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Effects of Demonstration Method on Senior Secondary School Students' Achievement in Geographic Information System (GIS) in Abaji Area Council, FCT-Abuja

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Abstract. The study investigated the effects of demonstration method on senior secondary school students' achievement in Geographic Information System (GIS). Six research questions and six null hypotheses were generated. The quasi experimental design which employed the non-randomized pretest-post test control group design was adopted. The study was conducted in Abaji Area Council of the Federal Capital Territory, Abuja, with a study sample consisting of 310 SS2 students were drawn using purposive sampling technique and four intact classes emerged. This comprised of two experimental group and two control groups. The experimental group was taught using demonstration method while the control group was taught using the conventional lecture method for a consecutive period of five weeks. Geographic Information System Achievement Test (GISAT) was developed to collect data on students' achievement in GIS. The instrument was validated by experts and GISAT reliability was tested at .802 using the Pearson Correlations at .01 level of significance. Research questions were answered using mean and standard deviation while t-test and Analysis of Covariance (ANCOVA) were adopted for data analysis. Results from the study revealed that demonstration method of teaching was effective in improving students' achievement in learning of GIS compared to conventional lecture method. It also showed that male students have higher achievement scores in GIS compared to their female counterparts.

Keywords: GIS, Achievement, Demonstration Method, Lecture Method School location and Gender.

1. Introduction

Geographic Information System (GIS) can be described as the general purpose computer based technology for handling geographical data in digital form in order to capture, store, manipulate, analyse and display diverse set of Geo-referenced data. GIS have been used in a variety of applications as a 'scientific tool' in natural resource management, health, mining, earth science, hazard management and petroleum research. Although GIS was specifically designed for professional spatial analysis, it is today being incorporated into many other disciplines including education. It is in connection to this that GIS has started finding a place in secondary school geography curriculum in many countries as it has been identified as one of the 21st century tools for communication, information processing and research which supports the development of

students' abilities in investigating, evaluating, integrating, creating and analysing information around them (Singh, Balan, Sabariah, Rosy & Oliver 2016).

The rapid development in the last two decades in computer and internet technology have resulted in many changes and reforms in education as well as other sectors of the society. Sahin (2010) observed that positive outcomes of using technology in education such as GIS has led many governments to initiate programs for the integration of GIS in schools as efforts are being intensified to equip schools with more computers and internet facilities. Consequently, Oppong and Amoah (2012) posited that GIS use has become so persuasive that it is emerging in secondary school education as its being integrated into geography classes in a number of countries. Today in Nigeria, following the Federal Government reform in education and developments in Geography curriculum, the curriculum incorporates GIS in order to equip and build students skills in spatial analysis. Artvinli (2010) observed that using GIS develops high level of analytical and synthetic thinking. Its application is a process that enhances students' thinking and evaluative skills such as processing the information obtained their justification and making appropriate reasons. However, the teachers' role in the effective teaching and learning of GIS largely depends on the skills or technique he/she possesses and the ability to adopt the most appropriate method. Achievement of students in GIS could only be attained when geography teachers adopt the appropriate teaching method in the class room.

There is no single method of teaching that can be suitably used to teach all aspects of any discipline but a combination of two or more produce better results. However, the method adopted at any time depends on a number of factors such as the nature of the topic, the age of the learner and the learning environment among others (Ugwu, 2014). A good teacher should be able to use variety of methods considered suitable for any given instruction. Among the various teaching methods, Ugwu (2014); Eya (2012) and Omoro & Nato (2014) identified demonstration method as one of the methods of teaching that can be used for science-related concepts. Demonstration method of teaching is a practical display or exhibition of the process which points out clearly the fundamental principles or actions involved (Kizlik, 2010). Literatures showed that demonstration instructional technique as an innovative instructional practice can only be effectively implemented if the teachers possess the right knowledge, skills and abilities related to its use in the classroom situation. Different studies show that it has positive effect on the academic achievement of students (Aladag 2010; Ugwu 2010 and Daluba 2013). However, the present concern for Nigerian Geography teachers with regards to acquisition of these qualities is born out of the fear that most of these teachers have been used to lecture teaching method (Mohammad, Bala & Ladu, 2016). This makes it difficult for them to adopt new trends of teaching. According to Gitau as cited in Omoro and Nato (2014), it was observed that although lecture method is teacher-centred, it is mainly used by geography teachers when presenting factual information or teaching in a large class. It is observed that despite lecture method is seen by modern educators as a traditional or out-dated method, it is still one of the most widely used methods of teaching and it is rather unfortunate that the lecture method does not yield much in terms of students expected outcome in the class. This has led researchers into searching for better and most appropriate methods of teaching geographical concepts such as GIS in secondary schools. Demonstration instructional technique has the benefit of stimulating thinking, promoting understanding, formulation of concepts and generalization (Anbessa 2010). It enables students to acquire knowledge in the firsthand form which connects theory with practice and fosters creative thinking.

