EFFECT OF ANALOGIES AS INNOVATIONAL APPROACH IN ENHANCING STUDENTS' ACHIEVEMENT AND INTEREST IN GEOMETRIC CONCEPTS AMONG TECHNICAL SCHOOL STUDENTS IN BENUE STATE, NIGERIA

Mercy I. Ani, Ijeoma A. Kalu, Roseline I. Iketaku & Abigail C. Obodo

Abstract

Senior secondary school students' achievements in Mathematics continue to fall below expectations, despite several interventions by multiple stakeholders. Hence, there is need to research more innovative teaching strategies in the delivery of Mathematics curricula content. This study, therefore, investigated the effect of analogies in enhancing students' achievement and interest in geometric concepts among technical school student in Benue state, Nigeria. A pretest, posttest, non-equivalent, control group, quasi experimental research design was adopted. Part I technical students (527) from the six technical schools in educational zones A and B in Benue State made up the study population, out of which 121 students were randomly sampled from four technical schools participated in the study. Two validated instruments; the Geometry Concept Test (GCT) and Geometry Interest Scale (GIS) were used for data collection. The reliability coefficient of the GCT was 0.75 using Kuder Richardson's formula 20, while the GIS had a Chronbach Alpha reliability coefficient of 0.85. Data collected were analysed using Mean, Standard deviation, and Analysis of Covariance (ANCOVA). The findings of the study revealed that students taught using Analogical Teaching Approach (ATA) achieved higher than students taught using conventional methods. Further findings also showed that the experimental group had higher interest than the control group. Based on the findings of the study, it was recommended that Federal, State and local government authorities in charge of education should organize frequent workshops, seminars for both teachers and students until everyone has mastered the analogical teaching approach and its application in understanding of Mathematics.

Keywords: Analogies, Innovational Approach, Student, Achievement, Interest, and Geometric Concepts

Introduction

Mathematics, a science subject that deals with numbers, is one of the key components of human learning. Hence, in addition to its place as a compulsory subject in Nigerian primary and secondary schools, a credit pass in it is as well a compulsory requirement for admission into science related courses in Nigerian universities. Hence a failure in it is a major obstacle to admission into the university and even getting a job. The study of Mathematics education involves such contents as quantity, structure, space and change (Agwagah, 2008). According to Agwagah, the major branches of Mathematics include Arithmetic, Algebra, Geometry and Analysis. The overall aim of these branches is to train students in thinking process through the use of mathematical skills which involves identification, description, tackling and solving problems (Adelodun, 2014).

Mathematics is everywhere and very useful in our daily living, and its role of Mathematics towards technological and industrial development cannot be overemphasised, especially at the different levels of education. Ojimba (2012) supported this fact by submitting that actual technological development would be impossible without Mathematics. Geometry, a branch of Mathematics, is one of the major themes in the Mathematics curriculum at the senior secondary school levels. The knowledge of geometry is applicable to day-to-day activities such as approximating the exactness of phenomena, estimation of distance, measurement of length and height, etc. geometry is very important in science and other related disciplines for human and societal development. Despite the relevance of geometry, there have been unsatisfactory remarks concerning secondary students' attempts of geometry questions in standardised examinations like West African Senior School Certificate Examinations (WASSCE). The poor achievement in Mathematics according to WAEC Chief Examiners Reports (2007 – 2015) could be associated to geometry questions arbitrarily attempted by the students. Musa and Bolaji (2015) also contended that few students who attempt geometry questions display weakness in answering while others avoided questions on geometry. In spite of the important place on Mathematics in our educational system, students in secondary schools continually perform poorly at SSCE and other external examinations (Mefor, 2014). The consistent unsatisfactory low performance in geometry questions during Mathematics examinations has been linked with many factors. Prominent among them is method of teaching Mathematics concepts.

