

Effect of GeoTAN Instructional Software Package on Secondary School Students' Interest in Geometry.

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Abstract

This study was carried out to determine the effect of GeoTAN Instructional Software Package (GISP) on secondary school students' interest in geometry and the influence of gender on the students' interest scores. Two research questions guided the study while three hypotheses were formulated and tested at 0.05 levels of significance. The study adopted quasi-experimental (non-equivalent control group) design with a sample of 240 students drawn from a population of 33,074 Senior Secondary School year two (SSS2) students in public secondary schools in Imo State. The data were collected with Geometry Interest Scale (GIS) with a reliability index of 0.75, determined using Cronbach Alpha method. GISP with content validity index of 0.82, determined using Kendall's W method and LPG were used as instructional tools. Mean and standard deviation were used to answer the research question; Two-way Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. Results from data analysis showed that: the students taught geometry using GISP have higher mean interest score in geometry than those taught with CM; $F(1, 235) = 482.024, p < .0005$, with an effect size of 0.67, no significant effect of gender on students' interest scores in geometry; $F(1, 235) = 2.703, P = 0.102$ and the interaction effect of method and gender on students' mean interest score is not significant $F(1, 235) = 0.318, P = 0.573$. Based on the findings, it was recommended that GISP could be used to generate and sustain secondary school students' interest in geometry.

Keywords: GeoTAN Instructional Software Package, Geometry and Interest.

Introduction

GeoTAN Instructional Software Package (GISP) is an instructional software package developed by the researchers based on ADDIE model which runs on computer to teach geometric concepts specifically chord properties, circle theorems and tangent to a circle using text, animation and narration simultaneously to the secondary school students. In other words, GISP is an instructional software package designed by the researchers for delivering instructions on chord properties, circle theorems and tangent to a circle equipped with instructional interactivity, visualization, audio and animation components. The whole essence is to enhance learners' concentration, participation, interactions, simplification, conceptualization and application of information communicated all in a bid to tackle students' poor interest in Mathematics. GISP is designed to enable students move sequentially from one stage of the lesson to another. Furthermore, it features instructional stages, such as presentation of introduction, list of lessons, specific objectives of each lesson, test on previous knowledge (or entry behaviour), content/activity development, using text, narration (voicing) and animation and students' performance activities, lesson evaluation and summary. GISP enables students to work independently and navigate from one stage of the lesson to another using Home, Next, Back and Exit Buttons. It is also equipped with the capacity to evaluate students simultaneously through the

drill component and gives immediate feedback to students' performance as it shows learners whether the option selected is right or wrong. The foregoing implies that GISP is designed to promote student-centred instructional activities wherein students become increasingly in control of their learning as against the conventional lecture method, which is fundamentally teacher-centred, necessitating passive participation among students. This is possible since the GISP features interactivity, individualization of instruction and students' choice of learning materials in line with their intellectual ability (self -pace learning) without teachers' interference which seemingly induces palpable tension. In its evaluation component, GISP is designed to give immediate feedback to students' performance as it shows learners whether the option selected is right or wrong during as well as promoting flexibility in instructional navigation from one link (or lesson sequence) to another using Home, Next, Back and Exit Buttons. The above enumerated benefits of the GISP are in tune with Nworgu (2017) who asserts that modern teaching approach involves the use of various activities that make room for the active participation of learners which enhances meaningful understanding of the lesson. This suggests that GISP presents geometry concepts such that learners participate actively in the lesson.

Geometry is one of the five themes in senior secondary school Mathematics curriculum. Geometry is an organized body of knowledge which describes and measures properties and uses logical deduction to establish a series of results in the form of theorems together with proofs, and some applications (Eniayeju & Azuka, 2010). It provides knowledge for designing Computer Aided Design (CAD), modeling, robotics, medical imaging, computer animation and visual presentation (Jacob, Decl, Bolaji, Kajuru & Musa, 2017). The obvious usefulness of geometry notwithstanding, the achievement of secondary school students in geometry is poor. Over 50% of West African Senior School Certificate Examination (WASSCE) candidates apparently dodge questions from geometry, with particular reference to chord properties, circle theorems and tangent to a circle (WAEC chief examiners report, 2018). Fabiyi, (2017) lends credence to this report by stating that geometry was among the concepts in Mathematics that students perceived difficult to learn. As a result, Nigerian Educational Research & Development Council, (NERDC, 2007) and National Council of Teachers of Mathematics (NCTM), (2013) suggested the use of computer system for instructional delivery in Mathematics particularly the difficult and abstract concepts. This emphasis is predicated on the view that the use of computer system in 21st century learning is a common global trend in pedagogy (Okorie, 2015). Hence, Osibanjo(2020) concluded that computer system should be used in instructional delivery in order to be in tune with the global trend. What this means is that instructional software package should be designed, developed and used in teaching Science, Technology, Engineering and Mathematics in schools in Nigeria.

