



Effect of Polya Model on Senior Secondary School Students' Academic Retention in Trigonometry in Kano State, Nigeria

S.I. Maruta ^a & A. A. Magaji ^b

^a Department of Mathematics, Federal College of Education Kano.

^b Department of Statistics, Kano University of Science and Technology Wudil.

Corresponding Author: simaruta@gmail.com

Abstract

The study examined the effect of Polya Model on Senior Secondary School Students' Retention in Trigonometry in Kano State. Quasi-Experimental Design was adopted. The study comprised a total of 9,770 SSII students from 25 senior secondary schools. A sample of 130 students of four intact classes were used. Two of the classes were from girls' schools for experimental and control groups and the remaining two were from boys' schools. One research question and null hypothesis were formulated, answered and tested at $p \leq 0.05$. Trigonometry Performance Test with reliability index of 0.86 was used for data collection. ANCOVA was the Statistical tool used. Results indicated that significant difference exists between mean retention scores of male and female students taught Trigonometry using Polya Model and those taught using Lecture. Students taught using Polya retained significantly better than those taught using Lecture Method. It was recommended that seminars be organised on Polya Model deployment.

Keywords: Male, Female, Polya Model, Retention and Trigonometry.

Introduction

Mathematics can be defined as a subject that encroaches into all aspects of human endeavour. It could also be described as the life wire in the studies of various disciplines. It is this importance of mathematics that compelled the Federal Government of Nigeria to make mathematics a compulsory subject from primary school through to the end of senior secondary school education (Bakke & Igharo, 2013).

Despite the relative importance of mathematics, it is very disappointing to note that academic performance and retention in the subject based on gender have remained consistently low, as persistently being reported by the West African Examination Council, 2005-2013. Retention, which is the act of retaining, may be defined according to Bichi 2002 as the act of "absorbing and holding" or "continue having holding"

Bichi (2002) sees retention as the ability to retain and later recall information or knowledge gained after learning. The initial stage of memory process is learning. If there is no sufficient intelligence for learning, there can be no retention. Conducive atmosphere is one of the key determinants of such sufficient intelligence for effective teaching and learning. Bichi (2002) is of the view that, "permanent and meaningful learning is the target of our educational endeavour". Understanding and retention are the products of meaningful learning when teaching is effective and meaningful to the students.

According to Aggarwal (2007) "the term retention is the process of relegation of the past experience in the sub-conscious mind of the individual in the form of mental experience." It is worrisome seeing students' consistent poor achievement and retention in this all-important subject (Mathematics).

Retention as a variable is the ability to remember things, task or material learned previously. In other words, it is the endurance of behaviour, which have been learned or acquired when the behaviour is not being utilized.

Retention ability involves the ability of learners to remember an instruction given. It is the ability of learner to demonstrate his/her cognitive skills in the subject. The process of retention has been described by Rundell, Michael and others (2004) as the ability to remember ideas and facts. Retention therefore, depends mainly on the teaching strategy adopted by the teacher. According to Akubuilu (2004), any instructional model, which elicits adequate student participation, has profound effects on students' retention ability. In the context of this work, retention refers to the act of absorbing, holding, or continuing to hold or have facts or things learned.

The strategy used in teaching Mathematics plays a great role in students' academic retention. The traditional lecture method only encourages students to be passive information receivers.

According to Abdullahi (2003) using concrete objects in learning leads to better retention of information and development of favourable attitude toward science and technology. Ezeamenyi (2004) stressed that failure to provide enough applications

to real life activity and social usage cum poor teaching techniques are strong limiting factors to students' retention in Mathematics. He contended that for the improvement of retention of learned materials in Mathematics, activity-based learning is indispensable. In support of this view, Akinsola and Popoola (2004) have observed that students' performance in Mathematics becomes poorer as the test items moved from those requiring ability to recall to those involving some understanding and problem solving. It is for these reasons and considering the number of learning activities involved in Polya Model that the researchers selected and determined the effect of Polya Model on Male and Female students' academic retention. The effectiveness of the model was compared with that of the Lecture Method.

