European Journal of Alternative Education Studies
ISSN: 2501-5915
ISSN-L: 2501-5915
Available on-line at: www.oapub.org/edu

doi: 10.5281/zenodo.3728245 Volume 5 | Issue 1 | 2020

IMPROVING STUDENTS' ACADEMIC ACHIEVEMENT AND INTEREST IN GEOMETRY THROUGH AUDIO-VISUAL RESOURCES AS INSTRUCTIONAL STRATEGY

Jane Itohan Oviawe,
P. S. O. Uddin[i]
Department of Vocational and Technical Education,
Ambrose Alli University,
Ekpoma, Edo State,
Nigeria

Abstract:
This study examined the effect of audio-visual resources as instructional strategy for improving students' academic achievement in geometry. The design of the study is a quasi-experimental non-equivalent group design. A sample of 123 senior secondary schools II students was drawn from two Model schools in Edo State, Nigeria. Two research questions and three hypotheses tested at .05 level of significance, guided the study. The instruments used for data collection was Geometry Achievement Test (GAT) and Geometry Students' Interest Inventory Scale (GSIIS). Audio-visual resources instructional approach and conventional lesson plans were developed by the researcher. The instruments were subjected to face and content validation by five experts. The reliability coefficient of GAT was found to be .75 using Kudder Richardson 21 K(R-21) formulae, while GSIIS had a reliability index of .90 obtained using Cronbach alpha method. Mean was used to answer research question while ANCOVA was employed to test the hypotheses. Results from the study showed among others that the utilization of audio-visual resources as an instructional strategy in technical colleges had positive impact on students' achievement and interest in geometry. It was recommended among others that technical drawing teachers should employ audio-visual instructional strategy in teaching technical drawing especially in geometry as it enhances students' academic achievement and interest.

Keywords: technical drawing, geometry, audio-visual resources, academic achievement, interest

[i] Correspondence: email janeoviawe98@gmail.com, janeoviawe@aauekpoma.edu.ng, uddinpatrick@gmail.com

1. Introduction

Technical drawing is the bedrock of all technological ideas and concepts that plays a significant role in the design, development and production processes of all the activities and works conducted by architects, engineers, technical drafters, craftsmen and technical teacher and students. It is basically the unequivocal language of technology used by architects, engineers, technologists, designers, craftsmen, operators, manufacturers and industrialists to commune ideas by means of pictures, drawings, graphics and symbols (Oviawe & Adeola, 2017). It is the way designers and the manufacturers in the technological world communicate their ideas and facts into realism by means of drawing. It is fundamental in the development of cognitive, creative abilities, analytical thinking skills and employability of an individual. It hones the critical thinking skills of its recipients and enables them to tackle real life issues rationally. Its objectives at the senior secondary school level in Nigeria are to: (i) provide an understanding of the theoretical and applied concepts relating to the use of information and communication technology (ICT) to facilitate visual communication of ideas in the construction and production industries; (ii) provide introduction of modern drawing studio practice; (iii) lay the foundation for technological development and further studies in building and engineering; and stimulate, develop and enhance entrepreneurship skills in the diverse areas of drawing studio practice (Federal Ministry of Education (FME), 2010). The secondary school technical drawing is structured in seven areas namely: drawing studio practice, geometrical constructions, development of geometrical solids, pictorial drawing, points and lines in space, building and engineering design and drawing, and business opportunities in drawing studio practice.

Geometry is the study of size, shape and position of two and three dimensional shapes and objects. According to Kuruiawati, Jinaedi and Manami (2015), geometry should be learned from primary school until university level. This implies that geometry is recognized as an important aspect of technical drawing because of its relevance to technology. Learning geometry is a fundamental skill to learn other topics in technical drawing (Aydogdu, 2014; Tieng & Eu, 2014). Geometry provides the following benefits: helps students gain the basic skills of analysis, comparison and generalization; useful in representing and solving problems in other technical drawing areas and in real life situations (Tieng & Eu, 2014). As fundamental as this area of technical drawing is, students' achievement and interest in this area has been on the decline. To this end, the Chief Examiner's Report of West African Examination Council (WAEC) (2010, 2011, 2012, & 2013) revealed that many students avoid answering certain questions especially those involving geometry. Ogbuanya & Onatunde (2015) opined that generally students fear and hate technical drawing which results to poor academic achievement and lack of interest in technical drawing (geometry inclusive). The lack of interest in geometry is as a result of the individual's cognitive development, instructional practices and materials. Other factors according to Oviawe (2019) are inappropriate instructional method used in teaching technical drawing affects students' achievement and does not encourage

students thinking process. To foster the interest, motivation and achievement of students in technical drawing, technological tools and equipment are required. But Oviawe and Uddin (2014) reported that there was dearth in the availability of the required technical drawing tools, equipment and materials required for its instruction in Edo State secondary schools. To this end, it becomes necessary to employ technological tools that touches learners' sub-consciousness and triggers quick recalling of the concepts being taught or learnt.

