EFFECTS OF POLYA AND BRANSFORD-STEIN MODELS ON STUDENTS' PERFORMANCE IN TRIGONOMETRY, AMONG SENIOR SECONDARY SCHOOL STUDENTS IN KANO STATE, NIGERIA.

BY

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ABSTRACT

The Study examined the Effects of Polya and Bransford-Stein Models on Academic Performance in Trigonometry among Senior Secondary School Students in Kano State. The Study used a Quasi-Experimental Pretest/Posttest, Control Group design. A sample of 190 (95 males; 95 females) Senior Secondary School two (SS2) Students selected from Six Senior Secondary Schools were drawn from the public Schools in Kano Metropolis. Three groups were involved for the Study namely: Experimental group one (Polya's Model), experimental group two (Bransford-Stein's Model) and Control group respectively. One research question was answered and one null hypothesis was formulated and tested at $P \leq 0.05$ *significance level. Trigonometry Performance Test (TPT) with reliability index 0.86 was the instrument used for data collection. Data collected were analysed using Mean, Standard Deviation and student t-test Statistics. Based on the findings of the study it was concluded that Polya and Bransford-Steins models have potentials to improve students' performance. The results indicated that students taught using Polya Model performed significantly better, followed by those taught using Bransford-Stein Model and Lecture Method. Based on the findings a number of recommendations were made among which is the employment Polya and Bransford-Stein Models in teaching Trigonometry at the senior secondary school levels, so as to enhance the students' academic performance and remove mathematics phobia.*

Keywords: Polya, Bransford-Stein Models, Performance and Trigonometry.

INTRODUCTION

National Policy on Education (FRN 2013), has stipulated that mathematics is one of the core subjects to be offered by all students till the tertiary levels of education. The importance accorded to Mathematics in the school curriculum from primary to secondary levels reflects accurately the vital role played by the subject in contemporary society. However, despite the relative importance of mathematics, it is very disappointing to note that students' performance in the subject, in both the internal and the external examinations has remained consistently poor. (WAEC 2005-2013).

Many researchers seem to be worried as to what factors are actually responsible for the fall in standard of students' performance in schools. This led many researchers to attribute the fall in academic performance to poor teaching techniques. To support this assertion, Salau (2009) submitted that many researchers have adduced that poor performance in public examination is traceable to teaching techniques by teachers. In the same vein, Ale (2009) also blamed the cause of the poor performance on the conventional method of teaching. He stressed that the traditional method of teaching does not allow students to accomplish learning and lacks meaningful and authentic learning activities to enable students construct their understanding of knowledge. According to Mtsem (2011), teaching method affects the responses of students and determines whether they are interested, motivated and involved in a lesson in such way as to engage in good learning.

What constitutes good teaching and learning of school subjects is the use of appropriate methods of teaching. Harrison (2010) asserted that many school subjects especially Mathematics is not being learn as it ought to be in Nigeria because of the inappropriate teaching methods.

Many researchers have been calling for total migration from the traditional teaching method to students' centered method. The call for a departure from the traditional methods of teaching with its attendant poor performance indices has been sounded by researchers such as (Abakpa 2011; Mtsem 2011) respectively. Based on the calls by researchers for a departure from the traditional methods of teaching, there is therefore, the need to advance a variety of teaching models having to do with heuristic problem-solving, to secondary school mathematics students in order to promote positive attitude towards problem-solving in Senior School Certificate Mathematics examinations.

The implication of lapses identified in the traditional teaching method is the that the non-traditional teaching methods such as problem-solving models that will improve students' performance have to be explored. It is in this regards that several models as suggested by Polya (1957), Bransford-Stein (1984), Gick (1986), Schoenfeld (1992), Meyer (1992) among others, whereby students are actively involved in the learning process, were advanced. In this types of models, the responsibilities of identifying the problem, exploring possible solutions and applying them to arrive at appropriate answers are done by the students. The teachers' role is just to observe and guide. Abah in Maruta (2018) advised that for effective teaching of mathematics to occur, the teacher should get the learners involved as much as possible in activities that will enable them to develop that needed process skills and attitudes relevant to scientific life.

