Journal of Research in Education and Society,
Volume 16, Number 3, December 2025
ISSN(p): 2141-6753 ISSN(e): 2795-3033
Published By
International Centre for Integrated Development Research, Nigeria
In collaboration with
Copperstone University, Luanshya, Zambia

Effect of Bransford-Stein Model Problem-Solving Instructional Strategy on Academic Achievement and Retention in Mathematics among Senior Secondary School Students in Akwa Ibom State

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ABSTRACT

The study examined the effects of Bransford-Stein Model (BSM) Problem-solving Instructional Strategy on Academic Achievement and Retention in Mathematics among Secondary School Students in Akwa Ibom State. A quasi-experimental pretest, posttest, control group design was used for the study. A sample of 200 (92 males, 108 females) senior secondary school two (SS2) students was drawn from the public secondary schools in Ikot Ekpene Town. Two intact classes were used for the study; the experimental class was taught using the BSM, and the control class was taught using the lecture method. Two research hypotheses were formulated and tested at a 0.05 significance level. The Mathematic Achievements test, with a reliability index of 0.83, was the instrument used for data collection. The data collected were analysed using mean, standard deviation, and analysis of covariance (ANCOVA). The findings indicate that students taught using BSM performed significantly better than those taught using the lecture method. Male students achieved more than their female counterparts taught with BSM. Also, male students retained more than their female counterparts when taught with the same BSM instructional strategy. It is recommended that female teachers should be employed and deployed to teach in order to encourage female students. Authors should use the steps of the BSM strategy in worked examples to afford teachers and students the opportunity to use the strategy. Teachers should use BSM for teaching mathematical concepts in schools, and more attention should be given to female students. These will enhance students' academic achievement and retention.

Keywords: *Bransford-Stein model, Achievement, Retention and Mathematics.*

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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 mathematical abstractions to understand and describe the world (Ogunsola, Adelana & Adewale, 2021). Maruta, Mohammed and Magaji (2023) defined mathematics as a subject that involves all aspects of human endeavours and could be described as the life wire in the studies of various disciplines. The Federal Government of Nigeria makes mathematics a compulsory subject from primary school through to the end of secondary school education (Ginsburg, 2016). According to Courtney (2016), Mathematics helps students develop the capacity to visualise mathematical content. Learning mathematics implies understanding symbols, language, relationships, identities, equations and other verbal problems (Bhat, 2017).

One goal of Trigonometry teaching is to improve students' ability to recognise a problem and apply their knowledge of trigonometry to solve 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 mathematics through the Bransford-Stein model during mathematics lessons, their academic achievement and retention will improve, and their fear of 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 a specific domain of mathematics. Mathematics achievement can be assessed at either an individual or a group level and hence, can be described as a multilevel construct. The author further stated that, at the 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, mathematical achievements are 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 & Oluwatoyin (2022), student achievement in mathematics measures the amount of academic content a student learns in a determined time. Student achievement has become a topic in education today because it is the outcome of the educational system. It is the extent to which a student, teacher or institution has their educational goals. The author further stated that mathematics achievement concerns itself primarily, with the students' performance in their teacher-

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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 encompasses all aspects of human endeavours. It could be described as the life wire in the studies of various disciplines. It is the 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 the improvement of retention of learned materials in mathematics, activity-based learning is indispensable. Retention depends mainly on the teaching strategy adopted by the teacher. He further pointed out that research evidence has 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 from having 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 and how they perceive and process reality. Oribhabor (2020) emphasises 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 ideas, as they aim to understand. In the same vein, boys emphasise 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 students have a wrong impression about mathematics, which they percieve as having many formulas to learn without knowing why; mathematics is a neverchanging, not lively subject; something for nerds and loners, and 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 have 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 rein and exposed to different strategies for solving problems. BSM is made up of five stages: (i) identifying the problem, (ii) defining the problem, (iii) exploring possible solutions, (iv) acting on the selected strategy, (v) looking back and evaluating the effects.