In the past the traditional teaching approach used to impact knowledge was successful, but the minds of today's generation vary from that of the past generation. This implies that today's learners are highly scientific literate and flow with the new technological tools in order to foster their knowledge. Therefore, the progression of education and educational technology should follow the progression of time thus this calls for new innovative teaching approaches that could address the needs of today's learners. This could be in form of instructional materials used for teaching.

Instructional materials are used to aid the transfer of information from one person to another (Madhavan, 2010). Miranda (2007) asserted that instructional materials are part of the instructional procedure because they supplement the instructional delivery approach adopted by the teacher. Many psychologists and researchers have dedicated themselves in search of how learning occurs and how the mind of a learner acquires knowledge. One of such psychologists is Albert Badura who argued that learning takes place through observation and imitation. Therefore, it is only when we know how knowledge is acquired, that we will be able to use appropriate teaching and learning approach (Alao & Adeniyi, 2008).

The social cognitive theory of Albert Badura is a type of learning undertaken by way of observation or imitation through which an organism (person) watches or observes another organism. A human being forms his/her behaviour by observing the way others behave; he/she endeavours to imitate others (Nnachi, 2007). The social learning theory has useful application in learning such as computerized systems. This means that the mastery of geometry skills and concepts in technical drawing might not be fully achieved without the use of good instructional delivery approaches such as audio-visual resources also referred by some researchers as videotaped instruction.

Videotaped instruction combines still and motion pictures in its pictorial presentation and it is a medium which may be used to achieve various teaching and learning objectives (Mudasiru, 2006). According to Agommuoh and Nzewi (2003), Videotaped instruction has the qualities of providing a semi-permanent, absolute and audio-visual record of events; potentials of increasing the probability that the students will learn more, retain better and thus achieve better. Videotaped instruction is an instructional approach that employs audio-visual resources.

Audio-visual resources are any device which by sight and sound increases the individual's practice, outside that attained through read labelled as an audio-visual (Singh, 2005). They are devices that are utilized in classrooms to promote students' learning procedure and make learning easier and remarkable. They are instructional

resources which include: film strip, LCD projectors, radios, television, computer, VCD player/machine, virtual classroom, electronic board, digital multimedia, etc. The characteristics of audio-visual classroom instruction are relevancy, useful and purposeful teaching, accuracy, interest; minimizes verbalism, comprehensibility, motivation and realism (Burtoon, 2016). Audio-visual resources provide students with realistic experiences which capture their attention and help in the understanding the historical phenomena. Jain (2004) asserted that audio-visual resources appeal to the mind through the visual auditory senses. Kunari (200) posited that they stimulate critical thinking and enhance understanding of the concept taught. Mohanty (2001) opined that the utilization of audio-visual resources in teaching and learning process has multifarious values. They give students the opportunity to make a more professional and consistent presentation. They create opportunities to enrich the academic competency of the students, while some concepts and educational objectives will be easy for learners to understand.

According to Kunari (2006), audio-visual resources help to boost lesson plans and provide the learners further ways to develop subject information. They concretize the knowledge to be presented and help in making the learning experiences real, lively and vital. They supplement the work of the teacher and helps in the study of the textbooks. Jain (2004) added that the application of audio-visual resources encourages the body movement and it may strengthen the control. Good learning resources can help solve certain problems as they provide accurate visual image and make learning easier for the students (Chacko, 1981). It clarifies the relationship between material objects and concepts. The significance of audio-visual resources in instruction are: helps to retain more concepts permanently; enables students to study well when they are inspired properly through different audio visual resources; grows the accurate image once the students see and hear properly; provide full example for conceptual thinking; creates the atmosphere of interest for students; helps to enhance the students' vocabulary; aids teachers to acquire sometime and make learning permanent; and provide direct experience to the student (Singh, 2005).