There exist a number of models that improve students' academic performance, retention ability and attitude for the teachers to use. They include Polya, Bransford-Stein, Gick, Schoenfeld, Rusbult, Simon and Newell, among others. All these models are interrelated, but which of them will be more appropriate in teaching in the classroom situation? This question leads to the conduction of researches in order to determine which of the models will be the best way of teaching Trigonometry.

Thus, this led to the conduction of the present research and determined the effects of Polya and Bransford-Stein Models on the Students' Performance.

Research Questions

The following research question guided the study:

What is the difference in the Students' Academic Performance when taught Trigonometry using Polya, Bransford-Stein Models and Lecture Method?

Null Hypothesis

The following hypothesis was formulated and tested at 0.05 level of significance.

H_0: There is no significant difference in the Students' Performance when taught Trigonometry using Polya, Bransford-Stein Models and Lecture Method.

Research Methodology

A Quasi-Experimental pretest/posttes and control group design was adopted for this study. The sample consisted of 90 males and 90 females senior secondary school two (SSII) students in six public senior secondary schools in Kano metropolis, Kano, Nigeria. The six schools were selected using simple random sampling techniques from 25 senior secondary schools in Kano metropolitan with a total population of 9,770 students in SS II at the time of this study. Due to lack of enough private coeducational schools in the state, out of the six drawn schools, three of the schools were selected from males' schools using balloting. While the other three schools were selected from the females' schools using similar procedure.

Three groups were involved in the study namely: Experimental group one, experimental group two and control group. Experimental group one were taught using Polya model, experimental group two were taught using Bransford-Stein model while the control group were taught using the conventional Lecture Method.

The instrument used to collect data for this study was Trigonometry Performance Test (TPT) with reliability index 0.86. The instrument consisting of 20 items were made by the researcher based on the SSII mathematics curriculum in Trigonometry. The items were developed using 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 instrument was validated by experts in mathematics education department. 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 six schools were pretested using TPT before the commencement of the treatment and ANOVA was used to analyse the scores at $P \leq 0.05$ significant level to justify that the six schools were not significantly different in the ability level. The students were taught by the research assistants who were trained by the researcher for two weeks before the commencement of the experiment. The treatment lasted for six weeks. After the six-week treatment, Posttest was administered and determined the effects of the treatments.

Results and Discussion

Research Question: What is the difference in the Students' Performance when taught Trigonometry using Polya, Bransford-Stein Models and Lecture Method?

Table 1: Mean Gain Scores of Students' Performance.

Treatment Groups	Mean	Pretest (TPT1)	Posttest (TPT2)	Mean Gain Score
Polya	Mean	4.43	12.45	8.02
	N	65	65	
	Standard Deviation	3.579	5.537	
Bransford-Stein	Mean	4.33	9.28	4.95
	N	60	60	
	Standard Deviation	4.653	4.585	
Lecture Method	Mean	4.02	6.22	2.20
	N	65	65	
	Standard Deviation	3.520	1.745	
Total	Mean	4.26	9.32	5.06
	N	190	190	
	Standard Deviation	3.917	3.956	

From Table 1 the mean gain scores of the students taught using Polya, Bransford-Stein Models and Lecture Method were 8.02, 4.95 and 2.20 respectively. This implies that the performance of students taught Trigonometry using Polya, Bransford-Stein Models and Lecture Method differ from one another as can be observed from their mean differences. To find out if the difference in the mean gain is statistically significant, the corresponding null hypothesis was therefore tested using t-test Statistic.

Null Hypothesis (H_O**):** There is no significant difference in the Students' Performance when taught Trigonometry using Polya, Bransford-Stein Models and Lecture Method.

