understanding. Through the interaction, the learner undergoes mental reconstruction to accommodate the new knowledge together with the already existing knowledge (Anyegbunam, Nwodo & Enibe, 2015). This study set to investigate the effects of audio-video teaching strategy which earns theoretical support from the cognitive multimedia learning theory on students' achievement in chemistry.

Existing literature shows that audio-video teaching strategy could be effective in improving students' achievement. However much empirical study has not been carried out to establish the effectiveness of audio-video teaching strategy on students' achievement in chemistry. A quasi-experimental study on audio-video teaching strategy and students' achievement in chemistry would likely yield an exciting result.

Problem of the Study

The importance of chemistry in recreation for individual benefit and national development cannot be over-emphasized. Hence its global inclusion in school curricula by many nations. However, students' achievement in chemistry is perennially poor and needs an improvement to meet up with national expectations. Literature establishes that the teaching method/strategy used by the teacher is a major factor that determines students' achievement. Use of audio-video teaching strategy could increase students' academic achievement in chemistry. Thus, the problem of this study is: What is the result of a quasi-experimental study on audio-video teaching strategy and students' achievement in chemistry?

Purpose of the Study

The purpose of this study was to find out the result of a quasi-experimental study on audio-video teaching strategy and students' achievement in chemistry. Specifically, the study set out to find out: The extent to which audio-video teaching strategy has effect on students' achievement in chemistry.

Scope of the Study

The study was conducted in Onitsha Education Zone of Anambra State, South-East of Nigeria. 2022/2023 Senior Secondary School 2 (SSS2) chemistry students were used for the study. While electrolysis was the topic used in a quasi-experimental study on audio-video teaching strategy and chemistry students' achievement.

Research Question

The study was guided by the following research question:

What are the mean achievement scores of students taught chemistry using audio-video teaching strategy and those taught using lecture method?

Hypothesis

The following null hypothesis was formulated and tested at the alpha level of 0.05.

Ho: The difference in mean achievement scores of students taught chemistry using audio-video teaching strategy and those taught using lecture method is not significant.

Methodology

A quasi-experimental study of pretest-posttest, nonequivalent control group design was adopted for the study. This is because intact classes were used which would not allow full randomization of subjects. The population of the study comprised all 3022 SSS2 chemistry students in Onitsha education zone of Anambra State, South-east of Nigeria. Electrolysis was purposively selected for the study because it has been adjudged to be one of difficult topics in chemistry (Igboanugo 2011; West African Examination Council, 2021 and 2022). Again, on further analysis, electrolysis comprises some of the abstract concepts in chemistry such as atom, electron, ion, mole, and other difficult aspects which include writing and balancing chemical equations, and mathematical problems. They all span through other areas and topics in chemistry. Electrolysis is in SSS2 scheme of work hence, the use of SSS2 in the study. A sample of 610 students from purposively selected 10 senior secondary schools, public and private schools inclusive was used

in the study. The selection was made based on availability of required facilities that can support the use of audio-video teaching strategy in the schools. Secondly because the regular chemistry teachers were used in the study, the chemistry teacher's ICT compliance was also considered for selection of schools. Experimental and control groups were randomly assigned to schools. Five schools were randomly assigned to experimental group while the remaining five schools were assigned to control group. Thus, respondents from each group have facilities in their schools that can support the use of audio-video teaching strategy. Population of the respondents in each of the experimental and control groups comprised of both males and females. Furthermore, all the schools are in urban location. However, those in the control group were not taught during the study with the audio-video facilities while those in the experimental group were taught using the audio-video facilities.

Instrument for Data Collection

The Chemistry Achievement Test (CAT), adopted from Igboanugo (2011) was the instrument used for the study. CAT comprised two sections, Section A and Section B. Section A sought for personal data of the subjects while Section B comprised of instructions and 35 items, 4-option multiple choice objective test covering electrolysis as recommended in the SSSII Chemistry curriculum (F. M. E, 2007). The options were lettered a, b, c, d with one option being the correct response while others are distracters.

CAT was face-validated by two are experts in chemistry education and an expert in Measurement and Evaluation. Also, a secondary school chemistry teacher face-validated the instrument. The validators reviewed and critiqued the various items on the instrument in terms of their clarity, relevance as they relate to the study and appropriateness of language and response options. Content validity of the CAT was assured by using the test blueprint which helped to ensure that all aspects of the content were covered. The test blueprint considered the number of periods that covered each concept and objective levels for each concept.

CAT was trial tested on 31 SS2 students of a school in Ogidi Education Zone of Anambra State, another area different from the area of study. Scores obtained were used to establish the internal consistency of the test items estimated to be 0.88 using Kuder- Richardson formula 20 (K-R- 20) method. The Kuder- Richardson formula 20 was suitable since two options were basically involved in each of the test items, the key and the distracters.