Researches (Ouellette, 2004; Osokoya, 2007; Ode, 2014; Nelson, Buabeng & Osafor, 2015) have indicated that audio-visual-aided instruction has greatly enhanced the learning outcomes of students in school subjects. Osokoya (2007) conducted a study on the effects of video-taped instruction on secondary school students' achievement in history and reported that the application of audio-visual aids improved students' achievement. Ode and Omokaro (2014) studied the impact of audio-visual resources on teaching and learning in some selected private secondary schools in Markudi and found that the utilization of audio-visual resources had significant impact on the instructions in secondary schools. Nelson, Buabeng and Osafor (2015) examined the impact of audio-visual aids on high secondary school students achievement in physics and reported that high secondary school students taught with audio-visual aided instruction performed better than those taught with traditional method; and that the Mean achievement scores of students improved significantly by the application of the audio-visual aided instruction irrespective of their gender.

Gender is a socio-cultural ascription of roles on the basis of masculinity or feminity. It is the social or cultural construct, characteristics, behaviours and roles which society ascribes to females and males (Okeke, 2008). Gender disparities in technical education fields have been attributed to family formation and child rearing, gender stereotyping, lifestyles choices, religion, careers preferences, personal choices among others (Ceci & Williams, 2011). These factors make certain careers and professions (engineering, architecture, and technical education programmes in which technical drawing is a core subject) are regarded as belonging to the male gender while others such as teaching, nursing, catering and home economics, typing and the arts are regarded as belonging to the female gender. The demand for skilled work force in the technological field will be difficult, if not impossible to meet, if the nature's future technological workforce does not reflect the diversity of the population (Institute for Higher Education Policy (IHEP), 2010). Schreiner and Sjoberg (2004) posited that interest is one of the most fundamental determinants of students' academic performance.

Interest is an affinity, preference or an inclination towards an event, set of activity or object. It is the psychological state of engaging or the predisposition to re-arrange with particular classes of objects, events or ideas over time (Hidi & Renninger, 2006). Researchers (Adodo & Gbore, 2012; Oviawe & Adeola, 2017) reported that interest predicted students' performance in their different ability levels. These studies supported the fact that interest is indispensable in students' engagement in academic activities.

2. Research Method

2.1 Research Design

The design of this study is quasi-experimental research design adopting pre-test, post-test non-equivalent control group design in determining the effects of audio-visual resources on students' academic achievement in geometry in secondary schools in Edo State. This was adopted because it was not possible to have a complete randomization of the subjects involved in the study.

2.2 Participants

The population for the study consisted of all the senior secondary students II in the five Model schools in Edo State, Nigeria. The sample of the study consisted of 123 students from two randomly selected senior secondary schools from the area. The experimental group had 63 students while the control group had 60 students. In each of the schools, two intact classes were randomly assigned to experimental and control groups.

2.3 Data Collection Instrument

The instrument used for data collection was Geometry Achievement Test (GAT) and Geometry Students' Interest Inventory Scale (GSIIS) were the instrument used for data collection. GAT was a 30-item multiple choices with five options (ABCDE) and five essay questions based on the themes and topics developed by the researchers with special

attention on two-dimensional shapes (2Ds), three-dimensional shapes (3Ds) and measurement based on the Technical Drawing FME (2010) curriculum. Each of the five options in the multiple choices item had one current answer and the other four options served as distracters. Both the multiple choice and essay items offered students the opportunity to fully express their cognitive ability on the contents of geometry. The construction of the instrument was guided by a table of specification. GAT was used for pre-test and post-test in both the experimental and control groups. After pre-test, the items were re-organized by the researchers before its administration for post-test. The experimental groups were taught geometry using audio-visual resources instructional strategy by their teachers trained on how to use the instructional strategy while the control groups were taught with the lecture method lesson plans.

The audio-visual resources instructional delivery approach employed for the study was packaged in a Compact Disc Read Only Memory (CDROM) developed by the combined efforts of the researcher and a Computer Programmer using the lesson script. The lesson script was presented by the researcher and it comprised of five lessons of 40 minutes duration each on the topic geometry. The topic geometry was chosen because it is an area of technical drawing which most students find difficult to understand and avoid attempting in examinations. The audio-visual approach was designed to help students know the step-by-step skills in geometry.

