International Journal of Scientific Research in Educational Studies & Social Development
p-ISSN: 2579-1052 | e-ISSN: 2579-1060
Volume 4 Number 1 July, 2020
IJSRESSD

Effects of Assessment for Learning and Geogebra on Mathematics Achievement and Interest in Colleges of Education in Nasarawa State, Nigeria

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Abstract

The trust of this study focused on the effects of Assessment for Learning (AFL) and GeoGebra on Mathematics Achievement and Interest in Colleges of Education Akwanga, Nasarawa State. Two research questions and two hypotheses were formulated to guide the study. The study adopted quasi-experimental research design. A sample of 110 NCE 2 Mathematics students, 71 from COE Akwanga emerged-experimental group B36, and control group C35 and Hill COE Gwanje emerged experimental group A 39. Mathematics Achievement Test (MAT) and Mathematics Interest Scale (MIS) were used for data collection. The MAT and MIS were validated by two experts. One from Mathematics department, COE Akwanga and the other one from Measurement and Evaluation unit, NSU Keffi which gave 0.78 and 0.82 indices. The reliability of MAT (0.79) was determined through KR21 and MIS (0.82) using Cronbach Alpha. Means and standard deviations was used to answered the research questions while ANCOVA and post hoc test was used for testing the null hypotheses at the 0.05 level of significant. The results of the study revealed that, students taught Mathematics using AFL and GeoGebra software performed significantly higher than those students taught Mathematics using lecture method. Further result showed that high interest of students taught Mathematics using AFL and GeoGebra software performed better than those taught using lecture method. Based on the findings, the following recommendation were made that lecturers should use assessment for learning and GeoGebra software in teaching Mathematics, encouragement in the aspect of comments made by lectures concerning learning outcome/achievement and interest in Mathematics in colleges of education should be implemented.

Keywords: *AFL, GeoGebra, Mathematics, Achievement, Interest*

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Background to the Study

In recent years, advancement in science and technology has made the process of teaching and learning more enjoyable through Information and Communication Technology (ICT) eLearning tools, such as GeoGebra, Course-Lab 2.4 software' which involves the use of Computer system (Galle, 2019). ICT have revolutionized the way people work, and have transformed educational systems by giving easy access to information, creating greater interest in learning content, increasing retention of information, and have made information sharing easier (Watson, 2011). The learners visualize something or an objects which cannot be seen easily in the real world, make learning easier and enjoyable through visual means; and create way for students to understand the innermost movement of an object (Weiss, Knowlton and Morrison 2012).

GeoGebra is free open-source dynamic software for mathematics teaching and learning that offers geometry and algebra features in a fully connected software environment. It was designed to combine features of dynamic geometry software (e.g. Cabri Geometry, Geometer's Sketchpad) and computer algebra systems (e.g Derive, Maple) in a single, integrated, and easy to-use system for teaching and learning mathematics, (Royati, Ahmad, and Rohani 2010).He argued that, students who had learned Coordinated Geometry using GeoGebra achieved significantly better than the students who learned in the traditional teaching method. Even though the use of GeoGebra is time consuming, teaching by using the software can render the students' learning process increasingly active. Moreover, learning mathematics with the help of GeoGebra allows for an active interaction between teachers and students.

Achievement of learners in every college of education in Nigeria is measured depending on the results of their learning outcome at the termination of the learning period, term, academic calendar or at the end of a programme. The level of academic achievement of a learner is determined based on assignment, test/examination scores, and marks or grades assigned by the instructor, lectures or examiner. Achievement is "a result-oriented construct aimed at accomplishing a particular task which terminates at the realization of the attainment of the programme" (Amakiri and Ukwuije, 2016). AFL makes students become more involved in the learning process and from this gain confidence in what they are expected to learn and to what standard. It aims to 'close the gap' between a learner's current situation and where they want to be in their learning and achievement. AFL involves students becoming more active in their learning and starting to 'think like a teacher'. They think more actively about where they are now, where they are going and how to get there.

