



Effects of audiovisual technological aids on students' achievement and interest in secondary school biology in Nigeria

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ABSTRACT

While Science teaching and learning is changing at an amazing pace in developed countries, same cannot be said of developing countries. Nigeria secondary school classrooms have remained 'chalk and board' affair with students seated in rows copying notes. In a developing country such as Nigeria, teachers need sustained support from colleagues at tertiary level who are compliant with the new technologies to help them learn how best to integrate technology into their teaching. In this paper, we describe a study that employed quasi experiment of the non-equivalent control group design. 150 senior secondary two (SS2) students of two intact classes randomly selected from two schools were assigned one to experimental and other to control. Training was given to a regular teacher of Biology that taught experimental group while the control group teacher did not receive training but given a template on the conduct of the study.

Two instruments for data collection were Biology achievement test and Interest scale. Mean and Standard Deviation and ANCOVA were used for data analysis. Result revealed that group exposed to lessons with Audiovisual technological contents integrated achieved higher in test scores than the group not exposed to. It was recommended that classroom teachers keep pace with development trend by learning and using new technologies (Audio-visual) in instructional delivery.

1. Introduction

Basic knowledge in science is essential for all forms of modern development. To be able to appreciate, control and effectively tap from and utilize the resources of the natural environment, it is imperative to acquire scientific knowledge which is a basic tool for all forms of industrial and technological advancement of any nation. Aware of this obvious fact, many nations, Nigeria inclusive have recognized the significance of science and technology and its developmental endeavours. Onu (2017) asserts that no nation can become great, without science and technology. The expression of the need for scientific and technological literacy for all Nigerians was a discussion opined by Ibe et al. (2016a). When Ibe said that we are living in a world where science and technology have become an integral part of world's culture, and thus reminded the nation of the need to keep pace with the world's development in science and technology.

Speaking on relevance of science, National Science Education Standards (2005) stated that science is a dynamic human activity concerned with understanding the working of our world. This understanding helps man to know more about the universe. In order to guarantee the

understanding of man of his environment, it becomes very necessary to re-examine the quality of our science Education, particularly biology as a popular science subject that records the largest number of students both at secondary and tertiary levels of Nigeria's education system.

Biology is a natural science concerned with the study of life and living organism, including their structure, function, growth, evolution distribution and scientific exploration (Hadjichambis et al., 2015). The effective study of biology will contribute in the improvement of agriculture which is basically one of the 17 sustainable development goals to be achieved by the year 2030. Despite the importance of Biology to the individual and nation, reports have shown persistent poor students achievement in SSCE conducted by WAEC (Chief Examiners Report, 2015–2017). The situation has been fluctuating, yet persistently under average achievement of students. None of the 3years recorded an average of 50% pass in SSCE examination. This poor achievement is not different from WAEC record in Enugu state and Nsukka local government Area of Nigeria. In 2015, out of the five South-East State in Nigeria that took part in SSCE by WAEC, Enugu state took last position with 51.91%. In 2016, out of the 10 group A states in Nigeria which Enugu state belong, Enugu state took 9th position in WAEC (Xmich, 2016). According to Chief

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Examiner's report (2016), students only performed better in biology practical (paper 3) and performed poorly in biology objective (papers 1) and in biology essay (paper 2). This problem has continued to generate several research concerns among stake holders on the underlying factors responsible for, as well as possible ways to combat this poor trend of poor achievement. Several reasons have been adduced for the poor achievement. Idoko and Njoku (2017) reported poor laboratory facilities, and poor pedagogical characteristics of teachers. Neji (2011) reported learner's personal characteristics. Authors like Olufunke (2012) and Igboabuchi (2010) lamented that teaching biology in secondary schools is defective. This has posed a lot of threat to students that have passion to undertake science courses that have biology as prerequisite requirement for entrance to tertiary institutions.