The methods used in teaching Mathematics, attitude of Mathematics teachers and students lack of interest in Mathematics leads to poor performance in Mathematics (Mbugua, Kibet and Nkonke, 2012). One of the important variables in learning is interest, since individuals tend to perform better in activities they are interested in. Simple statements made by individuals about their likes and dislikes can reveal their interest. In terms of learning, Chukwu (2001) noted that lack of interest in school subjects may be as a result of uninteresting teaching methods and incapability of parents

to meet with the financial demands of the subjects. Also, Landsford (2005) contended that interpersonal relationships whether positive or negative in nature, have profound effects on quality of life and achievement of students academically. Good interpersonal relationship with students is a leeway for the teachers' ability to create conducive classroom environment where students will be given the opportunity to manipulate materials, discuss results, take rational decisions, relate their constructed ideas to societal needs and hence develop the capability of solving problems in a dynamic society. Students' poor performance in Mathematics is a result of poor and ineffective instructional skills and methodologies by the Mathematics teachers. The way and manner Mathematics is being taught in schools left much to be desired.

Thus, efforts are being made by educators to improve students' performance through the use of appropriate teaching methods and approaches that will elevate students' interest and facilitate learning and enhance performance. Some of the teaching methods and approaches investigated include guided inquiry, discovery, expository/conventional, target task, laboratory methods, Polya problem solving to mention just a few (Suleiman and Hammed, 2019).

Although many of these methods have been in use for years, WAEC chief examiners annual report (2014) and comments still showed that students, performance in geometry section of the Mathematics examinations have not improved. This necessitates further investigations on the effectiveness of other innovative teaching methods and approaches on students' interest and performance in geometry. The researchers therefore proposed the need for studying the use of analogies as a teaching approach leading students to relate concepts to their past experience and discover facts for themselves. The study was carried out in Benue State of Nigeria. This area is chosen because not much work has been done in terms of educational research in this area.

The study aims at examining the effect of analogical teaching approach on students' achievement and interest in geometry. In specific terms, the study sort to investigate the effect of analogical teaching approach on students' achievement in geometry and the effect of analogical teaching approach on students' interest.

Research Questions

The research questions addressed in this study are:

1. What is the difference in mean scores of students taught mathematics with ATA and those with conventional method?

2. What is the difference in mean scores of analogical teaching approach (ATA) on part 1 technical students' interest in technical schools?

Research Hypotheses

The following null hypotheses tested at 0.05 level of significance guided the study:

$Ho_{1:}$ The mean achievement scores of part I students who receive geometry instruction using analogical teaching approach do not differ significantly with those taught using conventional methods to their counterpart who received instruction with the conventional method.

$Ho_{2:}$ The mean interest ratings of part 1 students who receive geometry instruction using analogical teaching approach will not differ significantly with those taught using conventional methods to their counterpart who received instruction with conventional method.

Methods

The design employed for the study was quasi-experimental research. Specifically, the design for this study is a non-equivalent pretest posttest control group design. Quasi-experimental design, according to Ali (2006), is a design that uses non-randomised group. This design is suitable for the present study because the researcher made use of intact classes. The study was carried out in two educational zones A and B of the State out of the three zones. The choice of the two zones was based on the fact that the zones were mostly populated with technical schools. The populous technical schools in the zones also gave sufficient sample size for more reliable result size was 527 students from six technical schools. This population constituted part I students because the students are not in final examination class, so they are more favorably disposed to be involved in the study. The sample composed 121 students, who were randomly selected among part 1 technical students from the four technical schools included in the study. The four schools were as well randomly selected from the six technical schools of the two zones by simple balloting. The sampled schools were lettered A, B, C and D. Schools A and B, with a total of 59 students selected, were used as experimental group while Schools C and D, with a total of 62 students as control group. Based on trade's shops, learners in technical schools are classed as follows: agricultural mechanisation (AM), fabrication and welding (FW), electrical installation (EI), motor mechanisation (MM), radio and television (RTV), fitting and machining (FM), refrigeration and air conditioning (RAC), carpentry and joinery (CJ). In each school, only one class of any shop was selected for the study by simple balloting. Two instruments – Geometry Concept Test (GCT) and Geometry Interest Scale (GIS) – were used for data collection. The test was developed by the researchers based on the test blue print and lesson plans prepared by the researchers. The initial draft of the GCT Instrument consisted of 35 items. This was modified sequel to content validity and item analysis. Final draft of 20 items was then considered out of the initial pool. GTC was used to establish the achievement while GIS was used to measure the interest.