There were also lesson notes vetted by two experts in chemistry education and two chemistry teachers from secondary school. The lesson notes covered seven weeks of study for each of the experiment group and the control group. For the experiment group, the lesson notes covered use of audio-video teaching strategy to teach electrolysis. For the control group, the lesson notes covered use of lecture method to teach electrolysis. The researcher prepared the lesson notes for both experimental and control groups. With the help from an ICT expert, audio-video instructional clips on subtopics in electrolysis were packaged for use in the experimental group.

Experimental procedure

Regular teachers in the sample schools were used in the study to teach their respective classes. This arrangement helps in removing the Hawthorne effect which might occur when a different teacher teaches the learners. Teachers in the experimental group were trained for three weeks by the researcher to:

- Familiarize the teachers with the contents, performance objectives, activities of the learner and the teacher in learning the content.
- Be in agreement with the researcher on the lesson notes prepared by the researcher.
- To learn the operation and technicalities of the audio-video teaching strategy.

Micro-teaching was part of the teachers' training. In the course of using the audio-video teaching strategy, students have access to audio-video records of instructions on the topics and concepts in electrolysis.

In the experimental group, the audio-video lessons prepared in advance were presented and used for instruction by the teacher in the class. These include teacher's presentation video clips of animations showing electron flow and migration of ions at electrodes; construction of electrolytic and electrochemical cells; electrolysis of different electrolytes; purification of copper using electrolysis, electroplating of metals. Other presentations include video clips of graphs verifying the laws of electrolysis, notes on different concepts such as mole, oxidation and reduction, electrolytes and non-electrolytes, and teacher's voiceover narrations. Students' demonstrations on construction of electrolytic cells and electrolysis were video and replayed for them.

In control group, the regular teachers used the lesson notes prepared by the researcher which was on use of lecture method without video or ICT resources to teach the same contents as in the experimental group. The researcher constantly monitored the two groups to ensure strict adherence by teachers to the lesson notes, operations and principles of each mode of instruction.

A pretest was administered to the subjects in both groups using CAT and the scores were recorded before the commencement of the experiment. The experiment was carried out during normal school hours using the school timetable for the classes. The experiment lasted for seven weeks. On the last day of the experiment, a posttest was administered to the subjects using the CAT. Scores obtained were recorded. The CAT used in posttest was the same in content as the CAT used in the pretest but differed in the sequence of items. Data collected from the pretest and the posttest were used to answer the research question and test the hypothesis.

Data Analysis

Analysis of the data was done using The Statistical Package for Social Sciences (SPSS) version 25.0. The research question was answered using mean and standard deviation scores. In order to test the hypothesis, the responses of the subjects on both the experimental and control groups were collated on statistical coding sheets on the basis of scoring levels. The set of data was then subjected to Analysis of Covariance (ANCOVA). ANCOVA was used to control the existing pretests covariates. One-way ANCOVA was used because only one independent variable (teaching method) was involved in the study.

Results

Results of the study are presented in Tables 1and 2.

Research Question: What are the mean achievement scores of students taught chemistry using audio-video teaching strategy and those taught using lecture method?

Table 1: Mean and standard deviation of students' achievement scores in chemistry due to modes of instruction

Modes of Instruction	Number of subjects	Pretest		Posttest		Gain mean score
		Mean	Std. dev.	Mean	Std. dev.	
Audio-video	310	15.34	1.72	58.62	1.32	43.28
Lecture	300	15.70	1.01	43.06	1.42	27.36

The results in Table 1 show that the pretest achievement mean score and the standard deviation of students taught using audio-video mode of instruction were 15.34 and 1.72 respectively while the post achievement mean score and the standard deviation were 58.62 and 1.32 respectively. The gain achievement mean score of students taught using audio-video mode of instruction was 43.28. Table 1also shows that the pretest achievement mean score and the standard deviation of students taught using lecture mode of instruction were 15.70 and 1.01 respectively while the post achievement mean score and the standard deviation were 43.06 and 1.42 respectively. The gain achievement mean score of students taught using lecture mode of instruction was 27.36. The difference in standard deviation indicates difference in clustering of scores around the mean scores of each group. Students' background, school location, availability of facilities and Hawthorne effect due to teacher's relative newness in school are some of the factors that might have caused the observed differences in pretests. Conclusively, results in Table 1 show that an improvement on students' achievement in chemistry when taught using audio-video teaching strategy.

Hypothesis: The difference in mean achievement scores of students taught chemistry using audio-video teaching strategy and those taught using lecture method is not significant.