The need to improve academic achievement of students in science subject at all levels of educational system in Nigeria has been of great concern to stakeholders in the sector. The situation of mass failure of students in science subject including geography has been attributed to several factors including inappropriate method of teaching, gender and school location

among others. For example, documented evidence by the National Examination Council (NECO) revealed that there is poor achievement in majority of the topics covered in the examination. Particularly, in geography, among the areas affected is GIS where most candidates have poor achievement and this is becoming worrisome to all.

Studies revealed that gender is a factor that can determine students' achievement. There has been evidence of a growing gender gap in the academic achievement of students. According to Ahmad et al (2011), gender gap refers to the under-achievement of male students in comparison to female students. Viehrig (2014) holds that it appears male students in many countries generally have higher achievement in geography or earth science and systematic thinking. Other studies studies reveal there is significant gender difference in the academic achievement of students in favour of males (Ballah 2015; Ugwu 2014). According to Nzewi (2010) he attributed the reason for gender gap achievement to a common belief that many view science related disciplines as a male dominated area as male students usually outperform their female counterparts. However, there are studies that show a higher overall achievement of females in a GIS course (Clark, Monk, & Yool cited in Viehrig 2014).

2. Statement of the Problem

The failure of students in GIS has become an issue of concern to geography teachers and different reports confirmed that this has resulted to students' low achievement. Although several factors could be responsible however, it is being viewed that the method of instruction adopted by most geography teachers for teaching and learning GIS may be faulty. According to Umar (2013), it was observed that if demonstration method is presented effectively by the teacher, it can positively affect students' achievement. However, studies show that the method is seldom practiced by most geography teachers and it is worrisome today that they still use the traditional lecture method other than methods that will help learners develop the right skills in geographical concepts such as GIS (Andrew 2014).

Students' failure as confirmed in the Chief Examiner's Report (NECO 2017) also attracted the researcher's attention. The document reported low students' achievement in GIS and it was blamed on the inability of Geography teachers to adopt the right method and also a rush over the topics to cover them. Shaibu (2017) observed that most science teachers use lecture and other conventional methods in teaching to enable them cover the syllables within the stipulated time. This necessitates the need for more effective and result oriented approach in GIS teaching that is capable of inducing students' critical thinking and reflective reasoning. Although similar studies have been conducted on the effectiveness of demonstration method in other disciplines, literature search reveals that no such studies had been linked to GIS achievement especially in the Federal Capital Territory (FCT).

3. Purpose of the study

The main purpose of the study is to determine the effect of demonstration method on senior secondary school students' achievement in Geographic Information System (GIS). The study is designed to also to:

- Determine the pre-test achievement mean score of experimental and control groups in GIS.
- Determine the post-test achievement mean score of experimental and control groups in GIS.
- Find out the pre-test achievement mean score of experimental and control groups in GIS based on gender.
- Find out the post-test achievement mean score of experimental and control groups in GIS based on gender.

4. Research Questions

The following research questions were formulated:

- What is the mean achievement score of experimental and control groups in GIS before experiment?
- What is the mean achievement score of experimental and control groups in GIS after experiment?
- What is the pre-test achievement mean score of experimental and control groups in GIS based on gender?
- What is the post-test achievement mean score of experimental and control groups in GIS based on gender?

5. Hypotheses

The study has the following null hypotheses:
There is no significant difference between the mean post-test achievement scores of control and experimental groups in GIS.
There is no significant difference between the mean post-test achievement scores of male and female students in GIS.

6. Methodology

The study adopted the quasi-experimental research design, particularly the non-randomized pre-test post-test control group design. The quasi-experimental design was considered appropriate because intact classes were used so as to avoid the disruption of normal class setting of schools. The design made use of already existing class settings in four secondary schools; two schools urban area and the other two from rural area.