Table 2: t-test Statistic on Students' Academic Performance for Polya's and Bransford-Stein's Models

Variables	N	Mean	SD	SD-Error	df	Cal t-test	Table t-value	Decision	Remarks
Polya	65	12.45	5.537	.687	123	3.462	1.96	**H_0** Rejected	**S**
Bransford	60	9.28	4.585	.592					

The outcome of student t-test Statistic in Table 2 reveal that significant difference exists in the academic performance of students when taught Trigonometry using Polya and Bransford-Stein Models. This was because the calculated t values of 3.462 was higher than the table t-value of 1.96 at 0.05 alpha level of significance. Groups taught using Polya Model had the higher mean Performance Score of 12.45 compared to Bransford-Stein's groups with mean Performance Score of 9.28. Therefore, the null hypothesis is rejected.

Table 3: t-test Statistic on Students' Academic Performance for Polya and Lecture Method.

Variable	N	Mean	SD	SD-Error	df	Cal t-test	Table t-value	Decision	Remarks
Polya	65	12.45	5.537	.687	128	8.653	1.96	H_0 Rejected	S
Lecture	65	6.22	1.745	.216					

From Table 3 the calculated t-value of 8.653 is greater than the table t-value of 1.96 at 0.05 alpha level of significance. This shows that there is significant difference in the performance of students when taught using Polya Model and those taught using Lecture Method. The significant difference is in favour of Polya's group with mean performance score of 12.45 compared to Lecture Method with mean performance scores of 6.22. Therefore, the null hypothesis is rejected.

Table 4: t-test Statistic on Students' Academic Performance for Bransford-Stein Model and Lecture Method.

Variable	N	Mean	SD	SD-Error	df	Cal t-test	Table t-value	Decision	Remarks
Bransford	60	9.28	4.585	0.59	123	5.017	1.96	H_0 Rejected	S
Lecture	65	6.22	1.745	.216					

Results of the student t-test Statistic reveal that significant difference exists in the performance of students when taught Trigonometry using Bransford-Stein Model and those taught using Lecture Method. Reason being that the calculated t values of 5.017 is greater than the table t value of 1.96 at 0.05 alpha level of significance. The groups taught using Bransford-Stein Model had higher mean performance score 9.28 compared to Lecture Method that has the mean performance score of 6.22. This implies that significant difference exists on the academic performance of students in favour of Bransford-Stein Model compared to Lecture Method when used in teaching Trigonometry. Therefore, the null hypothesis is rejected.

From the student t-test statistic in Table 2, 3 and 4, significant difference exists in the performance of students when taught Trigonometry using Polya, Bransford-Stein Models and Lecture Method. Students taught using Polya Model had the highest mean performance

score followed by Bransford-Stein Model while the groups taught using Lecture Method had the least mean performance score. The hypothesis which states that there is no significant difference in the Performance of Students when taught Trigonometry using Polya, Bransford-Stein Models and Lecture Method is therefore, rejected.

Discussion

The results of data analysis showed that Significant difference exist in favour of Polya Model in the Performance of Students followed by Bransford-Stein Model and Lecture Method when taught Trigonometry. This implied that Polya Model is more effective than both the Bransford-Stein Model and the Traditional Lecture Method when used in teaching Trigonometry. The finding authenticates the findings of Suleiman (2010), Fajemidagba and Suleiman (2012) and Ameen (2013) who found that Polya's Model had the higher effects on students' performance when compared with the Bransford-Stein Model and Lecture Method.

However, the results of the present study contradict Olawoye's (2006) findings. Her study revealed that students taught using Schoenfeld Model performed better than Students taught using Polya Model. The finding also is in line with the findings of Alio and Harbor-Peters (2000) who's findings of the study revealed that, the students taught using Polya Model had a better Achievement than those exposed to the Conventional Lecture Method. This is also in line with the findings of Galadima (2002) whose findings showed that Polya Problem-Solving Model has higher significant difference in teaching Algebraic Words Problems in Senior Secondary Schools when compared with Expository Method. The finding of the study also corroborates with the findings of Samuel (2013) whose results of the findings showed that experimental group of Polya achieved higher in Algebraic test than those taught using Lecture Method.