Computer performs the pedagogic functions using instructional software package. Instructional software package, is, therefore, defined as the combination of one or more files that necessitate the execution of a computer program for the purpose of communicating learning activities, skills and knowledge that are narrowed down to specific content areas to the learners in an interactive manner (Akukwe & Njoku, 2014). This means that the use of instructional software package is intended to make instructional activities learner-centred as against the conventional method which is fundamentally teacher-centred. Voogt, Knezek, Cox, Knezek and Brummelhuis (2011) opined that the use of instructional software package in education is a learner-centred approach. Unfortunately, there is an obvious dearth of relevant instructional software packages that are locally produced for teaching and learning of Mathematics, particularly the geometry in Nigeria. This, therefore, necessitated the development of GISP by the researchers and the determination

of its effect on students' interest in geometry since GISP is designed to present concepts in such a manner that can arouse and sustain students' interest in the subject.

Interest of the students plays an important role in the teaching and learning process. GISP that presents concepts in an interactive manner can possibly arouse and sustain students' interest in the subject. This, therefore, echoes the submission of NERDC (2007) that interest of students in Mathematics should be increased by reducing the abstractness of Mathematics through the use of computer. Interest is defined by Okorie (2014) as the emotional manifestation of ones like or dislike towards an object, activity or a combination of both. Muodumogu and Odey (2018) described interest as emotional manifestation which makes a person to become deeply involved in any activity of concern. Onyemowo and Utulu (2019) buttressed that interest is the disposition a person expresses in a subject. For the purpose of this study, therefore, interest is defined as students' reactions, feelings and impressions relative to geometry contents and concepts as well as the effectiveness of method used by Mathematics teacher. It, therefore, suggests that the degree of interest a student expresses in geometry is defined by the actual value placed on the activity in the subject. The value placement principally comes from the knowledge one acquires through interaction with the activities of interest. For example, interest of students in geometry will manifest when they interactively engage in activities in geometry that will help them acquire knowledge and improve their performances. Okigbo and Okeke (2011) opined that learning occurs when the interest of students is stimulated and sustained. It seems, therefore, that teaching method that provides students with activities that involve them in the teaching and learning process arouses and sustains their interest. Mansukhani (2010) concluded that the creation of an environment whereby learners invent their own knowledge through hands on projects and activities could increase interest. Patrick and Theresa (2015) noted equally that the use of learner centered strategies that involve learner's active participation by the teachers invariably arouse the students' interest. As such, in this study, GISP which is designed in such a manner that presents learning activities such that students are involved in the teaching and learning process is used to teach geometry to students in order to determine if it would enhance their interest in the subject.

Some empirical studies have shown that instructional software increases the interest of the students as compared to the traditional method (Giginna, 2013; Usman, Wishishi, Gambari, & Olayinka, 2017). Gweshe (2014) also reported that instructional software increased interest of students in the study of geometry. Gambari, Falode and Adegbenro (2014) reported, however, that there is no significant difference in interest of student who were exposed to instructional software package and those exposed to conventional method. On the strength of the foregoing, further study on effect of instructional software package on interest and the determination of influence of gender on interest in order to address the gap in findings become necessary.

