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EFFECT OF RUSBULT'S PROBLEM SOLVING MODEL ON UPPER BASIC SCHOOL STUDENTS' ACHIEVEMENT AND RETENTION IN TRIGONOMETRY IN NASARAWA WEST SENATORIAL ZONE, NIGERIA

[*1]Luke Aondona Imotor, [2]Friday Peter, [3]Enechojo Eucharia Zekeli, & [4]Tijjani Mustapha

[*1,2,3&4]Department of Mathematics Education,
Federal College of Education Odugbo, Benue State, Nigeria,
Email: imotorluke@gmail.com[1], ochejeeuchariaenechojo@yahoo.com[3] &
mustaphatijjani001@gmail.com[4]

Abstract

The study investigated the Effect of Rusbult's Problem Solving Model on Upper Basic School Students' Achievement and Retention in Trigonometry. two research questions guided the study and two research hypotheses were formulated and tested at 0.05 level of significance. The design for the study was quasi-experimental design (non-equivalent pre-test, posttest, post posttest, control design). Trigonometry Achievement Test (TAT) was used for data collection, which had internal reliability coefficient of 0.91 and validity index of 0.91. The Trigonometry Retention Test (TRT) was the same in content but differs in structure with the achievement test. Purposive sampling technique was used to select a sample size of 108 students. For the study, two classes were randomly chosen from the coeducational schools owned by the government, and both classes remained intact. Data collected from the subjects were analyzed using mean, standard deviation and analysis of covariance (ANCOVA). The results from the analysis indicated that Rusbult's Problem Solving Model enhanced students' achievement and retention in Trigonometry. It was recommended among others that, students should be taught Trigonometry using Rusbult's Problem Solving Model so as to improve their achievement and retention.

Keywords: Rusbult's Problem solving model, Achievement, Retention, Trigonometry, Upper Basic School

Introduction

Mathematics is a crucial subject that plays a vital role in everyday life due to its relevance to the individual and its interrelationship with other fields of studies. Wherever an individual finds himself in the society, he makes use of the knowledge of Mathematics either knowingly or unknowingly. Mathematics, according to Merrian-webster Dictionary, is the science of numbers and their operations, interrelations, combinations, generalizations and abstractions, as well as their space configurations and structure, measurement, transformations and generalizations. To Simeon and Francis (2012); Tukur and Adesina (2013), Mathematics is the queen of science and technology and also a tool for scientific and technological development. According to (Suleiman & Hammed 2019), without the study of mathematics, a country will never be rich or economically independent because science and technology rely on it for their basis. The technology driven society cannot strive successfully without Mathematics. In the view of Obarakpo (2015), for any nation to survive and develop, it has to improve on the teaching and

learning of Mathematics; a subject that has become the bedrock of any technological development.

Because of the importance of Mathematics in building a technology driven society and developing individuals thinking ability, the Federal Government of Nigeria (2014) has identified Mathematics as a core subject at both primary and secondary schools in Nigeria. Also, Mathematics is made a compulsory subject to be passed at credit level before securing admission to study any course in Nigerian Tertiary Institutions.

One of the important aspects of Mathematics is Trigonometry, a fundamental branch of mathematics that plays a crucial role in various fields, including engineering, physics, and astronomy (Bekene & Machaba, 2022). Trigonometry is a branch of school mathematics that has everyday application in the life of the child especially in estimation, construction technology and astronomical relationship (Sidhu, 2006). It is the aspect of school mathematics involving the measurement of distance, angles, lines, relationship and surfaces. Trigonometry enables the child to use the knowledge of mathematics in latitude and longitude, when he eventually becomes a pilot, sailor or navigator to locate position of landing (Chire & Akewn, 2010). The knowledge of trigonometry assists students to appreciate shapes and situations around their environment and helps to develop their inductive reasoning skills that become necessary ingredient for learning mathematics. The introductory aspect of Trigonometry at the basic secondary school level focuses on angles between lines, calculation of sizes of angles, angles in a triangle, Pythagoras theorem, bearing and angles of elevation and depression. The concept of Trigonometry is formally introduced in year three of the Upper Basic School in the Nigerian education curriculum where attention is focused on trigonometric ratios; the sine, cosine, tangent, use of trigonometric tables and application of trigonometric ratios. (Federal Ministry of education 9-year Basic Education Curriculum 2017). As the learners advance in Trigonometry, it becomes more of analysis and reasoning which help students to develop the skills of critical thinking, problem solving ability, deductive reasoning, logical argument and proof. Therefore, if students' foundation is well laid to have a clear understanding of the basic concepts in trigonometry at this level, it will go a long way to improving their performance in Trigonometry in particular and Mathematics in general, thereby enhancing their high achievement in the subject.