Besides the problem of poor achievement in secondary school biology, the common practice in Nigeria secondary school is that most of the students choose biology as one of the science subjects that is very easy to pass and not because they are interested in the subject. Interest as a factor is very essential in teaching and learning of biology. Ibe (2016b), conceptualizes interest as the feeling of one whose attention, concern or curiosity is particularly engaged by something. Onah (2015) stated that there is a very high positive relationship between interest and achievement. According to Onah, the students with low interest in a subject are low achievers and those with high interest in a subject are high achievers. There is also a correlation between student's interest and teaching methods used by teachers.

In view of this, some researchers suggest the use of innovative methods that will improve students' achievements and facilitate their interest in Biology (Aniweze, 2014; Onochie, 2010; Eziokwu and Eze, 2007).

Several innovative methods have been tried out and students still achieve poorly in Biology and show low interest in Biology. These underscores the need of trying out an innovative teaching strategy and technique that lends itself to present age globalization; exploring ways audio visual technological contents (materials) can impact on achievement and interest of students in Biology who live in an information, communication and technological age.

Audio visual materials are those materials that appeals to the sense of seeing and hearing simultaneously. It helps in maintaining and sustaining students' interest. The video gives the students the opportunities to take the instruction in its original form instead of abstract. For instance topic like human reproductive system treated in this study, students had opportunity of seeing the parts of human reproductive system and how the parts carryout their functions in an environment that appears somewhat "real life" instead of "show charts show diagrams of..." as contained in the Federal Ministry of Education Biology Curriculum for this topic in Nigeria.

Akram and Malik (2012) carried out a study on the "use of audio-visual aids for effective teaching of biology at secondary school level". The target population of the study comprised teachers of biology of both public and private schools. Descriptive survey was used as the research design. The findings revealed that teachers in public schools were more familiar with the importance and use of audio visual in teaching and learning of biology than teachers in private schools. The present study is a quasi-experiment of the nonequivalent control group design. Four coeducational secondary schools were drawn by random sampling of such school type because gender was considered in this study. The four schools were randomly assigned, two to experimental and control groups respectively. An intact class of Senior Secondary three (SS 3) was randomly selected from each of the four schools in Enugu North LGA of in Enugu state, Nigeria and used for the study. Thus the sample comprised of one hundred and fifty (150) students. The regular teachers were involved in the study via the training on integrating audio visual resource in their classroom Biology instruction with special reference to teaching Reproductive System of Human as contained in SS3 curriculum.

China and Dada (2013) investigated the effects of video-instructional package on students' achievements in biology. The quasi-experimental,

pre-test-post-test control group design was used for the study. The sample comprised of 180 senior secondary year two students from six (6) schools located in the 3 Educational Zones of Niger state of Nigeria. The students were divided into an experimental group of electronic instructional medium and a control group (traditional lecture instruction). Structured biology achievement test (SBAT) with internal consistency reliability co-efficient of 0.83 was used to measure the students' achievement before and after the treatment. The data obtained from the study were analyzed using the analysis of covariance (ANCOVA) and Schaeffer test indicated that the achievement of students' in biology greatly improved with the use of electronic instructional medium. This study is different from the present study because the present study will not use Schaeffer which affirm that the predicted difference after the study is small. Rather, since data collection instrument for this study are Biology Achievement Test (BAT) and Biology Interest Scale (BIS), which were administered as pretest and posttest, the reliability of BAT whose items were dichotomously scored was established using Kuder-Richardson formula 20 and the reliability index was 0.75. Chronbach.

Alpha was used for BIS which was polychotomously scored and the index was 0.67.

2. Theory/calculation

Theoretically, this study is based on Visual Auditory kinaesthetic learning theory (VAK) that was proposed by Fleming and visual (2006). According to Fleming, information should be presented using three styles namely: visual learner, auditory learner and kinaesthetic learner. Fleming asserts that the use of VAK in pedagogy allows teachers to prepare classes that address each of the three areas. Fleming suggested that the more a students is able to learn through a combination of all the modalities such as visual and auditory, the more embedded the learning will be. Visual auditory kinaesthetic (VAK) theory suggest that visual learners should be encouraged to among others: visualize spelling of words or facts to be memorized and that of auditory learners should be encouraged to use verbal analogies as storytelling to demonstrate their points. To this effect, VAK theory is suitable for this study because when audio visual materials are used during teaching and learning, the students will visualize spellings of words, memorize facts and use analogies and storytelling to demonstrate their points. This study will authenticate or refute VAK.

