BRANSFORD-STEIN MODEL AND ACADEMIC ACHIEVEMENT AND RETENTION IN TRIGONOMETRY AMONG SENIOR SECONDARY SCHOOL STUDENTS IN AKWA IBOM STATE

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Abstract

The study examined effects of Bransford-Stein model (BSM) on academic achievement and retention in trigonometry among secondary school students in Akwa Ibom State. A quasi-experimental pretest, posttest, control group design was used for the study. A sample of 300 (150 males, 150 females) senior secondary school two (SS2) students drawn from two public secondary schools in Ikot Ekpene were categorised into experimental class taught with BSM and control class taught by lecture method. Trigonometry Achievements Test with reliability index of 0.83 was the instrument for data collection. Research questions and hypotheses were analysed with mean, standard deviation and analysis of covariance (ANCOVA). Findings indicate that students taught with BSM performed significantly better than those taught through lecture method. It is recommended that female Mathematics teachers should be employed and deployed to teach Mathematics, which latently can serve as role models to female students. Also, teachers of Mathematics should use BSM in teaching trigonometric concepts. By adopting steps of BSM strategy in worked examples in their publications, authors will encourage and create opportunities for teachers and students to familiarise with the strategy that can enhance students' academic achievement and retention.

Keywords: Bransford-Stein model, Achievement, Retention and Trigonometry.

1.0 Introduction:

Mathematics is the study of the principles and patterns that govern numerical and spatial relationships, shapes, qualities and structures. It involves the use of logical reasoning, problem solving skills, and mathematics abstractions to understand and describe the world (Ogunsola, Adelana & Adewale 2021). Maruta and Magaji (2022) defined Mathematics as a subject that encroaches into all aspects of human endeavours and could be described as the life wire in the studies of various discipline. The author further stated that it is the important of mathematics that compelled the Federal Government of Nigeria to make Mathematics compulsory subject from primary school through to the end of secondary school education.

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

One of the goals of Trigonometry teaching is to improve the ability of students to recognise a problem and apply the knowledge of trigonometry to get the solution to the problem. Learning trigonometry will remain ineffective without an appropriate teaching strategy. For this reason, the researcher opined that, if students are allowed to experience trigonometry through Bransford-Stein model during trigonometry lessons, their academic achievement and retention will improve and their fear in learning the subject will vanish leading to greater positive productivity in all examinations.

Shear (2020) defined Mathematics Achievements as a construct used to represent the level or nature of demonstrated learning in relation to specific domain of Mathematics. Mathematics achievement can be assessed at either an individual or a group level and hence, can be described as multilevel construct. The author further stated that, at individual level, mathematics achievement represents the knowledge and skills a person has learned in particular areas of the subject. At a group level, mathematics achievement

represents the demonstrated learning of a classroom, school, school district, state or country, and can serve as an indicator of educational opportunities. In research and policy contexts, Mathematics achievements are usually measured with a test or assessment procedures. According to him, these tests can include both multiple choice and constructed response items.

According to Seun, Onocha and Oluwatoyin (2022), student achievement in Mathematics measures the amount of academic content a student learns in a determined amount of time. Student achievement has become an important topic in education today because it is the outcome of educational system. It is the extent to which a student, teacher or institution have their educational goals. The author further stated that mathematics achievement has to do primarily with the performances of the student in their teacher-made test or standardised achievement test administered by examining bodies. However, the major goal of the teacher is to improve the ability level of the students and prepare them for adulthood. Each grade level has learning goals or institutional standards that teachers are required to teach.

Mathematics can be defined as a subject that encroaches into all aspects of human endeavours. It could be described as the life wire in the studies of various disciplines. It is this importance of this subject that compelled the Federal Government of Nigeria to make it a compulsory subject from primary school through the end of senior secondary school education (Bakke & Igharo in Maruta & Magaji, 2022).

Nneji in Maruta, Mohammed and Magagi (2023), contended that for improvement of retention of learned materials in Mathematics, activity-based learning is indispensible. Retention depends mainly on teaching strategy adopted by the teacher. He further pointed out that research evidences have consistently indicated teaching method as a major factor determining achievement and retention of students in Mathematics. Hence, the search for better methods and newer innovations is a great challenge facing science educators. In the same vein, Maruta (2018), stated that the lecture method does not allow students to participate actively in the learning process and discourages them to have both inductive and deductive reasoning.