Despite the importance of Trigonometry, many students find it challenging due to its abstract concepts and complex formulas (Abdullahi, 2022). According to WAEC Chief examiner's report (2017), question on Trigonometry was poorly answered by most candidates because they could not analyze and deduce from the given diagram the correct trigonometric ratios to find the value of x. in order to unravel the mystery behind the poor achievement in the subject, Obarakpo (2015) opined that most teachers adopt the conventional approach to teaching which is the traditional approach to teaching whereby the teacher disseminates the information verbally to the students. Sometimes, the teacher writes on the chalkboard while the students listen, take notes and ask questions for clarification. He stated that, in the conventional approach, the teacher is in charge of the entire environment and serves as the decision maker.

To address the limitations of the conventional approach and its effects on poor performance of students in trigonometry, efforts have been made by researchers towards improving on students' achievement in Mathematics in general and Trigonometry in particular; especially at the secondary school level. (Egara & Mosimege 2023) posited that problem solving based strategy will lead to a significant improvement in students'

academic achievement in trigonometry and thus recommended that these be taught in our classrooms. According to Nekang (2013), problem solving in any academic area involves presenting a situation that requires resolution to the learner in instruction session in the classroom. Nekang said that, being a problem solver requires an ability to come out with means to resolve the situation fully. He added that in Mathematics, problem solving generally involves presenting a written out problem in which the learner has to interpret, device a method to solve it, follow Mathematics procedures to achieve the result and then analyze the result to see if it is an acceptable solution to the problem presented.

Problem solving models in Mathematics have been developed by many researchers some of which include: Polya, 1957; Guilford and Holfiner, 1971; Newell and Simpsons, 1972; Greeno, 1973; Brandsford and Stein, 1984; Schoenfeld, 1985 and Rusbult, 1989.

On his part, Rusbult (1989) developed a four-step problem solving model. The four steps are as follows:

I. Orientation: translating problem's words, pictures and free information into a clear idea of NOW (the situation that is defined by the problem statement) and the GOAL (what the problem is asking you to do)

II. Planning: figuring out how to get from where you are NOW to the GOAL

III. Action: start doing your plan, and continue until you have reached the GOAL.

IV. Check: ask yourself, "Have I answered the questions that were asked?" "Have I reached the GOAL?"

To ascertain the effectiveness of problem solving methods on students achievement, (Egara & Mosimege 2023) employed a non-equivalent control group pre-test-post-test quasi-experimental design to examined the effect of blended learning approach on secondary school learners Mathematics achievement with a sample size of 94 SS1 students in the Uzo-Uwani Local Government Area (LGA) of Enugu State. The data was analysed using mean (M) and standard deviation (SD), and the hypotheses were tested using analysis of covariance (ANCOVA) at a significance level of 0.05. Findings showed that learners tutored mathematics utilising blended learning improved their mathematics achievement. In another study, (Abiodun, Aderibigbe, Adebola & Ayoola 2024) Investigated the effects of heuristic problem solving strategies on students achievement and retention in mathematics in Ogun State using quasi experimental design with a sample size of 80 students. Data was analysed using independent t test. Results revealed that students in the experimental group achieved better than those in the control group. (Sualimon, Yusuf, Yakub, Isiaka & Syarif 2023) in their study investigated the effect of problem-solving method on pupils' academic achievement in mathematics in Ilorin South local government area of Kwara State. The study adopted a quasi-experimental design. The sample of the study consisted of 75 basic five (5) pupils. Data collected for the study were statistically analysed using mean and ANCOVA statistical tool. The results of the study revealed that problem-solving method had significant effects on the academic achievement of pupils in mathematics. Those taught using the problem-solving method (the experimental group) outscored those in the control group.

Another variable considered in this study is Retention. According to Hornby (2000), retention is the ability to remember experiences and things learnt after a period of time. This implies that the amount of knowledge or skills learnt, kept, maintained and

reproduced after a period of time reflects what is retained (Obarakpo,2015). According to (Onyeka, Eze & Okonkwo 2023), students who were exposed to a problem based strategy had a higher retention in Mathematics. In another study, (Egara & Mosimege 2023) examined the effect of blended learning approach on secondary school learners Mathematics achievement and retention. Results revealed that learners tutored using blended learning improved their retention scores more than those exposed to the conventional teaching method.