7. Population and sample

Population of the study is made up of all Senior Secondary Two (SS2) students in Governments owned secondary schools within the study area excluding private schools. The study covers only secondary schools run co-educational system. There are seven governments owned senior secondary schools, out of which four (4) are located within Abaji town which are considered as urban schools while the remaining three (3) are located outside Abaji town which are considered as rural schools. The total population of geography students in senior SSII in the study area is 901 students. This consists of 477 male and 421 female students.

The sample for the study comprised of 310 students offering Geography as a subject from four co-educational Senior Secondary Schools selected from both rural and urban areas of the study area. This comprised of 187 boys and 123 girls. Two intact classes, one each from the town (urban) and outside the town (rural) was selected to make up the experimental group. Students in another two intact classes, one each from the town (urban) and outside the town (rural) was selected to make up the control group. All these made up a total of four (4) intact classes for the study.

7.1 Sampling Technique

The sampling technique adopted in the study is the purposive sampling technique. Participants were categorized and sampled by the researcher based on similar characteristics they possess in their original intact class settings. This was to adequately represent secondary schools located in both urban and rural areas as well as to ensure that only senior secondary schools that have co-education were selected. The sampling method was basically to ensure equivalence of the two groups, as well as the variables reflected in the study.

7.2 Instrument for Data Collection

Geographic Information System Achievement Test (GISAT) was developed by the researcher and was used to collect data on geography students' achievement in GIS. The instrument had sections 'A' and 'B'. Section 'A' was made up of 30 items and each item contained options ranging from A to D for respondents to choose the correct option. Each correct option was scored 2marks, giving a total score of 60marks. Section 'B' contains essay questions with a total of 40marks giving a total of 100marks in all. The achievement items were taken from GIS main topics in SSII based on the new geography curriculum. The main GIS topics are: basic concepts of GIS, components of GIS and GIS data. The questions were subjected to measure six cognitive domains of students which include;

Knowledge, Comprehension, Application, Evaluation, Analysis and Synthesis. The GISAT was administered in both Pre-test and post-test so as to measure any significant mean difference between the scores of Experimental and Control groups.

In order to ensure content validity, the researcher examined the GIS topics based on the time spent in teaching and behavioural objectives stated. This was followed by the development of test items in accordance to the table of specification. The developed items were given to three experts, accompanied with the research questions and objectives for judgement to ensure appropriateness. Two experts from Geography education units and another from test and measurement in University of Jos were presented the instrument for expert judgements. The experts vetted the constructed test items in terms of clarity of language use, appropriateness and relevance of what they are meant to measure. The expert's validation included both face and content validity.

The reliability of the instrument for students' achievement was established by testing the internal consistency of the items. The reliability was obtained from the response of 30 SSII students who are not part of the sample in this study. Since reliability of instrument has to do with the degree of accuracy or precision in measurement of research instruments, result of the trial test was recorded in terms of overall performance on the test and re-test administered. The reliability coefficient of 0.802 was obtained after the test and re-test scores were computed using the Pearson Product Moment Correlation statistics.

7.3 Method of Data Collection and Analysis

Prior to treatment of the groups, a pre-test was administered to test students' achievement in GIS by distributing the GISAT items to both experimental and control groups. After the test, the scripts were collected and marked. This was followed with a presentation of a double lesson of 80 minutes taught to both groups for a period of five weeks. The two Experimental groups were taught using demonstration method while the other two control groups were taught using conventional lecture method for a period of five weeks. At the end of the fifth week, the Achievement scale (GISAT) was once more administered to both control and experimental groups after the experiment was completed. Students' scripts were collected; marked and analyzed.

The data collected through the administration GISAT was analysed using descriptive statistical tools including mean and standard deviation to answer all the research questions. Similarly, inferential statistics of Analyses of Covariance (ANCOVA) and t-test were adopted to test hypotheses one and two at .05% level of significance respectively. This is because the data were collected on interval scale.

8. Results

The data were analyzed and results are presented as follows:

Research Question One: What is the level of achievement of secondary school students in GIS before treatment?

Table 1: Descriptive Statistics of the Level of Achievement of Senior Secondary School Students in GIS Before Exposing them to Treatment.