Gender is an important variable in educational research of which its influence on interest has been subjected to verification. Okoli, (2011) defines gender as all the characteristics of maleness and femaleness a particular society has determined and assigned to each sex. United Nations Educational, Scientific and Cultural Organization, (UNESCO), (2017), opined that the study of Science, Technology, Engineering and Mathematics (STEM) is male dominated and substantiated this submission by stating that 17 women have won a Nobel Prize in physics, chemistry or medicine since Marie Curie in 1903, whereas 572 men have won Nobel Prizes; only 28% of all the world's researchers are women. According to UNESCO, the situation in West African sub-region is even worse as too many girls are held back by discrimination and expectations that influence the quality of education they receive and the subjects they study in

schools. However, Nzewi in Okolie (2018) opined that girls have the capacity to learn as much STEM subjects as boys under the same condition, that it is a function of the brain. The findings of Kocaman and Kızılkaya (2014) and Garba and Muhammad (2015) were contradicted by Maikudi (2015) who reported superiority of females over males in achievement and interest when taught geometry using instructional software package. According to the finding of Maikudi, female students achieved higher and retained more information than male students and equally expressed more interest than male students in geometry. From a neutral stance, Gambari, Shittu, Daramola, and Jimoh (2016) reported that there was no significant influence of gender on the mean achievement and interest scores of students taught Mathematics using instructional software package.

The present study, therefore, is undertaken to determine if the use of GISP, which is interactive and activity-based, will generate and sustain students' interest in geometry. The researcher also attempted to determine the influence of gender on students' interest scores in geometry when taught with GISP. This background has provided a rationale for this study wherein GISP was developed and validated for teaching geometry in secondary schools and determination of its effect on interest of secondary school students in geometry.

Purpose of the Study

The purpose of the study was to determine the effect of GISP on secondary school students' interest in geometry. Specifically, the purpose of the study was to:

1. determine the mean interest scores of secondary school students taught geometry using GISP and those taught using CM.
2. determine the mean interest scores of male and female students taught geometry using GISP.
3. determine the interaction effect of teaching method and gender on mean interest scores of students in geometry.

Research Questions

1. What are the mean interest scores of students who were taught geometry using GISP and those taught using CM?
2. What are the mean interest scores of male and female students who were taught geometry using GISP?

Null Hypotheses

1. There is no significant difference between the mean interest scores of students who were taught geometry using GISP and those taught using CM.
2. There is no significant difference in the mean interest scores of male and female students who were taught geometry.
3. There is no significant interaction effect of teaching methods and gender on mean interest scores of students who were taught geometry.

Research Methods

This study employed quasi-experimental design of the non-equivalent control group approach with pre-test and post-test measures. Non-equivalent control group design is a research design in which non-equivalent intact groups are randomly assigned to treatment groups; and thereafter the intact groups are pretested before treatment and post tested after treatment (Nworgu, 2015). The population of this study was 33074 (15325 males and 17749 females) Senior Secondary two

(SS2) (first term 2019/2020 session) across public secondary schools in Imo State Nigeria. The sample of the study was 240 SS2 students selected through a multistage sampling procedure. In the first stage, simple random sampling technique by balloting was used to select three education zones out of the six in the state. In stage two, purposive sampling technique was used to select 12 secondary schools using the three zones already selected as cluster, based on some predetermined criteria, namely; school type (public school, single sex and co-educational), availability of Information and Communication Technology (ICT) equipment (computer and computer laboratories) and existence of SS2 class. In the third stage, simple random sampling technique by balloting was used to select six secondary schools (two boys and two girls; and two co-educational) from the 12 public secondary schools. In fourth stage, simple random sampling technique by balloting was used to select and assign schools to experimental and control groups. Finally, in the fifth stage, intact SS2 classes from the experimental and control groups were selected. In this case, simple random sampling technique by balloting was used.

Thus, all the streams of SS2 classes in each of the sampled schools were written on slips of paper and put into a bag. Thereafter, one intact class was randomly selected from each of the sampled schools. Moreover, the intact classes in the experimental and control groups were located in different schools very far from one another. Experimental and control groups were taught geometry with GISP and Lesson Plan on Geometry respectively. GISP was face and content validated by educational technologists, computer programmers and Mathematics specialists. Afterwards, a pilot study was carried out with GISP. For this reason, GISP was used to teach 20 SS2 students outside the study area but who shared similar characteristics with the students used for the final study. The content of teaching in this study were topics in geometry particularly chord property, circle theorem and tangent to a circle. The instrument used for collection of data was Geometry Interest Scale (GIS), adapted from Abugu (2017). The instrument is made up of two sections - A and B. Section A was used to obtain bio data of the respondents while Section B was drafted to elicit information from students to determine the students' interest level prior to treatment and after the treatment as well as a 30 item structured questionnaire of the modified Likert four scale response option of Highly Interested (HI = 4 points), Interested (I = 3 points), Not Interested (NI = 2 points) and Highly Not Interested (HNI = 1 point). A student's score was therefore the sum of the weighted alternatives he or she had selected. Establishing the reliability of the GIS, trial testing of the instrument was carried out by administering the instrument on 30 students in Senior Secondary three (SS3). Thereafter, reliability measure of internal consistency was established using Cronbach Alpha analysis which yielded the internal consistency reliability coefficient of 0.75.

