UNIJERPS
Unizik Journal of Educational Research and Policy Studies VOL.17 (3);
January-June, 2024 https://unijerps.org
2023 Impact Factor:* 6.834;** 2022 ***Impact Factor*:** 5.156; ***2021 Impact Factor: 5.641;
2020 Impact Factor: 5.355. *Indexing and Impact Factor URL: http://sjifactor.com/passport.php?id=21363*

EFFECT OF RUSBULT'S PROBLEM SOLVING STRATEGY ON GENDER ACHIEVEMENT AND RETENTION OF UPPER BASIC SCHOOL STUDENTS IN TRIGONOMETRY IN KEFFI, NASARAWA STATE

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ABSTRACT

The study *determined the Effect of Rusbult's Problem Solving Strategy on Gender Achievement and Retention of Upper Basic School Students 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. Simple random sampling technique was used to select a sample size of 108 students, made up of 52 males and 56 females. Two intact classes randomly selected from the Government owned coeducational schools were used for the study. Data collected from the subjects were analyzed using mean, standard deviation and analysis of covariance (ANCOVA). The ANCOVA result ($F_{(1,45)} = 1.030$; $p= 0.15 < \alpha = 0.05$) of Mean Achievement of Male and Female Students Taught Trigonometry Using RPSS showed that male students achieved better than their female counterparts in the experimental group. There was however, no significant difference between male and female students' retention as shown from the ANCOVA result ($F_{(1,45)} = 3.584$; $p = 0.16 > \alpha=0.05$) of Mean Retention Scores of Male and Female Students Taught Trigonometry Using RPSS. It was recommended among others that female students at the Upper Basic Secondary School should be encouraged and given special attention in teaching and learning Trigonometry, in order to enhance their achievement in Mathematics.*

Keywords: Rusbult Problem solving Strategy, Gender, Achievement, Retention, Trigonometry, Upper Basic School Students.

Introduction

The importance of Mathematics in everyday life cannot be over emphasized 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. Madu and Hogan (2010) viewed Mathematics as a set of concepts, facts, principles, and operations that are fundamental to the existence of every individual. Ambali (2014) in a key note address delivered at the 51st annual conference of Mathematical Association of Nigeria described Mathematics as an indispensable subject, without which no nation could contemplate progress or development.

Due to the relevance and importance of Mathematics in developing an individual's entrepreneurial skills and building a technology driven society, the Federal Government of Nigeria (2014) has identified Mathematics as a core subject at both primary and secondary schools in Nigeria. Considering the importance of the subject to the individual's daily life and the society at large, it is expected that the students' achievement in Mathematics should be well above average. However, the achievements of students in Mathematics as shown by statistics from West African Examination Council (WAEC) at the Senior Secondary School Certificate Examination (SSCE) have not been encouraging as only 31% to 59% of the students who sat for the examination between 2014 and 2018 scored credit pass (WAEC annual chief examiner's report 2014-2018)

One of the aspects of Mathematics that suffers this development immensely is Trigonometry. 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. It is an area of mathematics that students believe to be particularly difficult and abstract compared with the other aspects of mathematics.

Trigonometry is a branch of Mathematics that deals with the relations of the sides and angles of triangles and with the relevant functions of any angles. Trigonometric ratios are of immense practical importance in engineering, surveying, architecture, navigation and many other areas of science and technology (Mathematical Association of Nigeria (MAN), 2006).

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. Rusbult (1989) developed a four step problem solving model. To him, most people enjoy the stimulating challenge of a good problem and the satisfaction of solving it. According to Rusbult, the problem solver feels this satisfaction more when the tools of problem solving are mastered. 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?"

Gender differences and achievement in Mathematics is another important factor which has been under contention in the study of Mathematics. Literature on gender and academic achievement in Mathematics are carried out with different findings.

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). Stanfy (2018) define retention as an ability to retain things in mind: specifically; a preservation of the after effect of experience and learning that makes recall or recognition possible. Retention is the extent to which the knowledge of Trigonometry acquired by the students is preserved and recalled when needed. Hence improving students' achievement in Trigonometry implies improving the level of retention of trigonometric concepts learnt.

Statement of the Problem

The place occupied by Mathematics in the nation's education curriculum is of eminent significance. Mathematics is important in shaping people's everyday life and development, and is critical to the survival of the world today and the future generations. Mathematical skills are no doubt relevant to a wide range of analytical, technological, scientific, security, political and economic applications and there is no doubt that a solid foundation in Mathematics prepares one for other educational and professional challenges. That is why the continuous failure of students in Mathematics in external examinations according to statistics by WAEC annual reports as earlier stated has become worrisome to all the concerned stakeholders. The use of inappropriate teaching methods has been adduced as one of the factors responsible for the poor performance. The disparity between gender equality might have also played a key role. Another factor responsible for this under achievement is the poor foundation of students in the subject at the formative stage of the education. Therefore, the researcher wishes to find out the Effect of Rusbult's Problem Solving Strategy on Gender Achievement and Retention of Upper Basic School Students in Trigonometry in Keffi, Nasarawa State.