Gender differences in Mathematics teaching, learning, achievement and retention have also been explained on the basis of gender differences in cognition and brain internalisation (Egara & Mosimege, 2023). In a similar argument, Allahnana, Akande Vintesh, Alaku and Alaku, (2018) argued that male and female students do experience the world in different ways. Firstly, they are positioned differently in society. Secondly, their learning styles are different in how they perceive and process reality. Oribhabor (2020) emphasise that most Mathematics classroom discourse is organised to accommodate male learning patterns, hence their high achievement in Mathematics. Also, the idea that Mathematics is for boys may result in low motivation in girls and could widen the gender gap in Mathematics achievement and retention in favour of boys. Boaler in Ajai and Imoko (2015) is of the view that the different learning goals of girls and boys leave girls at a disadvantage in competitive environments. Boys and girls preferred a Mathematics curriculum that enabled them to work at their own pace as their reasoning is different. Girls value experiences that allow them to think and develop their own ideas, as their aim is to gain understanding. In the same vein, boys emphasize speed and accuracy and see these as indicators of success. Boys are able to function well in a competitive environment of textbook based mathematics learning.

Many people do not know that mathematics is more that what is taught at school, and different from what most people think it is. Many students have wrong image of mathematics; that mathematics has many formula to learn without knowing why; mathematics is a never changing, not lively subject; something for nerds and loners, and also, maybe, something for boys and men and not for girls and women. Gender is a set of characteristics distinguishing between male and female, particularly in the case of men and women. The discriminating characteristics vary from sex to social life to gender identity. Gender differences in mathematics achievement and ability has been a source of concern as scientists seek to address the under-representation of women at the highest levels of education, (Asante in Ajai & Imoko, 2015).

Through BSM, learners are given free hands and exposed to different strategy for solving problems. BSM is made up of five stages (i) Identification of the problem (ii) Defining the problem (iii) Exploring possible solutions, (iv) Act on the selected strategy, (v) Look back and evaluate the effects.

1.1 Research Questions

The following research questions guided the study

i. What are the Achievement scores of males and females taught Trigonometry using Bransford-Stein model?

ii. What are the retention scores of males and females taught Trigonometry using Bransford-Stein model?

1.2 Hypotheses

The following hypotheses were formulated and 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 Bransford-Stein model.

Ho_2. There is no significant difference in the mean retention scores of male and female students taught trigonometry using Bransford-Stein model.

2.0 Methodology

The design used for this study was the quasi-experimental pretest, posttest, control group design. The target population of the study was all secondary school students in Akwa Ibom State. Two (2) public secondary schools was the sample for the study to guarantee uniformity because of same scheme of work and curriculum, learning condition of the students and period of work coverage is the same. The sample of the study comprised 300 students of equal gender ratio drawn from senior secondary schools two (SS 2) in Ikot Ekpene town. Only co-education schools were considered. Two out of 20 schools were selected using simple random sampling techniques; one was assigned experimental group and the other control group, using tossing a coin method. Trigonometry Achievement test (TAT) comprising 50 multiple choice objective questions with options A-D, developed by the researcher was used for data collection. TAT items were adapted from WAEC and NECO past questions, and New General Mathematics textbooks. The TAT was used for pretest and posttest. To determine Retention, Trigonometry Retention Test (TRT), which is the reshuffled items of the TAT was used. TAT underwent

both face and content validation by three experts, two in measurement and evaluation and one from mathematics department. The validity index was computed by taking the average of the index by various experts which yielded 0.83 coefficient of internal consistency. A trial test was given to students in one of the co-education schools that are not among the sampled schools. The reliability coefficient of the TAT was determined using Kuder-Richardson 20 (KR – 20) formula which yielded internal consistency index of 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 significance level using Analysis of Covariance (ANCOVA), where the pretest scores served as the covariates.

3.0 Results of Findings

Test of hypotheses and answers to research questions are presented below:

Research question 1: What are the mean achievement scores of males and females taught trigonometry using (BSM)?

Table 1: Mean ($\overline{X}$) and standard deviation (SD) of males and females taught trigonometry using BSM in TAT

Strategy	Gender	Type of Test	N	$\overline{X}$	SD
BSM	Male	Pretest	150	8.50	3.99
	Female	Posttest	150	19.92	3.67
		Pretest	150	8.92	3.26
		Posttest	150	19.46	2.90
Total			**300**		

Table 1 shows that the male students taught Trigonometry using BSM had mean scores of 8.50 and 19.2, standard deviations of 3.99 and 3.67 in pretest and posttest respectively. Female students taught Trigonometry using BSM had mean scores of 8.92 and 19.46 with standard deviations of 3.26 and 2.90 in pretest and posttest respectively.