Similarly, since the instrument would be used twice, the temporal stability of GIS was established using test-retest. To this end, GIS was administered again on the same students after two weeks. Thereafter, Pearson Product Moment correlation was used to compute the correlation co-efficient(r) of the instrument which yielded 0.81. GIS was administered on the students as pre-test before the treatment and post-test after the treatment. All the data were cleaned to ensure that outliers were not present in the data and negatively worded items were reversed. Afterwards, the data were analyzed using mean, standard deviation and Analysis of Covariance (ANCOVA).

Results and Discussion

Research Question 1: What are the mean interest scores of students who were taught geometry using GISP and those taught using CM?

Table 1: Mean interest rating scores of students taught geometry using GISP and Conventional Method.

Source of Variation	N	Pre-test		Post-test		Mean(\bar{X}) Gain
		\bar{X}	SD	\bar{X}	SD	
GISP	116	22.39	3.21	51.38	3.43	28.99
CM	124	22.59	3.08	29.62	6.00	7.03

The result in Table 1 shows that the pre-test mean interest score of students taught geometry using GISP is 22.39 and standard deviation of 3.21 while the students taught geometry with CM obtained a pre-test mean interest score of 22.59 and a standard deviation of 3.08. The result further shows that the post-test mean interest score of students taught geometry with GISP is 51.38 with a standard deviation of 3.43 whereas the students taught geometry with CM obtained a posttest mean interest score of 29.62 and a standard deviation of 6.00. The result further indicates that the mean gain interest score of students taught geometry with GISP is 28.99 while that of students taught geometry with CM is 7.03. Thus, the students exposed to GISP had higher mean gain interest score than the students exposed to CM.

Research Question 2: What are the mean interest scores of male and female students who were taught geometry using GISP.

Table 2: Mean and standard deviation for interest scores of male and female students taught geometry using GISP and those taught using CM.

Source of Variation	Gender	N	Pre-test		Post-test		Mean(\bar{X}) Gain
			\bar{X}	SD	\bar{X}	SD	
GISP	Male	54	22.63	2.80	52.17	3.01	29.54
CM	Male	57	22.37	3.40	29.75	6.17	7.57
Total		111					
GISP	Female	62	22.18	3.54	50.60	3.62	28.42
CM	Female	67	22.78	2.80	29.62	5.91	6.81
Total		129					

The result presented in Table 2 reveals that the male students exposed to GISP had a pretest mean interest score of 22.63 with a standard deviation of 2.80 and a posttest mean interest score of 52.17 with a standard deviation of 3.10. The mean gain interest score of male students exposed to GISP was 29.54. The female students exposed to GISP had a pretest mean interest score of 22.18 with a standard deviation of 3.54 and a posttest mean interest score of 50.60 with a standard deviation of 3.62. The mean gain interest score of female students exposed to GISP was 28.42. This result shows that male students exposed to GISP had a slightly higher interest than their female counterparts exposed to GISP. Table 2 reveals further that male students exposed to CM had a pretest mean interest score of 22.37 with a standard deviation of 3.40 and a posttest mean interest score of 29.75 with a standard deviation of 6.17. The mean gain interest score of male students exposed to CM was 7.57. The female students exposed to CM had a pretest mean interest score of 22.78 with a standard deviation of 2.80 and a posttest mean interest score of 29.62 with a standard deviation of 5.91. The mean gain interest score of female students exposed to CM was 6.84. This result means that that male students exposed to CM had a slightly higher interest than their female counterparts exposed to CM.

Hypothesis 1: There is no significant difference between the mean interest scores of students who were taught geometry using GISP and those taught using CM.

