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Abstract

Considering that science and technology is key to comprehending and providing solution to problems plaguing humanity, STEM education is vital to a great future. With this being so, students are encouraged to develop skills and competencies needed to become educators, innovators, researchers, and leaders in different STEM domains, who can solve the most pressing problems facing humanity, now and in the future. However, there seem to be shortage of interest from students to pursue STEM careers. In a bid contribute to raising the level of interest in STEM subjects, this study, conducted in Nsukka education zone of Enugu state, sought to explore the efficacy of audio-visual aided instruction for improving students' interest and achievement in STEM subjects, as well as its implications for library practice. Guided by four (4) research questions and four (4) hypotheses, the study adopted quasi experimental design and involved 135 Biology students. Duly validated and trial-tested BATRS and BIS were used to collect data. Results revealed that students taught with audio-visual aided instruction posted better interest scores and achieved better than their counterparts taught with conventional method. Implications of the findings for library practice was discussed, and the study recommended that AVA be utilized in teaching STEM subjects, the infrastructures needed to make that possible be put in place and librarians organise STEM resources such that audio and visual materials will be in same location, to allow students access them at the same time, and with ease.

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Introduction

Over the years, societies have evolved. In line with this evolution is the parallel evolution of methods of doing things, which has grown in equal sophistication to meet up with the increased demands of the now evolved society. Thanks to the industrial revolution which brought science and led to the technological development evident in the 21st century, methods of doing things have become and is becoming increasingly technologically-oriented. This (technology) among other indices has been used to categorize nations of the world into such groups as "developed," and "under-developed." Countries categorized as under-developed, one of which is Nigeria, is striving to become developed. This push towards attaining a recognized developmental status is done via science and technology-driven education. Science and technology thus are the "factory" that produces scientists, technologists, technicians, craftsmen and skilled artisans, who are required to improve the economy of any nation. Scientific and technological skills acquisition is therefore necessary for any nation to cope with the present challenges. (Ayao, 2007; Nbina, 2011).

Ali (2013) defined technology as the successful application of scientific ideas, principles, laws and theories, for the purpose of developing techniques for and or providing goods and services. It is through technology that appliances such as computers, televisions, refrigerators, fan, vehicles, airplanes and the likes are invented. Ali went furthers to state that science benefits technology while technology enhances the understanding of science. The contributions of science and technology to overall development of all nations cannot be emphasized. This is the reason science holds an important position in the curriculum of Nigerian educational system. It is in the bid to further underline the importance of science and technology to modern development that Science, Technology, Engineering and Mathematics (STEM) education was introduced in 2001 by the scientific administrators at the U.S. National Science Foundation (NSF) with three major goals; to expand the number of students who ultimately pursue advanced degrees/careers in STEM fields and broaden participation of women and minorities in those fields, expand STEM-capable workforce, and increase STEM literacy for all students, including those who don't pursue stem-related careers or additional studies in STEM disciplines (Hallinen, n.d.; National Academy of Sciences, 2011).

As a natural science, Biology is a STEM subject. Of all the STEM subjects offered by students in Nigerian secondary schools, Biology is considered the broadest, cutting across almost all science fields, and as such was made a compulsory subject for art, science and commercial students, until much recently. This makes Biology the ideal science subject to test the innovative application of audio-visual aided instruction for improving students' interest and achievement in STEM subjects. The Biology curriculum has six major contents which are: Concept of living; Basic ecological concepts; Plant and animal nutrition; Variations and variability; Evolution and Genetics, broken down into 64 units. These contents are arranged spirally such that the concepts to be taught are repeated

yearly, throughout the three-year duration of the subject, to cover all units in the curriculum. All repeated concepts are presented with greater depth and complexity, which increases as the subjects progresses over the three-year period (Ifeobu, 2014). The biology curriculum places emphasis on such teaching methods as field studies and guided discovery, as well as the acquisition of laboratory techniques/skills. However, as new technology-based methods evolve, researchers have advocated the use of more student-centered teaching strategies and instructional resources to enhance comprehension of Biology concepts. One such teaching resource is audio visual aids, which will be referred to as AVAs in this paper.