On the first day of the experiment GAT and GSIIS were administered as pre-test to all the students in the two groups. After this, the experimental groups were taught geometry for a period of five lessons within two weeks using audio-visual approach with the CDROM played in a laptop and projected on a screen using a projector for better and clearer view. Each lesson period lasted for 40 minutes.

GSIIS consisted of two sections: A and B. Section A contained information on students' name, gender and name of school while section B had items that addressed students' interest developed by the researcher from literature reviewed. The GSIIS items were rated on a five-point Likert type scale; viz: Strongly Agree (SA) -5, Agree (A) – 4, Undecided (U) – 3, Disagreed (D) – 2, Strongly Disagreed (SD) – 1. The interest inventory scores were non-dichotomous (that is, polychotomously) and positively scored. Both GAT and GSIIS were used for the pre-test and post-test. At the end of the lesson period, the post-test was administered to the students using GAT and GSIIS, with the item numbers reshuffled before being used for post-test.

2.4 Validity and Reliability of Instrument

The face and content validity of the instruments (GAT, GSIIS and its lesson plans) were determined by five experts: two in technical education, one in educational psychology, one in test and measurement, and one technical drawing teacher, their inputs were used in modifying and restructuring the instrument.

GAT and GSII were trial tested on a group of intact class of 45 senior secondary school II students within the study population who were not included in the main study using test-re-test method. GAT had a reliability co-efficient of .75 obtained using Kuder

Richardson's formula 21 (K_{R-21}), while GSII had a reliability co-efficient of .90 determined using Cronbach alpha computation.

2.5 Experimental Procedure

The researchers sought permission from the Principals of the schools to conduct the study. They sought for the cooperation of the technical drawing teachers in each of the schools and appointed them as research assistants in conducting of the study. The researchers explained the purpose of the study to them and requested for their assistance in conducting the experiment. The regular teachers in the experimental group were trained on the lesson plans prepared for the experiments two weeks before the study commenced. The reason for training the teachers was to ensure uniform instruction towards the validity of the experiment for easy generalization. The reason for the choice of using the regular technical drawing in the selected schools for the experiment was because if a new teacher other than the regular teachers comes in to teach the students using any instructional strategy, the students may think that something (experiment) is going on and that may affect their performance. However, before treatment, both group (experiment and control) were given pre-test. Both groups (experimental and control) were taught the same learning units for three weeks, after which the post-test was administered on the two groups in their intact classes. The scores of the treatment group in both pre-test and post-test were put together and compared with the scores of the control group in both pre-test and post-test. The entire experiment lasted for four weeks. The experiment came to an end with the post-test. The researchers ensured that adequate control measures were taken to eliminate all the extraneous variables that would have otherwise threatened the validity of this study.

The researchers took the following precautions in the course of the experiment:

1) attendance was taken at the beginning of every class session so that scores of students who would have missed any of the sessions was not used during data analysis;
2) the three groups were given equal number of treatment;
3) to prevent the subjects from being familiar with the questions of pre-test and post-test, the items were reshuffled; and
4) the time allowed for pre-test and post-test was the same.

2.6 Method of Data Analysis

Research questions were answered with Mean and Standard Deviation while the hypotheses were test at .05 level of significance using Analysis of Covariance (ANCOVA). The pre-test scores of were used as the covariates to their post-test scores.

3. Results

Research Question 1: What is the difference between mean achievement scores of students taught geometry using audio-visual resources and those taught using the lecture method?

Table 1: Mean and Stand Deviation of Pre-test and Post-test scores of Experimental and Control Groups in the Academic Achievement

Group	N	Pre-test		Post-test		Gain	
		$\bar{X}_1$	SD_1	$\bar{X}_2$	SD_2	$\bar{X}$	SD
Experimental	63	6.48	1.12	20.49	2.29	14.01	1.17
Control	60	6.65	1.13	13.85	1.97	7.35	.84

Table 1 reveals that the pre-test Mean scores of the students in the control group performed better (6.65) than the experimental group. However, the post-test Mean score showed that students' taught with audio-visual resources had higher post-test Mean scores of 20.49; while students in the control group taught with conventional teaching method had a Mean achievement score of 13.85. This implies that treatment (audio-visual resources) had positive effect on students Mean achievement scores in geometry.

Research Question 2: What is the difference between mean achievement scores of students taught geometry using audio-visual resources and those taught using the lecture method?