Table 1: Table of specification for GAT instrument

Content dimensions No	Topics	No. of periods	Wks	Ability dimensions Lower cognitive KL	CR	AP	Higher cognitive AN	SYN	EVA	Total
1	Identification and drawing of solid figures e.g cuboid, cylinder, cone, pyramid, prism, hemisphere and frustum of cone and pyramid.	8	2		4	1	3	1	1	10
2	Calculate the volume of solid figures.	8	2	1		3	2			6
3	Calculate volume of solid figures.	8	2				1	2		3
4	Calculate the volumes of containers and hollow bricks	8	2					1		1
	Total	32	8	1	4	4	6	4	1	20

The reliability of the test items was determined using Kuder-Richardson formula 20 (KR-20). The reliability coefficient of 0.75 was obtained. Also, is liability coefficient of 0.85, which showed that the instruments were reliable, was obtained using Cronbach Alpha technique for the Geometry Interest Scale. During the actual research work, the students in the treatment and control groups were pretested with the final draft of the GCT instrument before commencing treatment. The questions were retrieved from the students after the pretest. The treatment of this study involved teaching geometry concepts using analogical teaching approach (ATA) to experimental group while the control group was taught the same concepts using the conventional teaching method like lecture method. The results of the GCT items were obtained from the pretest and post-test were scored out of 20 points. That is, each option or rightly chosen by the subject carries one point, while those obtained wrongly carries no point (zero point). The options of the GIS are done using four points Likert Scale; Strongly Agree (SA = 4), Agree (A = 3), Disagree (D = 2), Strongly Disagree (SD = 1) for a positive item and revised is the case for a negative item.

The extraneous variables threats minimise the direct impact between the independent (teaching methods) and the dependent (achievement) variables such that their full effects are not realised. These threats include initial groups' non-equivalence of the subjects, researcher's selection bias, statistical regression and pre-test sensitisation. These threats are discussed as follows: (a) the non-equivalent control group design used for this study does not permit randomization of subjects into treatment and control

groups. Therefore internal validity threats of initial group equivalence and researchers' selection bias was controlled through the use of pre-testing to obtain base-line knowledge of each subject in the study (b). Pre-testing the subjects so as to obtain a base-line data on the subject may sensitise students for post-testing, which is a threat to internal validity. This threat of pre-testing sensitisation was checked by using different teachers to invigilate the students in the post-test, after re-shuffling the GCT items. In addition, the questions administered were collected from the students after the pre-test. The time interval of eight weeks between the two tests also minimised this threat. The internal validity threat of statistical regression as a result of the pre-test was also controlled. The use of ANCOVA controlled this threat. Other extraneous variables such as teachers qualification, school environment, infrastructure and school administrative set up, which may influence this study were minimised through the use of the training programme and monitoring the treatment and control groups by the researchers. The teachers who were given proper and adequate training were warned on the need to adhere strictly to instructions and keep to the teaching methods specified for a particular group. Thus, the researchers continuously and constantly monitored the schools throughout the treatment to check experimental and control groups. Data collected for the study were analyzed using Mean, Standard and Analysis of Covariance (ANCOVA). The null hypotheses were tested at $p < 0.05$ level of significance.

Results

Research Question One

What is the difference in mean scores of students taught mathematics with ATA and those with conventional method?

Table 2: Mean and Standard Deviation Pretest and Posttest of Experimental and Control groups in the Geometry Concept Test (GCT)

	Group	Mean	Std. Deviation	N
GCT Pretest	Control group	1.6774	1.30289	62
	Experimental group	2.8983	1.37333	59
	Total	2.2727	1.46629	121
GCT Posttest	Control group	4.9677	1.70792	62
	Experimental group	11.6271	2.52504	59
	Total	8.2149	3.96696	121

The data presented in Table 2 above shows that the mean scores of pretest (GCT) for the experimental group was 2.90 with standard deviation of 1.37, while the control group pretest mean was 1.68 and a standard deviation of 1.30. This implies that at the beginning of the study, the participants had almost the same geometric knowledge level. After the treatments were given, the experimental group mean was 11.63 with standard

deviation of 2.53 while the control group mean was 4.97 with standard deviation of 1.71. This result shows that the mean achievement scores of experimental group is higher than that of the control group. To explore for treatment gain while controlling for pretest scores, adjusted means are calculated as below:

Table 3: Adjusted means and standard errors on GCT

Control and Experimental groups	Mean	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
Control group	5.030(a)	.287	4.462	5.597
Experimental group	11.562(a)	.295	10.979	12.146

a Covariates appearing in the model are evaluated at the following values: GCT Pretest = 2.2727.