AVAs have been defined by various researchers as those instructional devices which are used in the classroom to encourage learning and make it easier and interesting (Rather, 2004); any device which by sight and sound increases the individual's experience beyond that acquired through reading (Singh, 2005); to instructional Aids that may be used to convey meaning without complete dependence upon verbal symbols or language (Anzaku, 2011). for the purpose of this study, audio visual aids will be regarded as both a teaching method and an instructional material. As a teaching method, audio visual aids are materials that can present a complete lesson with or without the presence of the teacher. This method implies that instructions are designed by the teacher and presented to the students who will independently learn from the materials. As an instructional material, the audio-visual aids are materials which the students can hear from, see, and learn by the combination of their ears and eyes. The study will also use filmstrip; video-taped instruction (VTI) and the use of overhead projector as working examples of audio-visual aids.

The importance of audio visual aids in the teaching and learning of Biology include; enabling students to be more attentive, motivated and interested in the lesson, as well as provide freedom for the students to discuss, comment and express their opinion during the lesson; improves teachers' performance by saving time and energy; increase retention rate of students (Prasad, 2005); enhances the academic achievement of students (Akram, Sufiana & Malik, 2012). This significance of audio-visual aids when applied in the teaching and learning of Biology has the potential to improve students' interest in the subject and by extension their academic achievement. Biology is by default supposed to be an interesting subject but considering how bulky it is and the methods adopted by teachers to deliver the lesson, it becomes boring to students. As a result, students' interest, which according Jumoh (2010) is a student's personal preferences with regards to learning, wanes, and with it their achievement in the subject. Considering ability of audio-visual aided instruction to keep students attentive and thus stimulate their interest in a lesson as highlighted by Prasad (2005), its application in the teaching and learning of STEM subjects (especially Biology), could positively affect students' interest and improve their achievement. This will bode well for STEM and informs the researchers'

quest to investigate the innovative use of audio-visual aided instruction on Biology students' interest and academic achievement.

Purpose of the Study

The study generally was designed to ascertain the effect of AVAs on the interest and achievement of Biology students. Specifically however, the study investigated the:

i. effects of AVAs and the conventional approach on student's interest.
ii. influence of gender on interest of students when exposed to AVAs.
iii. effects of AVAs and the conventional approach on student's achievement.
iv. influence of gender on achievement of students when exposed to Audio Visual Aids.

Research Questions

The following research questions guided the study:

1. What is the effect of AVAs and the conventional approach on students' interest?
2. What is the effect of gender on interest of students when exposed to AVAs?
3. What is the effect of AVAs and the conventional approach on students' achievement?
4. What is the effect of gender on achievement of students when exposed to AVAs?

Research Hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance.

Ho_1: There is no significant difference between the mean interest scores of students taught with audio-visual aided instruction and those taught through the conventional approach.

Ho_2: There is no significant difference between the mean interest scores of male and female students taught with audio-visual aids.

Ho_3: There is no significant difference between the mean achievement scores of students taught with Audio-Visual aided instruction and those taught through the conventional approach.

Ho_4: There is no significant difference between the mean achievement scores of males and females taught with audio-visual aids.

Research Method

The study, conducted in Nsukka Education zone, adopted quasi-experimental research design, specifically the non-equivalent control group type. This does not allow for randomization and as such, treatment and control groups were randomly assigned to intact classes. The population of the study comprised of all 7, 130 Biology students, in 31 public schools in Nsukka education zone.

A_1 X A_2

A_1 -X A_2

A_1 = Pretest **A_2**= Post-test
X = Treatment **-X**= No Treatment
--- = Non-equivalence of the groups

A three-step multi-stage sampling procedure was adopted to select 135 Biology students who took part in the study. First, purposive sampling technique was used to select four co-educational schools from the education zone with similar attributes (presence of properly-equipped Biology laboratory, and having at least two Biology teachers with minimum qualification of NCE). Then, random sampling was used to select one intact class from each school. Finally, treatment was randomly assigned to each intact class – one class being the experimental class and the other the control class.

Data was collected using an adapted Biology Interest Scale (BIS) and a Biology Achievement Test on Respiratory System (BATRS), both of which were duly validated, and trialed to have a K-R20 reliability index of .84.

Experimental Procedure

This study involved two groups of subjects – the Experimental group (taught wit AVA) and the control group (taught with conventional method). The researchers sent letters of request to two sampled secondary schools selected for the study – Model secondary school and Isienu community secondary school. The permission enabled the researchers to discuss with the Biology teacher(s) and the school authorities on the process of the research. The researchers then trained the Biology teachers in the school using the validated lesson plan on the process of teaching with AVA. A total of six (6) weeks was used for the study. During the first week, the research assistants, under the supervision of the researcher, taught the students definition, phases and conditions necessary for respiration; types and characteristics of respiratory systems were taught in the second week; week three covered mechanism of respiration in lower and higher animals; week four covered respiratory organs in animals; week five covered mechanism of respiration in man; and week six covered respiration in plants.