Specifically, this study will investigate;

1. The effect of audio visual materials on achievement of students in Biology.
2. The effect of audio visual materials on interest of students in Biology.
3. Determine the influence of gender on achievement of students in Biology.
4. Determine the influence of gender on interest of students in Biology.
5. Determine the interaction effect of method and gender on achievement of students in Biology.
6. Determine the interaction effect of method and gender on interest of students in Biology.

The following four questions were posed:

1. What are the mean achievement scores of students taught Biology using Audio-visual materials and those taught with conventional method?
2. What are the mean interest scores of students taught Biology using Audio-visual materials and those taught with conventional method?
3. What are the mean achievement scores of male and female students taught Biology?
4. What are the mean interest scores of male and female taught Biology.

3. Hypotheses

The following null hypothesis were tested at 5% level of significance.

Ho₁. There is no significant difference between the mean achievement scores of students taught Biology with audio-visual materials and those taught with conventional method.

Ho₂. There is no significant difference between the mean interest scores of students taught Biology with audio-visual materials and those taught with the conventional method.

Ho₃. There is no significant difference between the mean achievement scores of male and female students in Biology.

Ho₄. There is no significant difference between the mean interest scores of male and female students in Biology.

Ho₅. There is no significant interaction effect of method and gender on students' achievements in Biology.

Ho₆. There is no significant interaction effect of method and gender on students' interest in Biology.

4. Materials & methods

The study was carried out in Nsukka local Government Area of Enugu state in Nigeria. Quasi-experiment of the non-equivalent control group design was used. Two schools were assigned randomly to experimental and control groups. An intact class was randomly selected from each of the two schools. The sample size was 150 students who were pretested before the commencement of the study after permission had been obtained from the school authority. Approval for the study was granted by the Faculty of Education Research Project Ethics Approval Committee, University of Nigeria, Nsukka (Certificate no. FEC00056).

The study lasted for six (6) weeks. Week 1 was used for training regular teachers of the experimental schools on the conduct of the study using u-tube downloaded video on human reproductive system while the regular teacher in the control group schools was given lesson notes that guided their teaching. The regular teachers in both the experimental and control group administered the two instruments to the students as pre-test. Weeks 2, 3, 4 and 5 were used for the instructions. The table below is the lesson plan showing the contents of the lessons taught; activities carried out by both the teacher and students in the Audio-visual group during the teaching and learning processes that utilized eleven (11) periods of forty five (45) minutes each.

Lesson plan

Weeks	Contents	Activities
1	Training on conduct of the study. Male reproductive system, functions of labelled parts, female reproductive system, functions of labelled parts and reviews of structure of spermatozoon, its movement/actions unto fertilization, functions of various parts.	Training of regular teacher in experimental group using U-tube download video of human reproductive system. Control group teachers were given lesson note that guided their teaching for uniformity in control groups. The regular teacher of the experimental group had a mock exercise during which the teachers taught under researchers' supervision used for instructions.
2	Male reproductive system, structure and functions of labelled parts such as scrotum sac, epididymis, seminal vesicles.	Students through observation note the coiled nature of seminiferous tubules and joinings the epididymis to other parts and functions. viewing of the u-tube downloaded
3	Female reproductive system, structure and functions of labelled	Viewing of the U-tube downloaded video on passage of spermatozoon along these

(continued on next column)