Statement of the Problem

One of the goals of Mathematics teaching and learning is to develop the ability of learners to recognize a problem and apply the knowledge of mathematics to get the solution to the problem. The researchers believe that, if students are given the opportunity to experience mathematics through Polya during mathematics lessons, their academic retention will improve and their 'mathematics phobia' and sense of difficulty in the subject will vanish leading to greater positive productivity in all examinations. To achieve these goals, teaching through Polya Model is paramount. This is because the strategy in which the students are taught mathematics plays a great role in influencing their academic retention, attitude and performance. Therefore, learning mathematics will remain ineffective without an appropriate teaching strategy. Through Polya Model, learners are exposed to a different strategy for solving problems. They become curious to see the nature of solutions they get to challenging problems. With time, the learners are motivated to solve variations of given problems and then more complex problems. This means that learners refine and sharpen their problem-solving skills by solving more problems and this forms the basis for future problem-solving endeavours.

Objective of the Study

The usefulness of the application of trigonometry in our day-to-day activities and the role plays by trigonometry in other subjects, especially when the activities have to do with measurements of lengths, heights, angles and directions of an object cannot be over emphasized.

For these reasons and many others, it is necessary for any student to learn trigonometric concepts using

activity-based method, so that the concepts learnt could be remembered, retained and recall at any point in time. Unlike Lecture method, learning trigonometry using Polya model provides the students with opportunity for active participation in the learning process.

Trigonometry is a branch of mathematics which deals with the relationships between lengths, angles and triangles etc. Ginsburg, H.P. (2016). According to Acharya (2015) and Courtney (2016), Trigonometry helps students to develop the capacity of visualizing any mathematical contents differently. Basically, the contents in the trigonometry are based on the concepts of right-angle triangles. Bhat (2017). Therefore, learning trigonometry implies understanding symbols, language, relationships, identities, equations and other verbal problems.

Trigonometry according to Gur (2009), is still considered difficult by high school students, although it has been taught starting from the elementary school level. He further explained that the poor skills of students in organizing and utilizing of learnt facts, formulae and concepts of trigonometry into new situation such as for solving new formula and proving theorems/identities had made difficulties to learn Trigonometry.

In order to reduce or eliminate some of the difficulties and encourage knowledge retention in learning Trigonometry, the use of an appropriate method /strategy that involves students' active participation in the learning process is paramount.

The objective of this study was to examine the effects of Polya Model on Male and Female students' academic retention and compare the effectiveness of the model with Lecture Method when used in teaching Trigonometry.

Research Question

What are the differences between the mean academic retention scores of male and female students when taught trigonometry using Polya Model and those taught using Lecture Method?

Hypothesis

H₀: There is no significant difference between the mean academic retention scores of male and female students when taught Trigonometry using Polya Model and those taught using Lecture Method

Research Methodology

Quasi experimental design non randomized was adopted for this study. The study comprised a total of 9,770 SSII students from 25 senior secondary schools. A sample of 130 students of four intact classes were used. Two of the classes were from

girls' schools for experimental and control groups and the remaining two were from boys' schools. This was due to lack of adequate number of public coeducation senior secondary schools in the state. Otherwise, two intact classes from two coeducational senior secondary schools could suffice. The population of the SSII students in the metropolis as at the time of the study was 9,770. Two groups were involved for the study namely, experimental and control groups. The experimental

groups were taught Trigonometry using Polya Model while the Control groups were trained the same concepts of Trigonometry but using the conventional Lecture Method. The experimental group consist of 60 students (30 males and 30 females), while the control group consist of 70 students (35 males and 35 females) respectively. The teaching using Polya Model was guided by Polya's' principle of teaching (stages 1-4) as shown below:

Stage	Components of the Model	Students' Activity
1	Understanding the problem	Read the problem and identify the unknown. Can you state the problem in your own words?
2	Devising a plan or making a plan	Do you need a diagram? Restate the problem, make a representation of the strategy to employ. Do you use all the data, conditions etc.?
3	Carrying out the plan	Carry out the strategy identified and check each step. Are the steps taken correctly? Can your plan be proved correctly?
4	Looking back	Check the solution obtained and verify, if the strategy used lead to desired goals. Can you use the method for some other problems?