Both the AVA group and the conventional groups were taught the content of respiratory system for the six weeks. Prior to the experiment, the test instruments – BATRS and BIS was administered as pre-test to all the students in the sampled schools. After this, both the AVA and the conventional method groups were taught the respiratory system for a period of six weeks using projector and instructional videos. At the end of the lessons, the post test was administered to the students. The researchers marked and recorded the scores. The interest test was administered to the students. The teachers helped in distributing the instrument and answer sheets to the students. They also supervised the students and collected the answer sheets at the end of the test. Data collected from the study were analysed using mean, standard deviation and analysis of covariance (ANCOVA).

RESULTS

Research Question I: What is the effect of AVAs and the conventional approach on students' interest?

Table I: Mean ($\bar{X}$) and Standard Deviation (SD) of Students' Interest in Biology

Group	Pre-test			Post-test		
	n	Mean	SD	Mean	SD	Mean Gain
Experimental	69	2.87	.59	3.38	.36	.76
Control	66	2.78	.70	3.09	.40	.09

The data on students' interest in Table I above revealed that students taught biology using audio-visual instruction had post-test mean interest score of 3.38 while the mean interest score of students taught with conventional method of teaching was 3.09. Students taught biology using AVAs therefore had higher interest score than their counterparts taught biology with the conventional method of teaching.

Research question II: What is the influence of gender on interest of students taught with AVAs?

Table II: Mean ($\bar{X}$) and Standard Deviation (SD) of gender and Biology Students' Interest

Group	Pre-test			Post-test		
	n	Mean	SD	Mean	SD	Mean Gain
Male	32	2.61	.31	3.50	.30	.88
Female	37	3.10	.69	3.27	.38	.65

Table II shows a mean interest score of 3.50 for male students and 3.27 for female students. Male students thus had higher mean interest score than their female counterparts in biology.

Research Question III: What is the effect of AVAs and the conventional approach on student's achievement?

Table III: Mean ($\bar{X}$) and Standard Deviation (SD) of Students' Achievement in Biology

Group	Pre-test			Post-test		
	n	Mean	SD	Mean	SD	Mean Gain
Experimental	69	11.69	2.30	26.01	2.70	13.74
Control	66	11.34	2.48	17.46	4.02	6.10

The data on students' achievement in table III reveal that students taught biology using AVAs had post-test mean achievement score of 26.01 while the mean achievement score of students taught with conventional method was 17.46. Students taught biology using audio-visual aided instruction thus performed better than their counterparts taught biology using conventional method.

Research Question IV: What is the influence of gender on mean achievement of students when exposed to AVAs?

Group	Pre-test			Post-test		
	n	Mean	SD	Mean	SD	Mean Gain
Male	32	12.03	2.02	26.15	2.20	13.24
Female	37	11.40	2.51	25.89	3.09	14.24

Data on table IV revealed a post-test mean achievement score of 26.15 for male students, while the female students had a post-test mean achievement score of 25.89. Male students therefore, had

slightly higher post-test mean achievement score when compared to their female counterparts in biology when exposed to Audio Visual Aids.

Research Hypothesis I: There is no significant difference between the mean interest scores of students taught with audio-visual aided instruction and those taught through the conventional approach. Data for testing this hypothesis is represented in table V below.

Table V: Analysis of covariance of students' Mean Interest Scores in Biology

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	3.851[a]	4	.963	6.586	.000
Intercept	69.597	1	69.597	476.054	.000
Pre-interest	.066	1	.066	.449	.504
Group	3.040	1	3.040	20.791	.000
Gender	.384	1	.384	2.623	.108
Group * Gender	.336	1	.336	2.300	.132
Error	19.005	130	.146		
Total	1442.351	135			
Corrected Total	22.857	134			
a. R Squared = .297 (Adjusted R Squared = .267)					

Data on table V shows that the probability associated with the calculated value of F (20.791) for the effect of AVAs on interest of students in Biology is 0.000. Since the probability value of 0.000 is less than 0.05 level of significance, the null hypothesis was rejected. Thus, there is a significant difference between the mean interests scores of students taught with audio-visual aided instruction and those taught through the conventional approach.

Hypothesis II: There is no significant difference between the mean interest scores of male and female students taught with AVAs.