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Weeks	Contents	Activities
	parts. Physiological processes of releasing of eggs by the two ovaries.	pathways. Spermatozoon-vagina-cervix-uterus-fallopian tube-uterus-(for fertilization)-uterus (implantation if fertilization occurred)
4	Structure of the spermatozoon, parts and functions were taught	Students observed and discussed how the acrosome that caps the nucleus helps the spermatozoon to break the vitelline membrane of the egg, how the flagellum helps the sperm cell (spermatozoon) to swim towards the egg and how the neck of the spermatozoon to the tail was discarded after the nucleus of the ovum (egg cell) and sperm cell had fused.
5	Structure of the ovum, functions of labelled parts. Differences between male and female gametes	In the teaching and learning processes, students observed the slides on display, the nucleus at the center with a clear cytoplasm and outer membrane. Teacher replayed video on male and female gametes and gave students ample time to replay both on their computers. Students were given time to state the differences from their views of slides contents. Students at this instructional step raised questions in their groups. Attempts were also made by peer interactions within groups to resolve bottle necks while the teacher played the role of learning facilitator within group and between groups.
6	Posttest	Biology achievement test (BAT) and Biology interest scale (BIS) were re-administered to the experimental group and control group as posttest.

Teacher's probing questions and clarifications of students questions as the slides of the video were rolled on/displayed helped in driving home salient points and removed abstractions from physiological processes that go on in human during reproduction. The students were given time to observe, highlight and discuss the contents of the slides. Students on the instructional steps raised questions in their groups. Attempts were also made by peer interactions within groups in resolving bottlenecks while the teacher performed the role of learning facilitator within group and between groups. The regular teacher in the control group taught using the conventional method and was guided strictly by the lesson plan of the researcher and charts with the diagrams. After the instruction, to both the experimental and control groups, in the sixth (6) week, BAT and BIS were re-administered to both the experimental group and control group as post-test. Later the scripts were collected, marked by the regular teachers and handed over to the researcher for analysis.

5. Results

The results are presented in tables according to research questions and null hypotheses that guided the study.

Table 1 shows that students taught biology using Audio-visual materials had a pretest and posttest mean achievement scores of 8.28 and 12.69 with a mean gain of 4.41 while their counterpart in the control group had a pretest and posttest mean achievement scores of 8.32 and 8.93 with a mean gain of 0.61. The pretest mean scores of 8.28 8.32 in both the Audio-visual and control groups indicated a uniform take-off for both groups without the intervention role of audio-visual technological content. The Standard Deviation score in the posttest for Experimental

Table 1

Mean and Standard deviation scores of students' achievement scores in biology.

GROUP	N	Pre-test Mean	SD	Post-test Mean	SD	Mean Gain
Experimental	75	8.28	3.23	12.69	3.72	4.41
Control	75	8.32	1.60	8.93	2.82	0.61

group was 3.72 while the control group had an SD of 2.82. The low SD showed how compact students' scores clustered around the mean. Student taught using Audio-visual materials achieved better than their counterparts taught biology using conventional method.

Table 2 indicates that F-ratio of 78.106 with associated probability (2-tailed) ($p = 0.000$) is less than the significant level of 0.05. Since the probability value of 0.000 is less than 0.05 level of significant, the null hypothesis of no significance difference is rejected. Therefore, there is a significant difference between the mean achievement scores of students taught biology with Audio-visual materials and those taught with conventional method.

Table 3 reveals that students taught biology using Audio-visual materials had a pretest and posttest mean interest scores of 58.17 and 63.23 with a mean gain of 6.06 while the mean interest scores of students taught with conventional method of teaching were 50.12 and 55.25 in both pretest and posttest and a mean gain of 5.13. Student taught using Audio-visual materials were superior in interest development than their counterparts taught biology using conventional method.

Table 4 above indicates that F-ratio (5.913) with associated probability (sig (2-tailed) ($p = 0.016$)). Since the probability value of 0.016 is less than 0.05 level of significant; hence, the null hypothesis of no significant difference is rejected. Therefore, there is a significant difference between the mean interest scores of students taught biology with Audio-visual materials and those taught using conventional method.