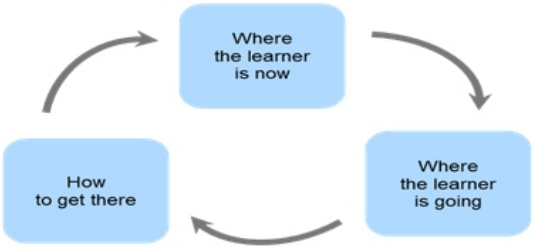

Fig. 1

Effective teachers integrate AFL in their lessons as a natural part of what they do, choosing how much or how little to use the method. AFL can be adapted to suit the age and ability of the learners involved. AFL strategies are directly linked to improvements in student performance in summative tests and examinations. Research shows that these strategies particularly help low-achieving students to enhance their learning (Amakiri and Ukwuije, 2016). He acknowledged that AFL strategies effectively improved biology achievement of students' such as the use of questioning, comment only, marking and self/peer assessment. In line with this finding, Alade and Olagunju cited in (Galle, 2018) reported that there is significant difference in the mean achievement scores of students taught with Peer-Assessment Strategy and there is no significant difference in the mean achievement scores of students taught without Peer-Assessment.

Assessment is the practical application of measurement and just as all testing could be subsumed under assessment, so could all assessment be subsumed under measurement (Chauhan cited in Anikweze, 2015). Assessment is the process of investigating the status or standard of a learner's achievement/attainment or the achievement of a group of learners, where group instructions prevail, regarding expected outcomes which must have been specified as objectives (Anikweze, 2015). Thus, there several specific assessment actions that could transform assessment of learning into assessment for learning as presented by Stiggins (2008 cited Anikweze 2019) which includes the following:

Balanced assessment as to meet the information needs of all instructional decision makers, refined academic achievement standards, Assuring the classroom assessment, Turning the learner into assessors during their learning, rethinking our feedback strategies, building on learners' success as the universal motivator and, Promoting assessment literacy through assessment systems (p 232).

Based on the UK's National Foundation for Educational Research report (NFER 2007), classifies types of formative and summative assessment as either formal or informal in Table 1.

Table 1: Assessment for Learning Strategies

	Formative Assessment	**Summative Assessment**
Informal	Questioning	Essay in uncontrolled conditions
	Feedback	Portfolios
	Peer assessment	Coursework
	Self-assessment	Teachers Assessment
Formal	Further analysis or test, exams,	Test
	Essays	Exams
	Target setting	Essay in controlled conditions

NFER (2007) argued that all of the assessment strategies in Table 1 support AFL if their ultimate use is to help the student progress in terms of their learning. A good example of using a summative assessment strategy in an AFL context is where a test or exam is used to identify a lack of understanding (e.g. in a particular area of the syllabus) and subsequently targets are set

to rectify this." In AFL, it is the purpose of assessment, rather than the nature of it, that is important. NFER (2007), outline five main processes that take place in assessment for learning includes the following:

Questioning enables a student, with the help of their teacher, to find out what level they are at, the teacher provides feedback to each student about how to improve their learning, Students understand what successful work looks like for each task they are doing, Students become more independent in their learning, taking part in peer assessment and self-assessment and Summative assessments (e.g. the student's exam or portfolio submission) are also used formatively to help them improve.

According to Anikweze (2019) defines Assessment For Learning (AFL) as all the systematic process taking by the teacher to assess the learners academic achievement. Black, Harrison, Marshall, Lee and Wiliam (2003), refer to Assessment For Learning "as every exercise embarked on by instructors and learners that serve as information which forms and advances the instruction and study exercise undertaken within the classroom". The currently practiced formative assessment process in Nigeria is mostly the More Frequent Testing and the Effective Data Management Approach. These approaches are traditional formative assessment and have been in use for decades, not only in Nigeria but globally.