Table VI: Analysis of Covariance of Student's Mean interest in Biology

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1.020[a]	2	.510	4.123	.021
Intercept	31.464	1	31.464	254.300	.000
Pre-interest	.118	1	.118	.958	.331
Gender	.528	1	.528	4.270	.043
Error	8.166	66	.124		
Total	800.082	69			
Corrected Total	9.186	68			
a. R Squared = .111 (Adjusted R Squared = .084)					

Data on table VI shows that the probability associated with the calculated value of F (4.270) for the effect of AVAs on interest of students in Biology is 0.043. Since the probability value of 0.043 is less than 0.05 level of significance, the null hypothesis was rejected. Thus, there is significant difference between the mean interests scores of students taught with Audio-Visual aided instruction.

Hypothesis III: There is no significant difference between the mean achievement scores of students taught with Audio-Visual aided instruction and those taught through the conventional approach. Data for testing this hypothesis is represented in table VII.

Table VII: Analysis of Covariance of Students' Mean Achievement Scores in Biology

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	2612.800[a]	4	653.200	60.671	.000
Intercept	1795.031	1	1795.031	166.727	.000
Pretest	77.542	1	77.542	7.202	.008
Group	2263.266	1	2263.266	210.218	.000
Gender	39.310	1	39.310	3.651	.058
Group * Gender	34.780	1	34.780	3.230	.075
Error	1399.615	130	10.766		
Total	68388.000	135			
Corrected Total	4012.415	134			

a. R Squared = .600 (Adjusted R Squared = .583)

Table VII shows that the probability associated with the calculated value of F (210.218) for the effect of AVAs on the achievement of students in Biology is 0.000. Since the probability value of 0.000 is less than 0.05 level of significance, the null hypothesis was rejected. Thus, there is a significant difference between the mean achievements scores of students taught with Audio-Visual aided instruction and those taught through the conventional approach.

Hypothesis IV: There is no significant difference between the mean achievement scores of male and female taught with audio-visual aids.

Data on table VII above shows that the probability associated with the calculated value of F (3.651) for the influence of gender on achievement of students when exposed to Audio Visual Aids is 0.58. Since the probability value of 0.58 is above 0.05 level of significance, the null hypothesis was accepted. Thus, there is no significant difference between the mean achievement scores of males and females taught with audio-visual aids.

Discussion of Results

The result from this study show that students taught using AVA achieved significantly better than the students taught using conventional approach. The significant difference could be as a result of the ability of the AVA to provide both audio and visual presentation of instructions unlike the conventional method which basically involves the teacher being the single source of information, as well as the fact that people easily forget what they hear, remember what they see, and retain better what they see and hear. It could also be due to the fact that AVA has the potential of making students learn more because it creates a fun-filled, interactive and entertaining classroom, which easily stimulates and sustains students' interest, and then facilitates learning.

This result of this study supports the views of Ashaver and Igyuve (2013), Akram, Sufiana and Malik (2012), Gul, Kiyani, Chuadhry and Liagut (2012), Agbo (2014), Chinna and Dada (2013) and Osokoya (2007), who indicated that students achieved significantly better when taught with AVA than when taught with the conventional method. Gul, et. al (2014) reported in their studies that the mean achievement score of students taught with AVA is greater than those taught with the

conventional method of teaching, the study therefore recommend that teachers should use AVA constantly in other to improve student's achievement in sciences.

On interest, the study revealed that the use of AVA in teaching and learning significantly enhances the level of interest of the student. This means that the type of instructional delivery approach used in teaching students the respiratory system resulted in significant increase in their interest. The use of AVA has certain advantages such as; it provides freedom to the students to discuss, comment, and express their opinion which they cannot while a conventional lesson is in progress. AVA also makes the students to be attentive, motivated and interested as compared to that classroom session that is in function without the use of AVA. The result of this study is in tandem with the views of Akram, Sufiana and Malik (2012) that are of the view that the use of AVA in teaching Biology was very effective as it increases the level of interest and keeps students motivated for learning.

The findings of this study indicate that male students taught using AVA achieved slightly higher scores than female students at all level. This could be due to the fact that some female students believe that science is too difficult and not important for their future. Also, the males are already inclined to science subjects and see it as a necessity, therefore paid attention to lessons. O'Dea (2018) submitted that girls routinely out-perform boys at school but that these gender differences were far larger in non-STEM subjects like English. However, in STEM subjects, achievement of male and female students is similar. This explains this disparity in achievement of male and female students in the STEM subject, Biology.