The data in Table 5 reveals a post-test mean achievement scores of 10.65 for the females, while the male students had a post-test mean achievement score of 11.14. Data also reveal that the pretest mean scores of both male and female students did not vary (8.30 and 8.26) appreciably. Males therefore, had slightly higher post-test mean achievement score when compared to their female counterparts in biology. Females had a mean gain of 2.39 while males had a mean gain of 2.84. Females had an SD of 3.81 while males had 3.80. However, the corresponding hypothesis reveals if the difference is substantial.

Table 6 indicates that F-ratio of 0.365 with associated probability (2-tailed) ($p = 0.546$) was obtained. Since the probability value of 0.546 is greater than 0.05 level of significant, the null hypothesis of no significance difference is retained. Therefore, there is no significant difference between the mean achievement scores of male and female students in biology.

The result in Table 7 reveals the mean interest rating of pre-test of 54.59 and post-test of 58.80 for females, while the male students had a mean interest rating of pre-test 54.76 and post-test of 60.12.

60.12. Male therefore, had slightly higher post-test mean interest score when compared to their female counterparts in Biology. Males had

Table 2

Analysis of covariance (ANCOVA) of students mean achievement scores.

Source	Type III Sum	Df of Squares	Mean Square	F	Sig.
Corrected Model	1126.255 ^a	2	563.127	81.595	.000
Intercept	233.663	1	233.663	33.857	.000
Pre-TestBis	596.095	1	6.095	.372	.200
Method	539.045	1	539.045	78.106	.000
Error	1014.518	147	6.901		
Total	19680.000	150			
Corrected Total	2140.773	149			

^a R Squared = .526 (Adjusted R Squared = .520).

Table 3

Mean and Standard Deviation Scores of Student's interest in biology.

GROUP	N	Pre-test Mean	SD	Post-test Mean	SD	Mean Gain
Experimental	75	58.17	8.34	63.23	7.52	6.06
Control	75	50.12	12.97	55.25	10.75	5.13

Table 4

Analysis of Covariance of students' mean interest scores in biology.

Source	Type III Sum	Df of Squares	Mean Square	F	Sig.
Corrected Model	7466.849 ^a	2	3733.424	71.623	.000
Intercept	5057.656	1	5057.656	97.028	.000
Pre-testBIS	5082.822	1	82.822	0.510	.320
Method	308.240	1	308.240	5.913	.016
Error	7662.511	147	52.126		
Total	541536.000	150			
Corrected Total	15129.360	149			

^a R Squared = .494 (Adjusted R Squared = .487).

Table 5

Mean and Standard Deviation Scores of male and female students taught biology.

Gender	N	Pre-test Mean	SD	Post-test Mean	SD	Mean Gain
Females	100	8.26	2.48	10.65	3.81	2.39
Males	50	8.30	2.69	11.14	3.80	2.84

Table 6

Analysis of Covariance of males and females mean achievement scores in biology.

Source	Type III Sum	Df	Mean Square	F of Squares	Sig.
Corrected Model	1131.464 ^a	4	282.866	40.637	.000
Intercept	234.891	1	234.891	33.745	.000
Pre-test BAT	595.034	1	6.095	.372	.200
Method	500.230	1	500.230	71.864	.000
Gender	2.544	1	2.544	.365	.546
method* gender	2.559	1	2.559	.368	.545
Error	1009.309	145	6.961		
Total	19680.000	150			
Corrected Total	2140.773	149			

^a R Squared = .529 (Adjusted R Squared = .516).

Table 7

Mean and Standard Deviation of male and female students' interest in biology.

Gender	N	Pre-test Mean	SD	Post-test Mean	SD	Mean Gain
Female	100	54.59	10.97	58.80	9.83	4.21
Male	50	54.76	13.36	60.12	10.59	5.36

higher mean gain (5.36) than females (4.21). It is also worthy of note that the pretest mean scores of both gender did not vary substantially (54.76 and 54.59). This implies that before the commencement of treatment their baseline were the same.

Table 8 indicates that F-ratio of (0.827) with associate probability (sig (2-tailed) ($p = 0.365$)) was obtained. Since the probability value of 0.365 is greater than 0.05 level of significant, null hypothesis of no significant difference was upheld. There is therefore no significant difference between the mean interest rating of male and female students in biology.