Statement of the Problem

In Nigeria, teaching Mathematics in Colleges of Education generally appears to be through conventional lecture method, taking, chalkboard illustrations, demonstrations and other lecturer-centered methods which enable students to only form mental models of concepts presented to them. This method may lead to loss of interest in learning Mathematics as students tend to forget what they learn easily. Therefore, the researchers would investigate the effects of Assessment for Learning (AFL) and GeoGebra on Mathematics Achievement and Interest in Colleges of Education in Nasarawa State, Nigeria.

Research Questions

The following research questions were posed to guide the study.

1. What are the mean achievement scores of students' taught Mathematics using of Assessment for Learning (AFL), GeoGebra software and conventional lecture method?
2. What are the mean interest scores of students taught Mathematics using Assessment for Learning (AFL), GeoGebra software and conventional lecture method?

Statement of Hypotheses

The following hypotheses were tested at 0.05 level of significant

Ho1: There is no significance difference in the mean achievement scores of students' taught Mathematics using of Assessment for Learning (AFL), GeoGebra software and conventional lecture method.

Ho2: There is no significance difference in the mean interest scores of students taught Mathematics using Assessment for Learning (AFL), GeoGebra software and conventional lecture method.

Research Method

The researchers adopted quasi-experimental design involving non-randomized pretest-posttest control group. The target population of the study consisted of 2,269 Mathematics Students in 4colleges of education in Nasarawa State. 1,269 are males' students while 1000 are females,2018/2019 academic session. The sample size of the study consisted of 110 NCE 2 Mathematics students from 2 colleges of education in Akwanga LGA (70 males and 40 female). Before obtaining the sample size of the study, a multi-stage stratified random sampling technique was employed. Nasarawa State was dichotomized into three senatorial zones, that is North senatorial zone, South senatorial zone, and West senatorial zone. Lottery method was used to select one senatorial zone, one Local Government Area and two colleges of education (College of Education Akwanga and Hill College of Education Gwanje) in Nasarawa State to form three groups.

Then,4 Colleges of Education in Nasarawa state were randomly selected through the lottery method. Serial numbers of the elements in the sampling frame were recorded on pieces of papers folded and mixed thoroughly before respondents were asked to pick at once without replacement. This technique gave the respondents equal opportunity of being selected thereby, reducing the bias effect that may interfere with the validity and reliability of the study.

Then NCE 2 Mathematics students in the 2 COEs selected in Akwanga LGA, North senatorial zone of Nasarawa State administered a pre-test and the results of the pre-test were used to identified groups with similar ability. The two COEs NCE2 students identified with a similar ability also demonstrated a similar interest in Mathematics before the study were considered as experimental groups A and B, and the conventional group C. The NCE 2 intact classes in each of the three groups in COEs(Mathematics/Computer, Mathematics/Economics and Mathematics/Geography) identified were clustered according to ability level (high, average and low ability) and randomly assigned to the treatment group (Experimental) and control group (conventional). Specifically, the three intact classes were clustered and randomly assigned to the experimental groups A and B while the three intact classes were clustered and randomly assigned to conventional group C.

Therefore, the experimental group A 39 students (Hill COEGwanje) were exposed to AFL, experimental group B 36 students (COE Akwanga) were exposed to use of GeoGebra software while the conventional group 35 students(COE Akwanga) were exposed to the used of conventional lecture. That is, among the three treatment groups, two groups emerged from COE Akwanga Groups B/C and one group from Hill COE Gwanje as Group A. Two instruments were developed by the researchers for data collection thus: "Mathematics Achievement Test (MAT) and Mathematics Interest Scale (MIS)". The MAT and MIS were subjected to expert's judgment for faced and content validity in Mathematics department, COE Akwanga and Measurement and Evaluation unit, NSU Keffi. The logical consensus of the experts which yielded 0.78 index for MAT and 0.82 index for MIS. The reliability of MAT was determined using KR21 r0.79 index and MIS was determined using Cronbach Alpha r0.82 index. Means and standard deviations was used to answered the research questions while ANCOVA and post hoc mean comparisons test using the Turkey HSD was used to test the null hypotheses at the 0.05 level of significant.