Table 2: Mean and Stand Deviation of Pre-test and Post-test scores of Experimental and Control Groups in the Academic Achievement

Group	N	Pre-test		Post-test		Gain	
		$\bar{X}_1$	SD_1	$\bar{X}_2$	SD_2	$\bar{X}$	SD
Experimental	63	1.15	.25	3.12	.32	1.61	.07
Control	60	1.15	.22	2.48	.26	.97	.04

Table 2 reveals that the pre-test Mean interest scores of the students in the experimental and control groups were the same (1.15). However, the post-test Mean score showed that students' taught with audio-visual resources had higher post-test Mean interest scores of 3.12; while students in the control group taught with lecture method had a Mean interest score of 2.48. This implies that treatment (audio-visual resources) had positive effect on students' Mean interest scores in geometry.

Hypothesis 1: There is no significant difference in the mean achievement scores of technical drawing students taught geometry with audio-visual resources and those taught using the lecture method.

Hypothesis 2: There is no significant interaction effect of the learning methods and gender on students' academic achievement in geometry in secondary schools.

Table 3 shows the F-calculated values for mean scores of experimental and control groups in the academic achievement and interaction effect of treatments and gender on students' interest scores in geometry. The F-calculated value for group is 221.150 with a significance of P at .000 which is less than .05. Therefore, the null hypothesis was rejected. This implies that there is a significant difference between the mean achievement scores of students taught geometry in technical drawing with audio-visual resources and those not taught with it. The interaction of treatments and gender had F-calculated value of

.157 with significance of P at .692 which is greater than .05. Testing at an alpha level of .05, the P value is much higher than the alpha level, therefore, the null hypothesis which states that there is no significant interaction effect of the learning methods and gender on students' academic achievement in geometry is retained. Hence, it is concluded that there is no significant interaction effect of the learning methods and gender on students' mean achievement scores in geometry.

Table 3: ANCOVA Showing Interactive Effects of Treatment and Gender at Post-test

Sources of Variations	Sum of Squares	DF	Mean Square	F cal-value	Sig.	Partial Eta Squared
Corrected Model	1369.479[a]	4	342.370	74.578	.000	.717
Intercept	990.842	1	990.842	215.835	.000	.647
GAT 1	.072	1	.072	.016	.901	.000
Gender	12.004	1	12.004	2.615	.109	.022
Group	**1015.245**	**1**	**1015.245**	**221.150**	**.000**	**.652**
Gender*Group	**.722**	**1**	**.722**	**.157**	**.692**	**.001**
Error	541.708	118	4.591			
Total	38520.000	123				
Corrected Total	1911.187	122				

[a.]R Squared = .717 (Adjusted R Squared = .707).

Hypothesis 3: There is no significant difference in the mean interest scores of technical drawing students taught geometry with audio-visual resources and those taught using the conventional teaching method.

Hypothesis 4: There is no significant interaction effect of the learning methods and gender on students' interest scores in geometry in secondary schools.

Table 4: ANCOVA Showing Interactive Effects of Treatment, Gender and Interest at Post-test

Sources of Variations	Sum of Squares	DF	Mean Square	F cal-value	Sig.	Partial Eta Squared
Corrected Model	12.701[a]	4	3.175	41.941	.000	.587
Intercept	24.710	1	24.710	326.401	.000	.734
GAT 1	.001	1	.001	.012	.912	.000
Gender	.072	1	.072	.947	.333	.008
Group	**8.674**	**1**	**8.674**	**114.579**	**.000**	**.493**
Gender*Group	**.107**	**1**	**.107**	**1.415**	**.237**	**.012**
Error	8.933	118	.076			
Total	992.573	123				
Corrected Total	21.634	122				

[a.]R Squared = .587 (Adjusted R Squared = .573).

Table 4 shows the F-calculated values for mean scores of experimental and control groups in the interest inventory and interaction effect of treatments and gender on students' interest scores in geometry. The F-calculated value for group is 114.579 with a significance of P at .000 which is less than .05. Therefore, the null hypothesis was rejected. This implies that there is a significant difference between the mean achievement scores of students

taught geometry in technical drawing with audio-visual resources and those not taught with it. The interaction of treatments and gender had F-calculated value of 1.415 with significance of P at .237 which is greater than .05. Testing at an alpha level of .05, the P value is much higher than the alpha level, therefore, the null hypothesis which states that there is no significant interaction effect of the learning methods and gender on students' interest scores in geometry is retained. Hence, it is concluded that there is no significant interaction effect of the learning methods and gender on students' mean interest scores in geometry.