HO₅. The interaction effects of method and gender on students' achievements is not significant.

The result in Table 6 shows that F-ratio of (0.368) with associate probability (sig (0.545)) was obtained. Since the probability value of

Table 8

Analysis of Covariance (ANCOVA) of students' mean interest rating in biology by Gender.

Source	Type III Sum	Df	Mean Square	F of Squares	Sig.
Corrected Model	7512.950 ^a	4	1878.237	35.758	.000
Intercept	5094.930	1	5094.930	96.996	.000
Pre-test BIS	5089.337	1	82.822	.511	.320
Method	253.706	1	253.706	4.830	.030
Gender	43.454	1	43.454	.827	.365
method* gender	3.094	1	3.094	.059	.809
Error	7616.410	145	52.527		
Total	541536.000	150			
Corrected Total	15129.360	149			

^a R Squared = .497 (Adjusted R Squared = .483).

0.545 is greater than 0.05 level of significance, the null hypothesis of no significance difference was retained. Thus there is no significant interaction effect of method and gender on students' achievement in biology. This can also be seen in the graph below.

Plot 1 shows that the interaction effect of method and gender on students' achievement in biology is not significant. This is because in the graph, there is no intersection between the graph lines of female (1) and male (2) students. The two graph lines move towards the control group showing that a slight interaction was observed in the control group while there is no interaction at all in the experimental group. Since there is no significant interaction effect of method and gender on students' achievement in biology, therefore, the null hypothesis was accepted.

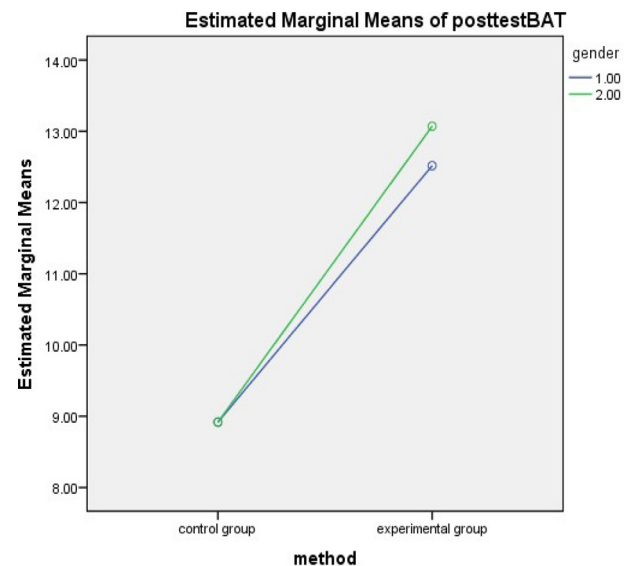
H0₆. There is no significant interaction of method and gender on students' interest in biology. The result in Table 8 shows that F-ratio of (0.059) with associate probability (sig (0.809) was obtained. Since the probability value of 0.809 is greater than 0.05 level of significance, the null hypothesis of no significance difference was retained. Thus there is no significant interaction effect of method and gender on students' interest in biology. This can also be seen in the graph below.

Plot 2 shows that the interaction effect of method and gender on students' interest in biology is not significant. This is because in the graph, there is no intersection at all between the graph lines of female (1) and male (2) students both in the control and experimental group. Since there is no significant interaction effect of method and gender on students' interest in biology, therefore the null hypothesis was accepted.

6. Discussion & conclusions

With respect to research questions one, students' taught using Audio-visual materials achieved better than their counterparts taught biology using conventional method. The corresponding hypothesis indicates a significant difference between the mean achievement scores of students taught biology with Audio-visual materials and those taught with conventional method. This finding supports the finding of China and Dada (2013) who found that students taught using video-instructional package achieved better in Biology than their counterpart taught using the conventional method. Audio-visual group students was superior in achievement test scores because students were given time to bring upon the learning process their senses -seeing, hearing and touching. Students in the instructional processes raised questions in their groups. Attempts were also made by peer interactions within groups and between groups in resolving bottlenecks while the teacher's role was guidance oriented. The teacher asked probing questions that elicited explanations and answers of students questions as the slides of the video were displayed. These helped in driving home salient points and removed abstractions.