Results

Research Question 1: What are the mean achievement scores of students' taught Mathematics using of Assessment for Learning (AFL), GeoGebra software and conventional lecture method?

Table 2: Mean Achievement Scores for Students in Experimental and Control Group

Groups	Treatment	No of Students	Pretest		Posttest		Achievement Gain
			Mean	SD	Mean	SD	
Exp-A	AFL Vs Geo	39	10.21	5.06	21.81	10.87	11.6
Exp-B	GeoGebra Vs Lecture	36	10.37	4.12	22.48	10.35	12.1
Con-C	Lecture Vs AFL	35	9.41	5.66	16.71	17.17	7.3

Table 2 shows descriptive statistics (means and standard deviations) for difference between mean achievement scores of students taught Mathematics using AFL, GeoGebra software and lecture method had closely achievement after the treatment in the three groups. Experimental Groups, group A used of AFL had 11.6 achievement gain, group B used of GeoGebra software had 12.1 achievement gain and group C lecture method had7.3 achievement gain respectively.

Research Question 2: What are the mean interest scores of students taught Mathematics using Assessment for Learning (AFL), GeoGebra software and conventional lecture method?

Table 3: Mean and Std Dev for Students Interest Score in Experimental and Control Group

Groups	Treatment	No	Pretest		Posttest		Interest Gain
			Weighted Mean	Weighted Std Dev.	Weighted Mean	Weighted Std Dev.	
Exp-A	AFL Vs GeoGebra	39	9.29	11.23	20.81	10.87	11.52
Exp-B	GeoGebra Vs Lecture	36	9.12	11.67	20.48	10.35	11.36
Con-C	Lecture Vs AFL	35	8.51	15.76	16.11	17.17	7.60

Table 3 shows descriptive statistics (means and standard deviations) for difference between mean interest scores of students taught Mathematics using AFL, GeoGebra software and lecture method had closely interest after the treatment in the three groups. Experimental groups, group A used of AFL had 11.52interest gain, group B used of GeoGebra software had 11.36interest gain and group C lectured method had 7.6interest gain respectively.

Testing of Hypotheses

Ho1: There is no significance difference in the mean achievement scores of students' taught Mathematics using of Assessment for Learning (AFL), GeoGebra software and conventional lecture method

Table 4: ANCOVA Result for Mean Achievement Scores of Experimental and Control Groups

Source of Variation	Source of Variation	Df	Mean Square	F	P	Sig
Corrected model	1126.641	3	1026.641	13.41*	.000	0.05
Intercept	102.641	1	102.641	10.8.0*	.000	0.05
Pretest	1092.342	1	1092.342	11.4.0*	.000	0.05
Groups	2126.641	2	126.641	5.64.0*	.001	0.05
Error	2326.320	107	6.320			
Total	2326.320	110				
Corrected Total	5126.423	109				

**Significant at 0.05 level of Significance (P<0.05)*

Table 4 shows results of ANCOVA that with the effect of pretest detached, there is a significant difference in the Mathematics academic achievement of students among the three groups as measured by their posttest scores, as F=5.64.00*, df=2, p=.001<0.05. Therefore, the null hypothesis that states there is no significance difference in the mean achievement scores of students' taught Mathematics using of Assessment for Learning (AFL), GeoGebra software and conventional lecture methodas measured by their posttest scores is rejected and the alternate hypothesis accepted. However, since a significant difference was observed among the 3 groups, there is a need to determine the direction of the significant difference. This was done using post hoc comparison using Turkey HSD, and the result of the comparisons is presented in Table 5.