Groups		**Pretest**		
	N	$\overline{X}$	**SD**	**Level**
Experimental	190	25.61	6.74	Low
Control	120	24.92	2.03	Low

Note: Decision is based on the $\overline{X} \leq 49.0$ = low, $\overline{X} > 49.0$ = High based on scores obtained from GISAT.

Table 1 analysis shows that the pretest academic achievement mean scores of both the experimental and control groups before the treatment are very low (M = 25.61, SD = 6.74 and M=24.92, SD=2.03 respectively).

Research Question Two: What is the level of achievement of secondary school students in GIS after treatment?

Table 2: Descriptive Statistics of the Level of Achievement of Senior Secondary School Students in GIS after Exposing them to Treatment.

Groups		**Posttest**		
	N	$\overline{X}$	**SD**	**Level**
Experimental	190	59.00	6.87	High
Control	120	24.92	2.85	Low

Note: Decision is based on the $\overline{X} \leq 49.0$ = low, $\overline{X} > 49.0$ = High based on scores obtained from GISAT.
Table 2 shows that the posttest mean scores of the experimental group (M = 59.00, SD = 6.87) after the treatment is higher than the mean bench mark ($\overline{X}$ >49.0) and that of the control group (M = 24.96, SD = 2.85). This suggests that before the intervention, secondary school students had low academic achievement in GIS, but exposure to demonstration method of teaching later increase their academic score.

Research Question Three: What is the pretest achievement mean score of experimental and control groups in GIS base on gender?

Table 3: Descriptive Statistics of GIS achievement test score of Senior Secondary School Students Base on Gender.

Gender		**Pretest**		
	N	$\overline{X}$	**SD**	**Remark**
Male	187	27.91	7.32	Low
Female	123	21.43	3.56	Low

Note: $\overline{X} \leq 49.0$ = Low, $\overline{X} > 49.0$ = High as obtained from GISAT (Overall mean score = 100)
Table 3 results indicates that the academic achievement mean scores of male students before the treatment: (M = 27.91, SD = 7.32) and female students (M=21.43, SD=3.56) are both low.

Research question four
What is the post-test achievement mean score of experimental and control groups in GIS base on gender?

Table 4: Descriptive Statistics of GIS achievement test score of Senior Secondary School Students Base on Gender.

Gender		**Posttest**		
	N	$\overline{X}$	**SD**	**Remark**
Male	187	56.36	7.50	High
Female	123	44.39	6.60	Low

Note: $\overline{X} \leq 49.0$ = Low, $\overline{X} > 49.0$ = High as obtained from GISAT (Overall mean score = 100)
Table 4 results indicates that the academic achievement mean score of male students after the treatment is (M=56.36, SD=7.50), higher than that of female students (M = 44.39, SD = 6.60). After the treatment, the

achievement scores of the male students was higher ($\overline{X}$ >49.0), while that of female students was lower ($\overline{X}$ <49). This represents that senior secondary school students differ in GIS academic achievement on gender basis with male students higher than the female students.

Hypothesis 1: There is no significant difference between the mean pre-test and post-test achievement scores of control and experimental groups in GIS.

Table 4: Summary of ANCOVA Test Difference between the Mean Pre-Test and Post-Test Achievement Scores of Control and Experimental Groups in GIS.

Source	Type III Sum of Squares	Df	Mean Square	F	p
Corrected Model	23817.22[a]	2	11908.61	51.93	0.000
Intercept	107819.08	1	107819.08	470.19	0.000
Pre-test Scores	23737.42	1	23737.42	0.15	0.703
Experimental Vs Control Group	33.41	1	33.41	103.52	0.000
Error	70397.38	307	229.31		
Total	826325.00	310			
Corrected Total	94214.60	309			

Dependent Variable: Posttest Attitudes Scores. R Squared = .622 (Adjusted R Squared = .566)

Table 4 computation indicates that both corrected model and the intercept of the variables are significant (P< 0.05). Also, the p-value =0.703 for pretest is greater than the significance level (95% confidence interval) which indicates no significance difference between the experimental and control group GIS pretest achievement scores, F(1,307) = 0.15, p>0.05. After controlling for pretest, the p-value = 0.000 for GIS achievement posttest scores between the experimental and control groups was less than the significance level (α<0.05/95% confidence interval). It posits that there is significant difference between the experimental and control groups academic achievement posttest scores in GIS, F(1,307) = 103, p< 0.05. Consequently, demonstration method of teaching explained 62.2% variance in GIS achievement posttest scores. From the statistics, it means that exposure to demonstration method has effect on the academic achievement test of senior secondary school students in GIS.