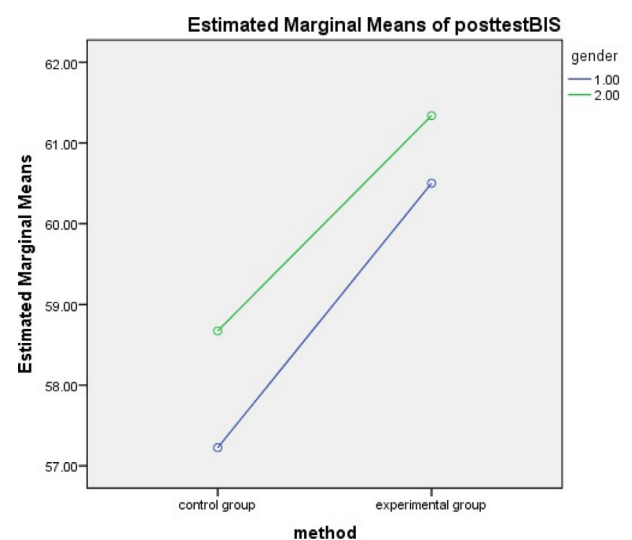
For research question two, students' taught using Audio-visual materials were superior in interest development than their counterparts taught biology using conventional method. The corresponding hypothesis indicates that there is a significant difference between the mean interest scores of students taught biology with Audio-visual materials and



Plot 1. Analysis of covariance on interaction effect of method and gender on students' achievement in biology.

those taught using conventional method in favor of those taught using Audio-visual aids. This goes on in affirming that the quality of teaching is central in development of students' interest. This finding supports VAK learning theory by Fleming and visual (2006), that information should be presented using three styles namely: visual learner, auditory learner and kinaesthetic learner. Fleming's submission that the more a students is able to learn through a combination of all these three modalities, the more embedded the learning will be was very glaring in this study. The finding also agrees with Onah (2015) who found that students taught set in mathematics using multimedia had a higher interest than their counterpart taught with the conventional method.

For research question three, although males had slightly higher post-test mean achievement score than females, the corresponding hypothesis shows that there is no significant difference between the mean achievement scores of male and female students in biology. For interaction effect of method and gender on students' achievement in biology, the finding indicates that there was no significant interaction effect of method and gender on students' achievement in biology. Method of instruction (Audio-visual) constantly exerted its effect on students' achievement irrespective of their gender.



Plot 2. Analysis of Covariance of interaction effects of method and gender on students' interest in biology.

For research question four, there was no significant difference between the mean interest rating scores of males and females in biology. Also there was no significant interaction effect of method and gender on students' interest in biology. These findings on influence of gender and interaction effects of gender and methods of instruction on the dependent variables of this study reaffirm Author (2016) submission that meaningful instructional approaches is a solution to gender differences in Science.

In conclusion, since Audio-visual technological contents has been integrated and tried out in teaching and learning process and enhanced achievement and interest were recorded, teachers should endeavor to use audio visual material during teaching and learning of Biology. Government on the other hand should also make these audio visual materials gadgets readily available for teachers to use as well as students. Learning and use of new technologies will provide a leeway of our country (Nigeria) joining and catching up with the developed nations that Science and Technology has become their dominant culture.

Finally, curriculum planners should encourage and integrate the use of audio visual materials in the curriculum for teaching and learning of Biology since it involves students actively participating in the lesson and manipulating the learning equipment.

Declarations

Author contribution statement

Ibe Ebere: Conceived and designed the experiments.

Joy A. Abamuche: Analyzed and interpreted the data; Wrote the paper.

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Competing interest statement

The authors declare no conflict of interest.

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