Table 5: Pair-wise Comparisons of Differences between Mean Achievement Scores of Students in Experiment and Conventional Groups

Groups	Groups	Mean Difference	Sig.
Experimental Group 'A'	Use of AFL	3.5711	.664
	Use ofGeoGebra	4.5711	.664
	Conventional Lecture	-12.1016*	.008
Experimental Group 'B'	Use of AFL	3.5711	664
	Use ofGeoGebra	4.5711	.664
	Conventional Lecture	-12.1016*	.008
Control Group 'C'	Use of AFL	3.5711	.664
	Use ofGeoGebra	4.5711	.664
	Conventional Lecture	-12.1016*	.008

The result of post hoc mean comparisons test in Table5 shows that there is a significant difference between the mean achievement scores of students taught Mathematics using AFL, GeoGebra software and conventional lecture method as revealed by the values 3.5711 and4.5711 in the column labeled mean difference.664and .664in the column labeled sig which is greater than 0.05. However, there is significant difference between the mean achievement scores of students taught Mathematics using AFL, GeoGebra and conventional lecture method as revealed by the mean difference 12.1016* in the column labeled .008in the column labeled sig which is less than 0.05. This means that the mean achievement scores of students in

experimental groups are significantly higher than the mean achievement scores of their counterparts in conventional group.

Ho2: There is no significance difference in the mean interest scores of students taught Mathematics using Assessment for Learning (AFL), GeoGebra software and conventional lecture method.

Table 6: Results of ANCOVA for Mean Achievement Scores of Expert and Control Groups

Source of Variation	Source of Variation	Df	Mean Square	F	P	Sig
Corrected model	1522.01	3	1221.041	13.41*	.000	0.05
Intercept	132.342	1	132.342	10.8.0*	.000	0.05
Pretest	1156.112	1	1156.112	11.4.0*	.000	0.05
Groups	5129.001	2	427.041	4.64.0*	.001	0.05
Error	3926.222	107	7.921			
Total	5343.311	110				
Corrected Total	7126.423	109				

Table 6 shows summary of ANCOVA that with the effect of pretest detached, there is a significant difference in the Mathematics academic achievement of students among the three groups as measured by their posttest scores, as F(4.64.0*), df=2, p=.001<0.05. Therefore, the null hypothesis that states there is no significance difference in the mean interest scores of students taught Mathematics using Assessment for Learning (AFL), GeoGebra software and conventional lecture method as measured by their posttest scores is rejected and the alternate hypothesis accepted. However, since a significant difference was observed among the 3 groups, there is need to determine the direction of the significant difference. This was done using post hoc comparison using Turkey HSD, and the result of the comparisons is presented in Table 7.

Table 7: Pair-wise Comparisons of Differences between Mean Achievement Scores of Experiment and Conventional Groups

Groups	Groups	Mean Difference	Sig.
Experimental Group 'A'	Use of AFL	3.3113	.644
	Use of GeoGebra	4.3378	.644
	Conventional Lecture	-12.1014*	.008
Experimental Group 'B'	Use of AFL	3.3113	.644
	Use ofGeoGebra	4.3378	.644
	Conventional Lecture	-11.1014*	.008
Control Group 'C'	Use of AFL	3.3113	.644
	Use ofGeoGebra	4.3378	.644
	Conventional Lecture	-11.1014*	.008

The result of post hoc mean comparisons test in Table7 shows that there is a significant difference between the mean achievement scores of students taught Mathematics using AFL, GeoGebra software and conventional lecture method as revealed by the values 3.3113 and 4.3378 in the column labeled mean difference.644and .644in the column labeled sig which is greater than 0.05. However, there is significant difference between the mean achievement

scores of students taught Mathematics the three groups as revealed by the mean difference -11.1014* in the column labeled.008in the column labeled sig which is less than 0.05. This means that the mean achievement scores of students in experimental groups are significantly higher than the mean achievement scores of their counterparts in conventional group.