From the above-reviewed studies, what is evident is that problem-solving is a viable approach for enhancing students' academic achievement. However, what is not known is the effect of Rusbult problem solving model on Upper Basic School Students Achievement and Retention in Trigonometry in Nasarawa West Senatorial Zone, Nigeria. Therefore, the researcher investigated to find answers to that effect.

Research Questions

The study was guided by the following research questions

I. What are the mean achievement scores of students taught trigonometry using Rusbult Problem Solving Model (RPSM) and those taught using Conventional Lecture Teaching Method (CTM)?

II. What are the mean retention scores of students taught Trigonometry using RPSM and those taught using CTM?

Hypotheses

The following null hypotheses (Ho) were formulated to guide the study and were tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean achievement scores of students taught Trigonometry using RPSM and those taught using CTM.

Ho_2: There is no significant difference in the mean retention scores of students taught Trigonometry using RPSM and those taught using CTM.

Methodology

The design used for this study was the quasi-experimental design (non-equivalent pretest, posttest, post posttest, control group design).

The Sample of the study comprised 108 students purposively drawn from two upper basic schools in Nasarawa West Senatorial Zone. Two schools were selected using simple random sampling techniques, of the two schools one was assigned experimental group and the other control group using lucky dip method. Data was collected using Trigonometry Achievement Test (TAT) which was developed by the researcher. The TAT was used for pretest and posttest. In order to determine retention, Trigonometry Retention Test (TRT) which comprised of the reshuffled items of the TAT was used. The TAT consisted of 27 multiple choice objective questions with options (A-D) developed by the researcher, derived from the topics on Trigonometry in upper basic three scheme of work. TAT items were adapted from recommended text books (MAN Mathematics and New General Mathematics Text books)

TRT was obtained by rearranging the items of the TAT. Hence both the TAT and TRT were alike in content but different in structure. The TAT was validated by three specialists, one in Measurement and Evaluation and two in Mathematics Education. The validity index was computed by taking the average of the index by various experts which yielded 0.91 coefficient of internal consistency. The reliability coefficient of TAT was determined using rank correlation and Spearman Brown's formula method. The internal consistency index was found to be 0.91. The data collected from the pretest, posttest and retention test were analyzed using mean and standard deviation to provide answers to the research questions while the hypotheses were tested at 0.05 significant level using Analysis of covariance (ANCOVA).

Results

Research Question one: What are the mean achievement scores of students taught Trigonometry using Rusbult Problem Solving Model (RPSM) and those taught using conventional lecture method (CTM)?

Table 1: Means and Standard Deviations (SD) of Students in TAT

Teaching method	Type of Test	N	Mean	SD
RPSM	Pre TAT	50	7.72	**2.61**
	Post TAT	50	18.68	**2.29**
CTM	Pre TAT	58	7.42	**2.64**
	Post TAT	58	10.53	**2.29**
Total		108		

Table 1 shows that the students taught Trigonometry using RPSM had mean score of 7.72 and 18.68 in pre-test and posttest respectively and standard deviations of 2.61 and 2.29 in that order. The students taught Trigonometry in the control group had mean scores of 7.42 and 10.53 in pre-test and posttest respectively and standard deviations 2.64 and 2.29 respectively.

Research Hypothesis One (Ho_1): There is no significant difference in the mean achievement scores of students taught trigonometry using RPSM and those taught using CTM.

Table 2: ANCOVA Result of Mean Achievement Scores of Students Taught Trigonometry Using RPSM and CTM
Computed at alpha = 0.05

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision
Corrected Model	1891.839[a]	4	472.960	109.452	.000	**S**
Intercept	1686.037	1	1686.037	390.183	.000	**S**
Pre TAT	67.762	1	67.762	15.682	.000	**S**
Groups	1736.216	1	1736.216	401.795	.000	**S**
Error	445.078	103	4.321			
Total	24439.000	108				
Corrected Total	2336.917	107				

Table 2 shows that the exact probability, p = 0.00 which is less than α = 0.05 level of significance (p<0.05), i.e ($F_{(1,103)}$ = 401.795; p = 0.00< α = 0.05). This implies that the treatment (RPSM) is a significant factor on student's achievement in Trigonometry. Hence the hypothesis of no significant difference is rejected. This implies that there was a significant difference in the mean achievement scores in favour of the students exposed to RPSM

Research Question Two: What are the mean retention scores of students taught Trigonometry using RPSM and CTM?