The implication of this study is that if students are given the opportunity to experience mathematics through Polya and Bransford-Stein Models during Mathematics lessons, their 'Mathematics phobia' and sense of difficulty in the subject will vanish leading to greater positive productivity in all examinations. Moreover, the failure rate in Mathematics will decline greatly if any of the two models is adopted in teaching Trigonometry by senior secondary school teachers.

Conclusion

The result of this study reveals that significant difference exists in the performance of students when Polya and Bransford-Stein Models are used in teaching Trigonometry concepts.

Recommendations

On the basis of the findings from this study, the following recommendations were made:

- Senior Secondary School Mathematics Teachers should be encouraged to use Polya and Bransford-Stein Models to teach trigonometry at Senior Secondary Schools levels. This will help the learners to be involved in activities that will enable them develop their own understanding of knowledge.

- Mathematics Curriculum Developers, Educators and Teachers should incorporate the Models of Polya and Bransford-Stein among others in the curriculum, in training and teaching of Trigonometry at the Senior Secondary School Levels.
- Government should advise book writers and Nigerian Education Research and Development Council (NERDC) to transform the textbooks of mathematics from the conventional form to new form as to meet the criteria of Polya's and Bransford-Stein's models among others.

References

Abakpa, B.O., (2011). Effects of Mastery learning approach on Senior Secondary School students' Achievements and interest in geometry. Unpublished Ph.D thesis. University of Agriculture, Makurdi.

Ameen, S.K. (2013). Comparative effects of two problem solving models on Nigerian secondary school students' performance in Mathematics word problems. An unpublished Ph.D thesis, University of Ilorin, Ilorin.

Fajemidagba, M.O & Suleiman, B. (2012). Effects of Polya and Bransford and Stein Problem Solving Models on Student's Performance in Mathematics. ABACUS: *Journal of the Mathematical Association of Nigeria (MAN)* 37(1) 124-133.

Federal Republic of Nigeria (FRN 2013). National Policy on Education. Lagos NERDC Press.

Galadima,I. (2002): The relative effects of heuristic problem-solving instruction on secondary school students performance in algebraic word problems. *Abacus: The Journal of the Mathematical Association of Nigeria, 27(1) pp57-65.*

Harbor Peters, V.F.A. (2000). Andragogical Inquiry: A Pedagogical Model for teaching Mathematics within the next Millenium. Abacus: Journal of Mathematical Association of Nigeria, 25(1), 65-73. 'Factors Affecting Students'Performane'. MPRA Paper No. 1362.

Maruta, S.I. (2018). Effects of Polya and Bransford-Stein Models on Attitude, Retention and Performance in Trigonometry among Senior Secondary School Students in Kano State. Un published PhD thesis of the Faculty of Education, Ahmadu Bello University Zaria, Nigeria.

Mtsem, A.A. (2011). Effects of diagnostic and contextual instructional strategy on students' interest and achievement in Secondary School Algebra. A PhD thesis of the Faculty of Education, Benue State University Makurdi.

Olayiwola, A.O. (2010). Procedures in Educational Research Nigeria; HAJAM Publications. http;//www.hrdc-drhc.gc.ca/arb/Retrieved August 14 2012.

Olawoye,F.A. (2006). The Relative Effects of Polya and Schoenfeld Problem-Solving Instructional Strategies on Senior Secondary School Students' Performance in Mathematics in Ilorin. Unpublished Ph.D Thesis, University of Ilorin, Ilorin.

Salau, M.O. (2009). The effects of class size on achievements of different ability groups in mathematics. Journal Science Teachers' Association of Nigeria, 31(1), 27-33.

Suleiman, B., (2010). The effect of Polya, Gick and Bransford and Stein problem-solving models on students' performance in statistics word problems. Unpublished PhD thesis, Department of Science Education, University of Ilorin, Ilorin, Nigeria.

W.A.E.C. (2005-2013). West African Examination Council. Mathematics Chief Examiner's Report. Yaba, Lagos; WAEC.