4. Discussion of Findings

The study revealed that there was significant difference in the academic achievement of students' as a result of the instructional methods in favour of the experimental group taught geometry using audio-visual resources. This finding is in line with earlier findings of similar experimental studies by Adedapo, Salawu and Afolabi (2001); Agommuoh and Nzewi (2003); Ouellette (2004); and Osokoya (2007) who reported students taught with audio-visual-aided resources instructional approach achieved significantly better than those taught with the lecture method. The low academic achievement of the students in conventional lecture method group is consisted with earlier findings from the experimental studies conducted by Bitrus (2014); Oviawe, Ezeji and Uwameiye (2015); Asaf and Zahoo (2017); Oviawe and Adeola (2017); Nnamani, Akabogu, Ulloh-Bethel, and Ede (2018); Oviawe (2019) who variously reported low academic achievement in the control group (conventional teaching method).

The findings of this study revealed that there was significant difference in the mean interest scores of students' due to instructional methods in favour of the experimental group taught geometry using audio-visual resources. This finding is in line with earlier findings of similar experimental studies by John (2007); Chumo (2014); Oviawe and Adeola (2017); Oviawe (2019) who found that innovative instructional strategies improve students' interest in learning. Obi (2006) on the same subject matter asserted that instructional strategies could improve both performance and interest of students supports the findings of this study. Hence, audio-visual aided instruction is more effective than the lecture method in improving students' academic achievement and interest in geometry. The findings of this study revealed that there was no significant interaction effect of treatments given to students and their gender with respect to their mean achievement and interest scores in the Geometry Achievement Test.

5. Conclusion and Recommendations

Since the findings of the study revealed that there was a significant effect of audio-visual instructional strategy on students' academic achievement and interest in geometry, it is concluded that audio-visual instructional strategy is a better instructional strategy than the lecture method for teaching. It can also be said that the inappropriate use instructional

methods in teaching subjects have far reaching negative effect on students' academic achievement and interest on students generally. Therefore, the use of audio-visual resources in teaching technical drawing in general and geometry in particular could improve students' achievement and interest. Based on the findings of this study, the following recommendations were made:

1) Technical drawing teachers should employ audio-visual instructional strategy in teaching technical drawing especially in geometry as it enhances students' academic achievement and interest.
2) Technical teacher education institutions responsible for the training of technical teachers to incorporate the use of innovative instructional strategies such as audio-visual among others into their curriculum in order to expose would-be teachers to diverse instructional methods. While teachers already on the field, should be retrained through in-service training such as conferences, seminars and workshops to up-date their knowledge.

References

Adedapo, Y. A., Salawu, I. O. & Afolabi, A. O. (2001). Effects of video and audio-taped instruction on cognitive learning outcomes in economics. *Ilorin journal of education*, 1 (1), 1-8.

Agommuoh, P. C. & Nzewi, U. M. (2003). Effects of videotaped instruction on secondary school students' achievement in physics. *Journal of the science teachers' association of Nigeria,* 38 (1), 88-93.

Alao, K. O. & Adeniyi, W. O. (2008). *Psychology of learning*. Abuja: National Open University of Nigeria.

Asaf, N. & Zahoo, U. R. (2017). Effects of peer tutoring strategy and students' success in mathematics. *Journal of research and reflection in education,* 11 (1), 15-30.

Aydogdu, M. Z. (2014). A research on geometry problem solving strategies used by elementary mathematics teacher candidates. *Journal of educational and instructional studies in the world*. 4 (1), article 7.

Bitrus, J. W. (2014). Effects of cooperative and competitive learning models on Pre-NCE students' cognitive achievement in ecology using concept mapping. *Unpublished M.Ed thesis, Department of science education, University of Nigeria, Nsukka.*

Burtoon, J. (2012). The impact of technology on students' engagement and achievement in mathematics classroom. Paper submitted in partial fulfilment of the requirements for the degree of Masters of Education, Memorial University, NL.

Ceci, S. J. & Williams, W. M. (2011). Understanding current causes of women under representation in science. PNAS early edition 1-6. Retrieved from www.pnas.org.cgi/doi/10.1073/pnas.

Chacko, I. (1991). Learning outcomes in secondary schools mathematics related to teacher and student characteristics. *Ph.D thesis, University of Ibadan, Ibadan*.