The instrument used to collect data for the study was Trigonometry Performance Test (TPT) with reliability index 0.86. The instrument consisting of 20 items was developed by the researchers based on the SSII Mathematics Curriculum in Trigonometry. The items were constructed using Bloom's cognitive level lower and higher order questions. The lower order questions covered knowledge and comprehension of the cognitive domain while the higher order questions covered applications and analysis. The 20 items were multiple-choice objective questions with five options (A, B, C, D& E). The TPT was scored out of 100% which means each correct answer is 5marks. The items were scrutinized and validated by the experts (Mathematics Educators) in the faculty of education, Ahmadu Bello University Zaria. The validated TPT was pretested in a pilot study and the reliability coefficient index was computed using PPMC to be 0.86. The reliability coefficient showed that the instrument was reliable and could therefore be used for the main study (Olayiwola, 2010). The four

schools were pretested using (TPT) before the commencement of the treatment and the result was analysed using ANOVA at $P \leq 0.05$ significant level to justify that the four schools were not significantly different in ability level. The result of the ANOVA analysis was presented as shown in the **appendix**. Later the two groups were exposed to six weeks' treatment by the research assistants who were trained by the researchers for a period of two weeks before the commencement of the experiment. At the end of the 6 week treatments Posttest was administered to the two groups and determined the performance effect of the treatments. After two weeks of no treatment the same questions were reshuffled, administered as post-posttest and determined the retention effect.

Results

To answer the research question, mean retention difference scores of students' retention was used.

Table 1: Mean Retention Scores of Students in Trigonometry for Polya Model and Lecture Method

Gender	Group	N	Mean Post-Posttest	Mean Difference Retention Scores
Male	Expt.(Polya Model)	60	28.88	19.11
	Contr. (Lecture Method)	70	9.77	
Female	Expt.(Polya Model)	60	20.43	9.57
	Contr. (Lecture Method)	70	10.86	



Contr. (Lecture Method)	70	10.86
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Table 1 shows that the mean Postposttest (retention) scores of 28.88 and 20.43 for male and female students taught Trigonometry using Polya model were higher than 9.77 and 10.86 mean postposttest (retention) scores of Male and Female students when taught Trigonometry using Lecture Method. The retention mean difference scores 19.11 for male and female students when taught using Polya Model was higher than the mean difference retention score

of 9.57 obtained using Lecture Method. Which indicate that Polya Model has positive effects on students in learning Trigonometry. The results also showed that both Male and Female students taught Trigonometry using Polya Model retained better than their Male and Female counterparts when taught the same Trigonometry concepts using the Lecture Method.

Table 2: ANCOVA Summary of effects of Polya Model and Lecture Method on Students Postposttest (Retention) Scores in Trigonometry.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	15045.904 ^a	3	5015.301	97.751	.000
Intercept	79008.528	1	79008.528	1539.913	.000
Gender	876.067	1	876.067	17.075	.000
Groups	13294.725	1	13294.725	259.120	.000
Gender*Groups	1471.802	1	1471.802	28.686	.000
Error	13134.631	256	51.307		
Total	106377.000	260			
Corrected Total	28180.535	259			

a. R Squared = .534 (Adjusted R Squared = .528)

Table 2 shows that at 0.05 level of significance for df 1, the P-value 0.000 is lower than the 0.05 alpha significance, and the computed F value of 28.686 is greater than 3.000 F critical value at df 1. Therefore, the null hypothesis which state that there is no significant difference between male and female students' retention (Post-Post-test) scores was rejected.

Discussion

The results implicated method of teaching as a major factor affecting students' academic retention in Mathematics. The findings of this study revealed that significant difference exist between the academic retention of Male and Female students when taught Trigonometry using Polya Model and those taught using Lecture Method.