Table 2: Summary of analysis of covariance (ANCOVA) of modes of instruction on students' achievement score in chemistry

Dependent Variable: Post Test Source	TYEPE III sum of squares	Df	Mean square	F	Significant	Partial Eta Squared
Corrected model	17153.424[a]	2	8576.712	157.545	0.001	0.758
Intercept	226659.014	1	226659.014	4163.476	0.001	0.312
Pretest achievement	3.441	1	3,441	0.063	0.802	0.398
Mode of instruction	17153.278	1	17153.278	315.087	0.001	0.722
Error	15460.917	607	54.440			
Total	800675.000	610				
Corrected total	32614.341	609				

The results in Table 2 shows that the exact probability value of 0.001 associated with modes of instruction is less than 0.05 level of significance (F (1, 607) = 315.087, p = 0.001). The partial eta squared value of 0.722 indicates that the effect which compared with Cohen's guidelines of *0.2*= small effect, *0.5*= moderate effect and *0.8*= large effect is considered to be moderate. The effect size of *0.722* indicates that 72% of the variance in the students' posttest

scores is explained by the independent variable (mode of instruction). This means that difference in the mean achievement scores of students taught using audio-video strategy and lecture method is significant and will not be attributed to errors associated with the study. The null hypothesis of no significant difference in mean achievement score of students taught chemistry using audio-video teaching strategy was therefore rejected. Thus the researcher concluded that there was significant difference in the mean achievement score of students taught chemistry using audio-video teaching strategy and those taught using lecture method.

Discussion of Findings

Table 1 shows that student taught chemistry using audio-video teaching strategy had improved achievement score. Table 2 further confirms that the difference in achievement score of students in chemistry taught using audio-video teaching strategy was significant. This result implied that audio-video teaching strategy is efficacious in improving students' understanding in chemistry. This result conforms to cognitive multimedia learning theory of Richard Meyer (1977) who maintained that use of auditory and visual channels in instruction increases the learner's mental ability. The two channels of mental representations, auditory and visual, provided by audio-video strategy must have increased learners' memory and understanding of chemistry concepts which resulted in improved students' achievement. In line with the view of Davis & Norman (2016), learners through the intervention of the audio-video strategy, became active in the learning process by identifying and choosing important materials, organizing the materials into visual and auditory models and integrating the new models with prior knowledge for accommodation and easy retrieval. The result of this study conforms to Rojas (2023) who found the use of video demonstration to be effective in improving students' conceptual understanding of chemistry. The present result is also in consent with Obi, = et al. (2022) who discovered audio-video based instruction to be effective in supporting teaching and learning sciences. Through the audio-video teaching strategy, what the learner heard was confirmed by what he/she saw and felt which resulted to overlearning. In line with the views of Kumar, Gangwar and Mehrotra (2023), different kinds of learners from different backgrounds were taking care of by using the audio-video teaching strategy which allowed teachers and learners to control the pace of teaching and learning exercise. Furthermore, the result of this study conforms to Uko & Babayemi (2023) and Schwarz & Kuonen (2021) who assert that use of audio-video strategy in instruction facilitates thinking and problem solving, and fosters mastering learning. The education implication of this study is that a teaching strategy such as audio-video strategy that uses different mental representations, of audio and visual if adopted by the teacher would significantly increase the outcome of teaching and learning chemistry. Teachers should embrace the use of audio-video teaching strategy in teaching chemistry for a better result.

Recommendation

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

(1) Literature showed that teachers use mainly lecture method in teaching chemistry. However, this study has revealed the effectiveness of audio-video teaching strategy against the lecture method therefore teachers should adopt audio-video teaching strategy in teaching chemistry to improve students' achievement in chemistry.
(2) Literature showed lack of resources required for audio-video teaching strategy. Since this study has proved the effectiveness of audio-video teaching strategy in teaching and learning chemistry, school owners, government and non-government organizations should encourage the use of audio-video teaching strategy in chemistry instruction by providing the required resources.

Conclusion

The literature showed perennial learners poor understanding and achievement in chemistry. Learners' poor achievement in chemistry persists despite suggested teaching methods by researchers. Thus, the need for a continual search for a better teaching strategy in chemistry which necessitated the present study cannot be over-emphasized. This study carried out a quasi-experimental study on audio-video teaching strategy and students' achievement in chemistry. Results of this study showed a significant improvement on students' achievement in chemistry when audio-video teaching strategy was adopted as a mode of instruction. Based on the results of the study recommendations were made which if implemented can increase teachers' adoption of audio-video teaching strategy for improvement on students' achievement in chemistry.

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