Discussion of Results

Table 2 shows descriptive statistics (means and standard deviations) for difference between mean interest scores of students taught Mathematics using AFL, GeoGebra software and control groups had closely similar interest after the treatment in the three groups. The experimental groups had a higher mean achievement gain scores than the control group as reflect in the Table2. Drawing inferences from hypothesis one in Table 4 shows the effect of pretest detached, there is a significant difference in the Mathematics academic achievement of students among the three groups as measured by their posttest scores, as F=5.64.00*, df=2, p=.001<0.05. Therefore, the null hypothesis that states there is no significance difference in the mean achievement scores of students' taught Mathematics using of Assessment for Learning (AFL), GeoGebra software and conventional lecture method as measured by their posttest scores is rejected and the alternate hypothesis accepted. However, since a significant difference was observed among the 3 groups, there is a need to determine the direction of the significant difference.

The result of post hoc mean comparisons test in Table5 shows that there is a significant difference between the mean achievement scores of students taught Mathematics using AFL, GeoGebra software and conventional lecture method revealed that mean achievement scores of students in experimental groups are significantly higher than the mean achievement scores of their counterparts' inconventional group. Findings is in agreement with the findings of Royati (2010) who's finding indicated that students who had learned Coordinate Geometry using GeoGebra was significantly better in their achievement compared to students who underwent the traditional learning, In the same way, Alade and Olagunju in Galle (2018) who's finding revealed that there is significant difference in the mean achievement scores of students taught with Peer-Assessment Strategy while there is no significant difference in the mean achievement scores of students taught without Peer-Assessment Strategy by integrating ICT into their everyday teaching practice, teachers can provide creative opportunities for supporting students' learning and fostering the acquisition of mathematical knowledge and skills.

Consequently, Table 3 shows descriptive statistics (means and standard deviations) for difference between mean interest scores of students taught Mathematics using AFL, GeoGebra software and control groups had closely similar interest after the treatment in the three groups. The experimental groups had a higher interest gain scores than the control group as reflect in the Table 3. This is an indication that AFL and GeoGebra software as more effects on students' interest in Mathematics related concepts more than the Conventional lecture method. Drawing inferences from hypothesis two in Table 6 shows the effect of pretest detached, there is a significant difference in the Mathematics academic achievement of students among the three groups as measured by their posttest scores, as F=4.64.0*, df=2,

p=.001<0.05. Therefore, the null hypothesis that states there is no significance difference in the mean interest scores of students taught Mathematics using Assessment for Learning (AFL), GeoGebra software and conventional lecture method as measured by their posttest scores is rejected and the alternate hypothesis accepted. However, since a significant difference was observed among the 3 groups.

lastly, the result of post hoc mean comparisons test in Table7 shows that there is a significant difference between the mean achievement scores of students taught Mathematics using AFL, GeoGebra software and conventional lecture method as revealed that the mean achievement scores of students in experimental groups are significantly higher than the mean achievement scores of their counterparts in conventional group. Findings is in agreement with the findings of Amakiri and Ukwuije (2016)who's firings revealed that, Assessment For Learning strategies effectively improved biology achievement of students'; biology academic achievement of students was enhanced by the following AFL strategies: use of questioning, comment only marking and self/peer assessment but the most effective is comment only marking; AFL has a significant effect on biology academic achievement of students. Based on the results of the study

Conclusion

Based on the findings, Assessment for Learning and GeoGebra software strategies are effective in improving and enhancing Mathematics achievement of students in college of education and students taught Mathematics using AFL and GeoGebra software strategies performed better than those in taught using conventional lecture method. The study also acknowledges that there was high level of interest in learning Mathematics among students that were taught with GeoGebra software and AFL than their counterpart in lecture method in COEs.

Recommendations

Based on the findings of the study, the following recommendations were made:

1. Mathematics lecturers should use assessment AFL and GeoGebra software to lecture would stimulates students' interest and encouragement toward learning Mathematics in colleges of education.
2. Comments should be made by lecturers to direct the students on what they need to be done to improve their learning outcome/achievement and interest in Mathematics in colleges of education should be implemented

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