From the Table 3, the difference between the adjusted means is the treatment gain which is 6.532. To investigate further whether the noted difference in the students' means achievement is statistically significant, hypothesis one was tested:

Hypothesis One

The mean achievement scores of Part 1 students who receive geometry instruction using analogical teaching approach do not differ significantly with those taught using conventional methods**.**

Tests of Between-Subjects Effects

Table 4: ANCOVA for GCT scores

Source of Variation	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power(a)
Corrected Model	1342.978[a]	2	671.489	145.271	.000	.711	290.542	1.000
Intercept	1977.426	1	1977.426	427.799	.000	.784	427.799	1.000
GCT Pretest	2.297	1	2.297	.497	.482	.004	.497	.108
Group	1064.780	1	1064.780	230.356	.000	.661	230.356	1.000
Error	545.435	118	4.622					
Total	10054.000	121						
Corrected Total	1888.413	120						

a. R Squared = .711 (Adjusted R Squared = .706)

Table 4 reveals that $F_{(2,121)} = 145.271$ was significant ($p < 0.05$), while the effect of the effect of the covariate, GCT Pretest ($F = .497$; $p > .05$) was not significant. This implies that the mean achievement scores of Part 1 students who received geometry instruction using analogical teaching approach did differed significantly. Therefore the stated hypothesis H_{01} is rejected.

Research Question Two

What is the difference in mean scores of analogical teaching approach (ATA) on part 1 technical students' interest in technical schools?

Table 5: Mean and Standard Deviation Pretest and Posttest of Experimental and Control groups in the Geometry Interest Scale (GIS)

	Groups	Mean	Std. Deviation	N
GIS Pretest	Control group	29.6290	5.53153	62
	Experimental group	28.2373	6.17095	59
	Total	28.9504	5.86920	121
GIS Posttest	Control group	48.7742	9.68253	62
	Experimental group	61.8814	7.69927	59
	Total	55.1653	10.93568	121

From table 5 above, the pretest mean scores in the experimental group was 28.24 with standard deviation of 6.17 while in the control group the mean pretest GIS scores was 29.63 with standard deviations of 5.53. This means that at the beginning of the study, the students were almost at the same level in their interest in geometry before the commencement of the study. After the treatments were given, the experimental group means was 61.88 with standard deviation of 7.70 while the control group's mean was 48.77 and a standard deviation of 9.68. The result shows that the experimental group had a higher mean achievement than the control group. To further ascertain whether the noted difference in the students' interest is statistically significant, hypothesis two was tested:

Hypothesis Two: The mean interest ratings of Part 1 students who receive geometry instruction using analogical teaching approach will not differ significantly with those taught using conventional methods to their counterpart who received instruction with conventional method.

Table 6: Covariance (ANCOVA) for GIS scores

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power(a)
Corrected Model	5212.172[a]	2	2606.086	33.651	.000	.363	67.302	1.000
Intercept	13333.779	1	13333.779	172.171	.000	.593	172.171	1.000
GIS Pretest	18.486	1	18.486	.239	.626	.002	.239	.077
Group	5193.609	1	5193.609	67.062	.000	.362	67.062	1.000
Error	9138.522	118	77.445					
Total	382579.000	121						
Corrected Total	14350.694	120						

a R Squared = .363 (Adjusted R Squared = .352)$p<0.05$

The data presented in Table 6 above, shows that The difference between the interest scores of the experimental and control groups $F_{(2,121)} = 33.651$ was significant ($p < .05$), while the effect of the covariate GIS Pretest ($F = .239$) was not significant ($p > .05$). The null hypothesis H_{02} is also rejected.

Discussion of Findings

Based on the findings of the study, the results showed that teaching method is an important factor to consider in students' achievement in geometry. This result is in line with Ugwuadu (2010) who concluded that students who received instruction using concept mapping, guided discovery and inquiry method concept had better performances compared with those who received instruction with conventional methods. The success of the experimental group over the control group could be due to the fact that the experimental group was provided with variety of analogical materials, appropriate reasoning, and step-by-step transfer of knowledge to the problem at hand that facilitated understanding and retention of what has been learned.