Table 3: Summary of two-way ANCOVA of interest rating scores of students taught geometry using GISP and Conventional Method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	9889.409 ^a	4	2472.352	141.539	.000	.707
Intercept	1300.830	1	1300.830	74.471	.000	.241
Preinterest	1602.840	1	1602.840	91.761	.000	.281
Method	8419.799	1	8419.799	482.024	.000	.672
Gender	47.207	1	47.207	2.703	.102	.011
Method * Gender	5.554	1	5.554	.318	.573	.001
Error	4104.887	235	17.468			
Total	312703.000	240				
Corrected Total	13994.296	239				

a. R Squared = .707 (Adjusted R Squared = .702)

Table 3 reveals significant main effect of GISP on students' interest in geometry; $F(1, 235) = 482.024$, $p < .0005$, with an effect size of 0.67 (partial eta squared = 0.672). The null hypothesis was therefore rejected. So, there is significant difference between the mean interest scores of students who were taught geometry using GISP and those taught using CM. The result indicates that students who were taught geometry using GISP had higher interest in geometry than those taught using CM.

Hypothesis 2: There is no significant difference in the mean interest scores of male and female students who were taught geometry.

Hypothesis 2 was tested with ANCOVA in order to determine the influence of gender on students' interest scores in geometry and the result of the test is summarized in Table 3. Table 3 reveals that there is no significant effect of gender on students' interest scores in geometry; $F(1,235) = 2.703$, $P = 0.102$. The null hypothesis was not rejected. The result suggests that there is no significant difference in the mean interest scores of male and female students in geometry.

Hypothesis 3: There is no significant interaction effect of teaching method and gender on mean interest scores of students who were taught geometry.

Hypothesis 3 was tested with ANCOVA and the result of the test is summarized in Table 3. Result in Table 3 shows that there is no significant interaction effect of method and gender on students' mean interest scores in geometry; $F(1, 235) = 0.318$, $P = 0.573$. The null hypothesis was not rejected. This means that interaction effect of method and gender on students mean interest scores in geometry does not influence students' interest in geometry.

Discussion

Findings of this study demonstrates that the mean interest scores of the students taught geometry using GISP was higher than those taught with CM. Furthermore, result in Table 3 showed also that there is significant difference between the mean interest scores of students who were taught geometry using GISP and those taught using CM. This implies that method of teaching has significant effect on the interest of the students. In order words, the interest of students in geometry improved tremendously when taught using GISP than when taught using CM. This

finding is in agreement with the findings of Gweshe (2014), Okorie (2014), Nwanne and Agommuoh (2017) who found in their respective studies that students taught using instructional software package method showed more interest in mathematics, chemistry and physics respectively. Perhaps, the reason is that the content of the study in GISP is relevant to the students' learning needs and aspirations. The self-paced learning and principles of over learning inherent in the package, possibly made the students to achieve higher in geometry. In addition, GISP contained activities that aroused and sustained the students' interest both in geometry and the package itself.

On the interest of male and female students in geometry, the finding indicates that male students who were exposed to GISP had higher mean interest score than female students who were exposed to GISP. On the other hand, the male students who were exposed to CM had higher mean interest score than female students who were exposed to CM. Thereupon, ANCOVA was applied to test hypothesis 2 which showed that there was no significant difference between the mean interest scores of students who were taught geometry. This finding suggests that gender does not influence mean interest scores of male or female students who were taught geometry. Perhaps, this is because both male and female worked at their own pace without undue pressure or embarrassment. This finding is in line with the findings of Akgül (2014), Michael, Omiola, Awoyemi & Mohammed (2014), Udobia (2018) who reported respectively that gender had no significant effect on students' interest in Mathematics.

The result of hypothesis 3 shows also that there is no significant interaction effect of method and gender on mean interest scores of students in geometry. This finding is in line with the findings of Giginna (2013) and Nwaodo (2016) who reported in their respective studies that interaction effect of method and gender on mean interest scores of students is not significant. However, this finding is not in agreement with the finding of Onah (2015) who reported that the interaction effect of method and gender on mean interest scores of students was significant. The reason for this difference in finding could be from the instructional software used in these studies. That is, the present study used researcher developed instructional software package whereas Onah used commercialized instructional software package.

Conclusion

Based on the findings presented and discussed in this study, it was concluded that GISP is effective in arousing and sustaining students' interest in geometry without any gender influence.

Recommendations

From the findings of this study, it was recommended that Mathematics teachers should use GISP in teaching geometry in senior secondary school.

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