The findings further revealed that, students taught using Polya model had the highest retention compared to those taught using Lecture Method. The implication was that, students exposed to Polya Model tend to retain Trigonometry concepts better than those exposed to Lecture Method. This is in line with the findings of Umar, et al (2006) and Samuel (2013) who reported that there was a significant difference between the retention ability in favour of students taught using problem-solving when compared with those taught using Lecture Method.

The finding was also in line with that of Hoidn and Karkkainen (2014) who reported that students taught using problem-based teaching method retained more knowledge than those taught using LTM. The finding was also in line with that of Smuel (2013) whose findings revealed that experimental group of Polya retained more than their counterpart in the control group.

However, the finding contradicts that of Wynn, Mosholder and Larsen (2014) who reported that gender effect was insignificant in the knowledge retention of students taught using problem-solving model.

Conclusion

Based on the findings of this study, it was concluded that Polya Model has great potential to improve Male and Female students' academic retention.

Recommendations

It was recommended among others that Government, through the Ministry of Education should ensure the provision of adequate instructional materials at the Secondary Schools level to facilitate the use of Polya Model in teaching Trigonometry in particular and Mathematics in general. This will stimulate and involve all students to enhance their academic performance and retention ability in the subject better than using the Lecture Method



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**Appendix
Oneway**

PRETEST	Descriptives							
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
SCHOOL A (Male)	30	4.7000	2.98444	.54488	3.5856	5.8144	.00	10.00
SCCHOL B (mALES)	30	4.2000	3.71762	.67874	2.8118	5.5882	.00	10.00

SCHOOL C (FEMALES)	35	4.3429	5.35198	.90465	2.5044	6.1813	.00	18.00
SCHOOL D (FEMALE)	35	4.4571	3.85275	.65123	3.1337	5.7806	.00	12.00
Total	130	4.4231	4.07462	.35737	3.7160	5.1301	.00	18.00

ANOVA

PRETEST

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.059	3	1.353	.080	.971
Within Groups	2137.671	126	16.966		
Total	2141.731	129			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: PRETEST

Scheffe's

(I) SCHOOLS	(J) SCHOOLS	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
SCHOOL A (Male)	SCCHOL B (MALES)	.50000	1.06351	.974	-2.5136	3.5136
	SCHOOL C (FEMALES)	.35714	1.02482	.989	-2.5468	3.2611
	SCHOOL D (FEMALE)	.24286	1.02482	.997	-2.6611	3.1468
SCCHOL B (mALES)	SCHOOL A (Male)	-.50000	1.06351	.974	-3.5136	2.5136
	SCHOOL C (FEMALES)	-.14286	1.02482	.999	-3.0468	2.7611
	SCHOOL D (FEMALE)	-.25714	1.02482	.996	-3.1611	2.6468
SCHOOL C (FEMALES)	SCHOOL A (Male)	-.35714	1.02482	.989	-3.2611	2.5468
	SCCHOL B (mALES)	.14286	1.02482	.999	-2.7611	3.0468
	SCHOOL D (FEMALE)	-.11429	.98461	1.000	-2.9043	2.6758
SCHOOL D (FEMALE)	SCHOOL A (Male)	-.24286	1.02482	.997	-3.1468	2.6611
	SCCHOL B (MALES)	.25714	1.02482	.996	-2.6468	3.1611
	SCHOOL C (FEMALES)	.11429	.98461	1.000	-2.6758	2.9043

Homogeneous Subsets

PRETEST

Scheffe's

SCHOOLS	N	Subset for alpha = 0.05
SCCHOL B (Males)	30	4.2000
SCHOOL C (FEMALES)	35	4.3429
SCHOOL D (FEMALES)	35	4.4571
SCHOOL A MALES)	30	4.7000
Sig.		.971

The Analysis of Variance (ANOVA) statistics showed that the four schools used for this study have the same level ability. Reasons being that the calculated p value of 0.971 is above the 0.05 alpha level of significance and the computed F value of .080 is lower than the 3.00 F critical value. Their

mean performances are 4.700, 4.2000, 4.342 and 4.457 for schools A, school B, School C and school D respectively. The mean comparison test using Scheffe's test put all the mean performance in one subset implying that they have the same ability