Hypothesis 2: There is no significant difference between the mean post-test achievement scores of male and female students in GIS.

Table 5: t-test Analysis of Difference between the Mean Post-Test Achievement Scores of Male and Female Students in GIS

Group	N	$\overline{X}$	SD	Df	T	p
Male	187	56.36	7.50			
				308	3.50	0.000
Female	123	44.39	3.60			

P < 0.05

Table 15 analysis indicates that the p-value = 0.000 is lower than the level of significance (α<.05 / 95% confidence interval) at 308 degree of freedom. Thus, the null hypothesis is rejected and signifies that there is significant difference between male and female students' achievement scores in GIS, t (308) = 3.50, p < 0.05. Male students had higher posttest mean scores (M=56.36, SD=7.50) compared to their female counterparts (M=44.39, SD=3.60) which shows that gender has effects on the academic achievement scores of senior secondary school students in GIS after exposing to demonstration method of teaching.

9. Discussion of Result

Result reveals that students had low academic achievement in GIS but after exposure to demonstration method of teaching by the teacher, students' achievement in GIS was significantly high. In other words, students' achievement was high in GIS when taught using demonstration method. This result is in congruence with the findings of Aladag (2010); Ugwu (2014); Daluba (2013) and Mohammed, Bala & Ladu (2016) on the academic achievement of students in their studies. The result shows that demonstration method gives the students opportunity to repeat what the teacher had done in the class and students who were actively committed to the learning process achieve success.

The result also reveals that male students had higher scores in GIS compared to their female counterparts. This is consistent with the finding of Viehrig (2010), Ballah (2015) and Ugwu (2014) that male students performed better than female students in their studies. This still affirms to a claim that some African societies still perceive science and technology courses as male domain (Nzewi 2010). It also agrees with the finding of a similar study conducted by Mohammad, Bala & Ladu (2016) on the effectiveness of demonstration and lecture methods in learning concepts in economics among secondary school students. The study reported that demonstration method was effective in the learning of economic concepts among secondary school students. Following the outcome of the study therefore, demonstration method of teaching as found to have significant effect on the achievement of senior secondary school students in GIS.

10. Conclusion

It is obvious that demonstration method of teaching allows students' participation and significantly improves students' achievement in Geographic Information System based on this study. The achievement observed in the experimental groups was possible as a result of the opportunity teacher gave students to carry out or repeat activities demonstrated in the course of learning. This outcome is therefore the confirmation that demonstration method focus is to achieve both psychomotor and cognitive objectives that generates great deal of interest and enthusiasm for practice as well as providing skills required for it (Umar 2013). The study therefore serves as empirical evidence that demonstration instructional strategy is one of the best strategies that improves students achievement in the teaching and learning of GIS

The outcome on gender take ones attention to the claim by Nzewi (2010) that the common practice of assignment roles to males and females within most African societies has given rise to perceiving science and technology (including GIS), as a male domain while females tend to stay away which has resulted to differences in their achievement. Male students were observed to have better skills with the accuracy of handling and manipulating the GIS tools used in teaching and this significantly contributed to their high achievement compared to their female counterparts.

11. Recommendations

Based on the findings of the study, the following recommendations are offered:

- Following the fact that demonstration method of teaching was effective in the teaching of GIS, Curriculum planners should ensure that demonstration method is recommended as teaching method for GIS topics and conduct training of geography teachers on the need for the rapid change from using lecture method in teaching of concepts in geography.
- The government, school management bodies, teachers, parents and other stakeholders in education should initiate programmes that are capable of increasing female students' interest, participation and enrolment in science subjects in the secondary schools. This will gradually eliminate a common societal impression that science is a male domain thereby improving female interest in the sciences including GIS.

- Ministry of education and other relevant bodies in the education sector should ensure the supply of science or GIS learning facilities to schools such as textbooks, GPS, Computer systems, power sources, digitizers, scanner and internet facility among many others. This will provide an enabling environment to maximise the full potentials of students in science related subjects and concepts like GIS by improving their interest in such discipline. This will gradually solve the problem of gender-gap among students by developing self confidence in them especially, the female students. When this is done, female students can favourably compete with their male counterparts in GIS.

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