This result supports the views of previous researchers like Abdu-Raheem (2012), Igbo, Onu and Obiyo (2015), Ayodele (2009) and Atovigba, (2012). The findings from these researchers indicate that gender has a significant effect on achievement. Igbo, Onu and Obiyo (2015) in their study to investigate the influence of gender stereotype as a predictor of secondary school student's self-concept and academic achievement, reported that male students performed better than their female counterparts whereas Ayodele (2009) reported in his study that female students achieved better than their male counterparts. Nevertheless, the finding of these studies (as with the current one), disagree with Oludipe (2012), Ifeakor (2005) and Mudasiru (2005) who found no significant difference in academic achievement and interest of male and female students.

Implication of Findings for STEM

Considering the clamour for more students to enrol in STEM subjects and go on to pursue Science, Technology, Engineering and Mathematics-related courses, and the empirical data which proves that teaching method adopted by teachers contributes to students developing a "complex" perspective towards science subjects, it is important that/imperative for teachers to adopt teaching

methods which keeps students interested in STEM subjects. Interest builds into sustained interest and this contributes positively to achievement. Findings from this study indicate that audio-visual themed instructional procedures contribute positively to students' interest and achievement in Biology (a STEM subject) and as such, AVA should be explored as a strategy/innovative method for improving students' interest and achievement in STEM subjects generally.

Implications for Library Practice

Findings of this study has enormous implications for practices in our libraries primarily because teachers and students need reading materials to study. These reading materials are accessible in libraries. The study was anchored on Fleming's VAK theory, and has demonstrated that students who were exposed to audio-visual resources during the teaching and learning process, learned better than those who were not. This presents some insight for libraries and librarians. STEM is an important area of study in contemporary society, as nations around the world devout resources to building their science base. In that same line, school libraries are furnished with books, chart, and other resources for science teaching and learning.

The study therefore underscores the need for libraries to not only have visual materials/resources like printed books, pictures, charts and the like, but also stock up audio resources like audiobooks, especially audio versions of the books in the libraries, audio and video lessons around topical STEM issues (like climate change, photosynthesis and the likes), among others. These audio resources will ensure that students and teachers have access to two modes of learning resources readily available in the library, and choose whichever suits their learning needs at a given time. The process of cataloguing these resources should also be done in a manner which makes it easier for users of a given textual material to locate the audio version with relative ease.

Also, the provision of audio and video resources in the libraries informs the need to maintain serene and calm atmosphere within the libraries. It is a convention for librarians to display 'silence' signs within her walls, but observation has shown that library users occasionally disturb others with noise. This disturbance is likely to increase when libraries make audio materials accessible to her users. Users of audio library resources must therefore be encouraged to utilize headsets/headphones, so as not to disturb the serenity of the library. This can also be achieved when all libraries digitalized their resources and make audio-visual versions of their resources available for download on the electronic library space. This will reduce the number of users who physical the library, and by extension ensure that tranquillity is maintained within her walls. Where possible, these accessories should be provided by the libraries. There is need therefore for libraries to jettison the conventional practices of letting

their users rely primarily on textual materials because as demonstrated by this study, learning is more effective when the content is presented in different modes.

Recommendations

Based on the findings of this study, the researchers recommend that;

i. Since the use of AVA in teaching has been found to enhance achievement and interest in Biology, Biology teachers (and STEM subject teachers alike) should utilize AVA in the teaching, especially for topics that are somewhat "abstract."
ii. AVAs cannot fully be implemented where necessary infrastructures are not put in place. As such, school administrators at all levels should procure enough computers for all secondary schools.
iii. The audio-visual lesson employed in this research was basically on downloaded videos. Professional organizations like the Nigerian Association for Educational Media and Technology (NAEMT), Science Teachers Association of Nigeria (STAN) and all other stakeholders in Education who are concerned with improving instruction, should undertake the production of appropriate instructional videos for use in schools.
iv. Government should encourage and sponsor in-service educational opportunities for interested teachers to learn the basic skills of producing instructional videos and other instructional materials.
v. In order to promote interest in STEM, teachers should be innovative in teaching STEM subjects, employing hands-on and participatory instructional methods (like AVA), in teaching.
vi. Libraries should make available audio and audio-visual versions of the text resources they have catalogued so users of the libraries will have access to different modes of assimilating information from books.
vii. Extra measures should be taken to ensure that the library space is quiet while in use. Audio and audio-visual materials can be made downloadable at the library website, so users can access them without having to come to the libraries.

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