Table 3: Means and Standard Deviations (SD) of Students in TRT

Teaching Method	Type of Test	N	Mean	SD
RPSM	Post TAT	50	18.68	2.29
	Retention test	50	18.92	3.00
CTM	Post TAT	58	10.53	2.29
	Retention test	58	10.10	2.08
Total		108		

Table 3 shows that students taught Trigonometry using RPSM had mean score of 18.68 and 18.92 in posttest and retention test respectively and standard deviations of 2.29 and 3.00 in that order. While students taught Trigonometry using CTM had mean scores of 10.53 and 10.10 in posttest and retention test respectively, with standard deviations of 2.29 and 2.08 in that same order.

Research Hypothesis Two (Ho_2): There is no significant difference in the mean retention scores of students taught trigonometry using RPSM and those taught using CTM

Table 4: ANCOVA Result of Mean Retention Scores of Students Taught Trigonometry

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision
Corrected Model	2277.058[a]	4	569.264	117.447	.000	**S**
Intercept	104.796	1	104.796	21.621	.000	**S**
Posttest	147.704	1	147.704	30.474	.000	**S**
Groups	120.711	1	120.711	24.904	.000	**S**
Error	499.239	103	4.847			
Total	24508.000	108				
Corrected Total	2776.296	107				

Using RPSM and CTM
Computed at alpha = 0.05

Table 4 indicates that the exact probability, p= 0.00 is less than $\alpha = 0.05$ ($p<0.05$), i.e. ($F_{(1,103)} = 24.904$; $p = 0.00 < \alpha = 0.05$) implying that the treatment (RPSM) is a significant factor on students' retention in Trigonometry. Therefore, the hypothesis of no significant difference is rejected. This means that there was a significant difference in the mean retention scores in favour of subjects exposed to RPSM.

Discussion

The findings of this study have shown that Rusbult problem solving model is effective in enhancing students' achievement in trigonometry compared to the conventional method. Moreover, the test of hypothesis one proved that a significant difference exists between the achievement scores of students who received trigonometry instruction using Rusbult problem solving model than those who were taught with the conventional approach, in favour of those who received trigonometry instruction with Rusbult problem solving model. This implies that the Rusbult problem solving model effectively enhances students' achievement in the mathematics concept. It shows that students in the experimental group achieved higher than those in the control group because they had mastery of the topics taught as a result of the method used in teaching them. This finding agrees with the findings of (Egara & Mosimege 2023; Abiodun, Aderibigbe, Adebola & Ayoola 2024 and Sualimon, Yusuf, Yakub, Isiaka & Syarif 2023) who showed that problem solving method of teaching positively affected the students' performance in Mathematics. Furthermore, the result showed that the mean retention scores of students in the experimental group were significantly above those in the control group. Thereby agreeing with the findings of (Onyeka, Eze & Okonkwo 2023 and Egara & Mosimege 2023). The ANCOVA result showed that there was a significant difference in the achievement and retention of students taught Trigonometry using RPSM. This implies that teaching Trigonometry using RPSM improved students' achievement and retention.

This study proves that the problem-solving Model has more positive effect on students' achievement in mathematics than the conventional lecture method. Overall, the results obtained from this study agree with the general expectation of Mathematics educators that activity-oriented teaching strategies which center on the learner are more educationally rewarding than the conventional lecture method which is teacher-centered.

Conclusion

Using Rusbult problem solving model significantly improved students' achievement in trigonometry more than the conventional approach. This was observed in the mean achievement score of students in the experimental group being higher than that of students in the control group. The results obtained from this study agree with the general expectation of Mathematics educators that activity-oriented teaching strategies which are students-centered are more educationally rewarding than the conventional lecture method which is more of teacher-centered. It is therefore, imperative for a better students' academic achievement in trigonometry because, it is a fundamental branch of mathematics that plays a crucial role in various fields, including engineering, physics, and astronomy.

Recommendations

Considering the findings from the study, the following recommendations were made:

I. Mathematics teachers at the secondary school level should be encouraged to use RPSM for teaching their students Trigonometric concepts in Mathematics.

II. Curriculum planners should include RPSM as one of the recommended strategies for teaching Trigonometry.

III. Mathematics educators, Federal and State ministries of education, and teacher training institutions should train and organize workshops to expose pre-service Mathematics teachers on the use of RPSM in teaching Trigonometry and Mathematics in general.

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