Hypothesis one (Ho_1): There is no significant difference in the mean achievement score of male and female students taught trigonometry using BSM.

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

Table 2: ANCOVA result of mean achievement of male and female students taught Trigonometry using BSM computer at alpha = 0.05

Score	Type III sum of squares	Df	Mean square	F	Sig.	Decision
Corrected model	2991.839	4	747.960	186990	0.000	S
Intercept	4786.037	1	4786.037	1196.509	0.000	S
Posttest	87.762	1	87.762	21.941	0.000	S
Group	2476.233	1	2476.233	619.058	0.000	S
Gender	84.726	1	84.726	21.182	0.20	NS
Group gender	321.344	1	321.344	80.336	0.315	NS
Error	12183.988	295	41.302			
Total	**591.39.000**	**300**				
Corrected Total	**13916.500**	**299**				

The exact probability, P = 0.020 is less than α = 0.05 show that gender is a significant factor on the achievement of student taught Trigonometry using BSM. Hence the Null hypothesis is rejected.

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

Table 3: Mean and standard deviation of male and female student taught trigonometry using BSM in TRT

Score	Gender	Types of Test	N	$\bar{X}$	SD
BSM	Male	Posttest	150	19.92	3.67
	Female	Retention	150	20.79	4.58
		Posttest	150	19.46	2.90
		Retention	150	19.12	3.12
Total					

Table 3 shows that made student taught Trigonometry using the BSM had mean scores 19.92 and 20.79, standard deviations of 3.67 and 4.58 in posttest and retention respectively.

Female students taught Trigonometry using BSM had mean scores of 19.46 and 19.12, standard deviations of 2.90 and 3.12 in posttest and retention respectively.

Table 4: ANCOVA results of mean retention scores of male and female students taught trigonometry using BSM

Score	Type III sumof squares	Df	Mean square	F	Sig.	Decision
Corrected model	3871.36	4	967.840	241.960	0.000	S
Intercept	5.20.697	1	520.697	130.174	0.000	S
Posttest	179. 804	1	179.804	44.951	0.000	S
Group	360.712	1	360.712	90.178	0.000	S
Gender	28.461	1	28.461	7.115	0.170	NS
Group gender	12.674	1	12.674	3.169	0.071	NS
Error	13084.821	295	44.355			
Total	68721.426	300				
Corrected Total	**14654.304**	**299**				

Table 4 indicate that the exact probability P = 0.17 which is greater that = 0.05. this means that gender is not a significant factor on the retention level of students taught Trigonometry using BSM. Hence the null hypothesis was accepted.

4.0 Discussions of Findings

The result showed that both male and female students in the experimental group had higher achievement in Trigonometry than those in the control group. But the male students scored a little higher than their female counterparts in the experimental group. This agrees with the work cited by Effiom and Abdullahi (2021) that boys generally achieve higher than girls on standardised mathematics test.

Furthermore, the result shows that the mean retention scores in the students in the experimental were significantly above those in the control group. Thereby, agreeing with the findings of Ajai and Imoko (2015); Egora and Mosumege (2023) and Mahaweruimana, and Mutarutinya (2023). Male students had a higher mean retention than their female counterparts among those taught trigonometry using BSM.

Results of mean achievement scores of male and female students taught Trigonometry using BSM shows that there was a significant difference between gender and strategy since the probability level 0.020 was less than significant level of 0.05. The result of the retention shows showed no significant difference between gender and strategy

5.0 Conclusion

Based on the findings of the study, it was concluded that Bransford-Stein problem solving model has more positive effect on student's achievement and retention in trigonometry than the traditional (lecture) method. This positive effect on students' achievement happens to be higher for the male students than the female counterpart even though the difference in their achievements for both groups was not significant. The overall results obtained from this study agree with the general expectation of educators that activity-based teaching strategies which are student-centred are more educationally rewarding that the traditional (lecture) method which is more of teacher-centred.

6.0 Recommendations

- The following recommendations were made from the study: Female teachers should be employed and deployed to teach in order to encourage female students.
- Authors should be encouraged to use the steps of BSM strategy in their worked examples in order to afford teachers and students the opportunity to use the strategy.
- Teachers should be encouraged to use BSM for teaching their students Trigonometric concepts in school, and more attention should be given to the female students.

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