Chumo, C. C. (2014). Effects of practical investigation on scientific creativity among secondary schools biology students in Kericho district, Kenya. *Journal of educationand practice,* 5 (8), 43-51.

Federal Ministry of Education (2010). *Senior secondary school curriculum for technical drawing*. Abuja: NERDC.

Institute for Higher Education Policy (2010). *Diversifying the STEM pipeline: The model replication institutions program*. Washington, D.C.

Jain, P. (2004). *Educational technology.* New Delhi: Moujpur publication.

John, B. (2007). The effect of concept mapping instructional strategy on students' achievement and interest in HIV/AIDS contents in health and physical education. *Benin journal of health and disease studies*, 6 (1), 68-74.

Kunari, C. (2006). *Methods of teaching educational technology.* New Delhi: Moujpur publication.

Kuruiawati, T. J., Jinaedi, D. & Manami, A. T. (2010). *Educational technology for teachingand learning* (4th edition). Boston, M.A.: Allyn & Bacon/Pearson Education Inc.

Madhavan, T. (2010). Teaching learning materials. Retrieved from *blog @wordpress.com*

Miranda, Z. (2007). Using power point in the classroom. Retrieved from http://www.mirandazinnel.suite101.com/using_powerpoint_classroom.

Mohanty, J. (2001). *Educational technology*. New Delhi: Rajouri Garden.

Nelson, R. O., Buabeng, I. & Osafor, D. K. (2015). Impact of audio-visual aids on senior highschool students' achievement in physics. *Eurasian journal of physics and chemistryeducation*, 4 (1), 46-54.

Nnachi, R. O. (2007). *Advanced psychology of learning and scientific enquiries*. Enugu: John Jacob Classic pub. ltd

Nnamani, P. A., Akabogu, U. J. Ulloh-Bethel, C. A. & Ede, O. M. (2018). Effect of reciprocal peer tutoring on computer students' achievement in expository essay writing: Implication for school counselling. *International journal of applied engineering research*, 13 (21), 15102-15107.

Obi, C. N. (2006). Comparative study of the effects of two problem-solving models on students' achievement and interest on word problems in algebra. *Unpublished M.Ed thesis, Department of science education, University of Nigeria, Nsukka.*

Ode, E. O. & Omokaro, D. A. (2007). *Basic principles and practice of librarianship*. Benin City: PSG-France publications.

Okeke, E. A. C. (2008). Classification and analysis of gender concepts. Focus on research, reproductive health education, and gender sensitive classrooms. *Science teachers' association of Nigeria- Gender and STEM Education series* (2), 5-8.

Osokoya, I. O. (2007). Effects of video-taped instruction on secondary school students' achievement in history. *International journal of African and African American studies,* 6 (1), 27-34.

Ouellette, R. P. (2004). *The challenges of distributed learning as new paradigm for teachingand learning.* College Park, USA: University of Maryland College, Pittsburgh, Johnstown.

Oviawe, J. I. (2019). Effects of blended learning approach and students' academic performance blocklaying and concrete works trade in technical colleges in Edo State, Nigeria. *International Journal of Educational Benchmark (IJEB)*, 12(1), 45-53.

Oviawe, J. I. & Adeola, L. (2017). Effects of concept mapping instructional strategy onstudents' academic performance and interest in technical drawing in technical colleges in Edo State, Nigeria. *IOSR Journal of Research and Method in Education (IOSR-JRME),* 7 (3) Ver. 1 (May-June) 9-15.

Oviawe, J. I., Ezeji, S. C. O. A., & Uwameiye, R. (2015). Comparative effectiveness of three methods on the academic performance of students in building technology in Nigerian polytechnics. *European Scientific Journal* 11 (12), 274–285.

Oviawe, J. I., & Uddin, P. S. O. (2014). Level of availability and utilization of educational resources for teaching technical drawing in secondary schools in Edo State. *Journal of Industrial Education and Training* 3, 151–168.

Schreiner, C. & Sjoberg, S. (2004). *ROSE: The relevance of science education: Sowing the seeds of ROSE*. (Oslo, Department of teacher education and school development, University of Oslo).

Tieng, P. G. & Eu, L. K. (2014). Improving students' Van Hiele Level of geometric thinking using geometer's sketchpad. *Malaysian online journal of educational technology*, 2(3), 20-31.

West African Examinations Council (2013). *Chief Examiner's report*. Ghana: WAEC.