Regarding students' interest, table 5 revealed that students taught geometry with analogical teaching approach had enhanced interest score of (61.95) more than those who received instruction on geometry with conventional method (47.06). The reason may have been that the students were curious and anxious to transfer knowledge from what they know to the problem at hand with the use of analogies. These made them to understand faster as they form mental pictures of the concepts correctly. Their high interest must have contributed immensely to the high achievement. This agrees with Waseka, Simatwa and Okwach (2016) who concluded in their investigation that students who are properly handled and taught well are bound to develop a high interest for that subject and the teacher who taught it than those who are poorly managed.

Conclusion

Geometry is a branch of Mathematics: its knowledge and applications are needed for individual and societal developments. Analogical teaching approach performed better than the conventional method in enhancing students' achievement in geometry. Analogical teaching approach also enhanced students' interest in Mathematics more than the conventional method. This may imply that students achievement in geometry is related to the way and manner (method) the concept are presented

Recommendations

Based on the findings of this study, the researchers put forward the following recommendations:

1. The method of the analogical teaching approach should be sustained due to its application in understanding of Mathematics concepts.
2. Mathematics teachers should endeavour to use analogy method in teaching difficult Mathematics themes. Since this method enhances achievement and interest and has the potentials of developing critical thinking, in-depth understanding and creative abilities in the students.
3. Primary, secondary, technical and teacher training colleges should include the use of analogy technique in their Mathematics education programme and expose such technique to their students and teachers.
4. Federal and State Ministry of Education should organize periodic in-service training as well as regular workshops; seminars and conference to update teachers' knowledge on the effective use of innovative teaching methods and other current trends in education.

References

Adelodun, O. A. (2014). Relevance of the mathematics education programmes of the Nigerian colleges of education to the teaching of junior secondary mathematics. *Journal of Education and Practice*, 5(7), 24-28

Agwagah, U. N. V (2008). Mathematics beyond calculation: aesthetic values. Abacus: *The Journal Mathematics Association of Nigeria,* 33(1), 70-79.

Ali, A. (2006). *Conducting Research in Education and the Social Sciences*. Enugu: Tashiwa Networks Ltd.

Chukwu, J. O. (2001). Effect of selected local games on primary school pupils' achievement and Interest in subtraction Operation. Unpublished Ph.D. Thesis, University of Nigeria, Nsukka.

Landsford, J. E. Antonucci, T. C., Akiyama, H. & Takahashi, K. (2005). A quantitative and qualitative approaches to social relationships and well-being in the United States and Japan. *Journal of Comparative Family Studies,* 36(1), 1–22.

Mbugua, Z. K. Kibet, K. & Nkonke, G. R. (2012). Factors contributing to students' poor performance in mathematics at kenya certificate of secondary education in kenya: a case of Baringo County, Kenya. Retrieved on 19th October, 2014 from http://www.aijcrnet.com/journals/Vol_2_No_6_June_2012/11.pdf

Mefor, C. (2014). Nigeria: Identifying Problems of Poor Performance in Mathematics and Way Out. Retrieved on 19th October, 2014 from http://allafrica.com/stories/201101200591.html

Musa, D. C. & Bolaji, C. (2015). Effect of laboratory approach on junior secondary school students' achievement in geometry and mensuration in Kefi education

zone, Nasarawa state. ABACUS: *Journal of the Mathematical Association of Nigeria*, 40(1), 328 – 339.

Ojimba, D. P. (2012). Strategies for Teaching and Sustaining Mathematics as an Indispensable Tool for Technological Development in Nigeria. Retrieved on 19th October, 2014 from http://www.mcser.org/images/stories/MJSS

Suleiman, Y & Hammed, A. (2019). Perceived causes of students' failure in mathematics in Kwara state junior secondary schools: implication for educational managers. *International Journal of Educational Studies in Mathematics,* 6(1), 19-33.

Ugwuadu, O. R (2010). The effect of guided inquiry and lecture methods on students' academic achievement in biology: a case study of Yola north local government area of Adamawa state. *Knowledge Review,* 21, 107-114

West African Examinations Council, (WAEC, 2010 - 2015). West African Examinations Council *Chief Examiners Report* Lagos.

Waseka, E. L. Simatwa, E. M. W. & Okwach T. O. (2016). Influence of teacher factors on students' academic performance in secondary school education. a case study of Kakamega County, Kenya. *Greener Journal of Educational Research, DOI: http://doi.org/10.15580/GJER.2016.4.060216102*