Many empirical studies have been conducted by different researchers which are relevant to this study. The review covered studies on problem solving strategies, studies on gender and achievement, studies on retention and achievement.

In a study on mathematics achievement based on gender among 8th grade school students in Jordan, Belal, Veloo and Selvan (2015) used a sample of 337 students comprising 179 males and 158 females selected from eight public secondary schools in Alkoura district using stratified random sampling. Mathematics test comprising 30 items were used for data collection and was analyzed using independent sample t-test. Findings from the study showed that female students scored higher than male students in numbers, algebra, mathematics achievement and spatial visualization. There was however, no significant difference in geometry base on gender. This study seeks to investigate if gender has any influence on students' achievement in trigonometry when taught using Rusbult problem solving strategy.

Sabahat (2015) in a research, gender difference in mathematics achievement and its relation with reading comprehension of children at upper primary stage used a sample of 307 upper primary children, 160 girls and 147 boys through purposive sampling method. Mathematics achievement test was used for data collection and analyzed using mean, standard deviation and t-test. Findings showed significant difference between mathematics achievement of boys and girls at upper primary school stage. Here, the researcher to employed quasi experimental design to determine the Effect of Rusbult's Problem Solving Strategy on Gender Achievement and Retention of Upper Basic School Students in Trigonometry.

Arhim (2015) conducted a quasi-experimental research to find out differences in mathematics performance of students using performance assessment driven instruction at the senior high school level at Ghana national college Cape Coast. Two form one science classes were used for the study and were assigned as the experimental and control groups. The sample consisted of 82 students. Data was collected through the use of open ended test in mathematics, and analyzed using t-test. The result showed that performance assessment driven instruction improved students' problem solving abilities, but showed no bias between genders. In this study, Upper Basic School Students will be exposed to Rusbult problem solving strategy to determine the effect on gender achievement and retention in trigonometry.

In the same vein, another study was undertaken by Ajai and Imoko (2015) to assess gender in mathematics achievement and retention by using a problem based learning (PBL). The design of the study was pre-posttest quasi-experimental. 428 SS1 students using multi-stage sampling from ten grant aided and government schools were involved in the study. 261 male and 167 female students were taught algebra using PBL method of instruction. Algebra Achievement Test (AAT) was used for data collection and analyzed using t-test at 0.05 level of significant. The study revealed that male and female students taught algebra using PBL did not significantly differ in achievement and retention scores, thereby revealing that male and female students are capable of competing and collaborating in mathematics. Here trigonometry will be taught to both male and female students using Rusbult problem solving strategy to determine the effect on their achievement.

Considering the varying findings on gender and achievement in mathematics from the

reviewed studies, the researcher wishes to find out the effect of gender achievement and retention of upper basic school students in trigonometry when taught using Rusbult problem solving strategy.

Research Questions

The study was guided by the following research questions

1. What are the mean achievement scores of male and female students in Trigonometry when taught using RPSS?
2. What are the mean retention scores of male and female students in trigonometry when taught using RPSS?

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 male and female students taught Trigonometry using RPSS.

Ho_2: There is no significant difference in the mean retention scores of male and female students taught Trigonometry using RPSS.

Research Method

The design used for this study was the quasi-experimental design (non-equivalent pretest, posttest, post posttest, control group design). The target population of the study made up of all the upper basic school students in Keffi, Nasarawa State. Only public schools were considered for the study to guarantee uniformity, since they are using the same curriculum and scheme of work, and the teachers' motivation as well as the learning condition of the students and period of work coverage is the same. The Sample of the study comprised 108 students (52 males and 56 females) drawn from two upper basic three schools in Keffi town. Considering gender in the study, only co-educational schools were considered. Two out of 14 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. The instrument, Trigonometry Achievement Test (TAT) which was developed by the researcher was used for data collection. 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 school three scheme of work. TAT items were adapted from recommended text books (MAN Mathematics and New General Mathematics Text books). Trigonometry Achievement Test underwent both face and content validation 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. A trial test was given to students in one of the co-educational schools that are not among the sampled schools. This enabled the researcher to obtain data from which the reliability was determined. 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), where the pretest scores served as the covariates.

Presentation of Results

Test of hypotheses and results of acceptance or rejection of null hypotheses and research questions are presented below.

Research Question One: What are the mean achievement scores of male and female students in trigonometry when taught using RPSS?

Table 1: **Means and Standard Deviations (SD) of Male and Female Students Taught Trigonometry Using RPSS in TAT**

Strategy	Gender	Type of Test	N	Mean	SD
RPSS	Male	Pretest	24	7.50	2.99
		Posttest	24	18.92	2.67
	Female	Pretest	26	7.92	2.26
		Posttest	26	18.46	1.90
Total			50		

Table 1 shows that the male students taught Trigonometry using RPSS had mean scores of 7.50 and 18.92, standard deviations of 2.99 and 2.67 in pretest and posttest respectively. Female students taught Trigonometry using RPSS had mean scores of 7.92and 18.46 with standard deviations of 2.26 and 1.90 in pretest and posttest respectively.

Research Hypothesis One (Ho$_1$)

There is no significant difference in the mean achievement scores of male and female students taught trigonometry using RPSS

Table 2: **ANCOVA Result of Mean Achievement of Male and Female Students Taught Trigonometry Using RPSS.**

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
Pretest	67.762	1	67.762	15.682	.000	S
Group	1736.216	1	1736.216	401.795	.000	S
Gender	26.529	1	26.529	6.139	.015	S
group * gender	4.450	1	4.450	1.030	.313	NS
Error	445.078	45	4.321			
Total	24439.000	50				
Corrected Total	2336.917	49				

Computed at alpha = 0.05
The exact probability, p = 0.015 which is less than α = 0.05. i.e ($F_{(1,45)}$ = 1.030; p= 0.015< α = 0.05) shows that gender is a significant factor on the achievement of students taught Trigonometry using RPSS. Hence the null hypothesis was rejected.

Research Question Two: What are the mean retention scores of male and female students in trigonometry when taught using RPSS?

Table 3: **Mean and Standard Deviation of Male and Female Students Taught Trigonometry Using RPSS in TRT**

Strategy	Gender	Type of Test	N	Mean	SD
RPSS	Male	Post-test	24	18.92	2.67
		Retention	24	19.79	3.58
	Female	Post-test	26	18.46	1.90
		Retention	26	18.12	2.12
Total			50		

Table 3 shows that the male students taught Trigonometry using the RPSS had mean scores 18.92 and 19.79, standard deviations of 2.67 and 3.58 in posttest and retention respectively. Female students taught Trigonometry using RPSS had mean scores of 18.46 and 18.12, standard deviations of 1.90 and 2.12 in posttest and retention respectively

Research Hypothesis Two (Ho_2)
There is no significant difference in the mean retention scores of male and female students taught trigonometry using RPSS.

Table 4: **ANCOVA Results of Mean Retention Scores of Male and Female Students Taught Trigonometry Using RPSS.**

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
Group	120.711	1	120.711	24.904	.000	S
Gender	9.723	1	9.723	2.006	.160	NS
group * gender	17.373	1	17.373	3.584	.061	NS
Error	499.239	45	4.847			
Total	24508.000	50				
Corrected Total	2776.296	49				

Computed at alpha= 0.05
Table 4 indicates that the exact probability p = 0.16 which is greater than α= 0.05. i.e. ($F_{(1,45)}$ = 3.584; p = 0.16> α=0.05). This implies that gender is not a significant factor on the retention level in students taught Trigonometry using RPSS. Hence the null hypothesis was not rejected.

Discussion

The results showed that both male and female students in the experimental group had higher achievement in Trigonometry than those in the control group. However, the male students scored a little higher than their female counterparts in the experimental group. This agrees with the work cited by John and Benjamin (2015) that boys generally achieve higher than girls on standardized mathematics test.

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 Anyamene, Nwokolo, Anyachebelu and Anemelu (2012), and Obi, Agwaga and Agah (2014). The male students had higher mean retention than their female counterparts among those taught Trigonometry using RPSS.

Result of Mean Achievement of Male and Female Students Taught Trigonometry Using RPSS shows that there was a significant difference between gender and strategy since the probability level of 0.015 was less than significant level of 0.05. The result for the retention showed no significant difference between gender and strategy.

Conclusion

Based on findings of the study, it is concluded that Rusbult Problem Solving Strategy has more positive effect on students' achievement and retention in Trigonometry than the conventional lecture method. This positive effect on students' achievement tended to be higher for the male students than the females even though the difference in achievement for both groups was not significant. Overall, 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.

Recommendations

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

1. Mathematics teachers at the secondary school level should be encouraged to use RPSS for teaching their students Trigonometric concepts in Mathematics starting from the basic school which is their formative stage. And more attention should be given to the female students
2. Authors and publishers of Mathematics text books should be encouraged to use the steps of this strategy in their worked examples in order to afford Mathematics teachers and students the opportunity to use the strategy even with little or no guidance.
3. Female teachers should be employed and deployed to teach mathematics to encourage the female students.

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