Mathematics is a fundamental subject that plays a crucial role in the development of critical thinking, problem-solving, and analytical skills. Despite its importance, many senior secondary school students in Nigeria struggle with mathematical concepts, leading to poor academic achievement and retention. The conventional teaching methods often employed in mathematics classrooms, which emphasize rote memorization and procedural fluency, may not adequately equip students with the skills to tackle complex mathematical problems. This has resulted in a high failure rate in mathematics examinations and a lack of interest in pursuing mathematics-related courses in higher education. The inability of students to effectively apply mathematical concepts to solve problems has significant implications for their future careers and the nation's development. Therefore, there is a need to explore innovative teaching approaches that can enhance students' problem-solving skills, academic achievement, and interest in mathematics. This study seeks to investigate the effects Bransford-Stein Problem-solving model on academic achievement and retention among senior secondary school students in mathematics.

Research Hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance:

1. There is no significant difference between the mean achievement scores of male and female students in mathematics taught using Bransford-Stein problem-solving model instructional strategy.
2. There is no significant difference between the mean retention scores of male and female students in mathematics taught using Bransford-stein problem-solving model instructional strategy.

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METHOD

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 were the sample for the study to guarantee uniformity because of the same scheme of work and curriculum, learning conditions of the students, and period of work coverage are the same. The sample of the study comprised 200 students 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 the experimental group and the other the control group, using the coin tossing method. The Mathematics Achievement Test (MAT), comprising 50 multiple-choice objective questions with options A-D, developed by the researcher, was used for data collection. MAT items were adapted from WAEC and NECO past questions and the New General Mathematics textbooks. The MAT was used for pretest and posttest. To determine Retention, MAT was reshuffled and administered to the students two weeks after the posttest. MAT underwent content validation by three experts, two in measurement and evaluation, and one from mathematics education from the Department of Science Education, Michael Okpara University of Agriculture, Umudike. A trial test was given to students in one of the co-education schools that is not among the sampled schools. The reliability coefficient of the MAT was determined using the Kuder-Richardson 20 (KR–20) formula, which yielded an internal consistency index of 0.83. 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 a 0.05 significance level using Analysis of Covariance (ANCOVA), where the pretest scores served as the covariates.

RESULTS AND DISCUSSION

Table 1: Mean achievement score and standard deviation of male and female students taught using Bransford-Stein problem-solving model instructional strategy

Variable		Pre-test		Post-test		Achievement
Gender	N	$\bar{X}$	SD	$\bar{X}$	SD	mean gain
Male	29	16.62	4.24	54.07	8.44	37.45
Female	33	18.97	7.38	51.52	8.08	18.97

Table 1 shows the mean achievement score and standard deviation of male and female students taught mathematics using the Bransford-Stein problem-solving model instructional strategy. Male students had a pretest mean score of 16.62 with a standard deviation of 4.24 and a posttest score of 54.07 with a standard deviation of 8.44 and an achievement gain of 37.45, while female students had a pretest mean score of 18.97 with a standard deviation of 7.38 and a posttest mean score of 51.52 with a standard deviation of 8.08 and an achievement gain of 18.97. The standard deviations were closely spread and indicate low variability in scores. This indicates that male students taught using the Bransford-Stein problem-solving model instructional strategy achieved more than their female counterparts taught with the same Bransford-Stein problem-solving model as instructional strategy.

Hypothesis 1

There is no significant difference between the mean achievement scores of male and female students when taught using Bransford-Stein problem solving model instructional strategy.

Table 2: Analysis of Covariance (ANCOVA) of male and female students mean achievement scores when taught mathematics using Bransford problem-solving model instructional strategy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	131.027[a]	2	65.513	.910	.414	
Intercept	4342.347	1	4342.347	60.344	.000	
PRETEST	7.680	1	7.680	.107	.746	NS
GENDER	107.949	1	107.949	1.500	.231	NS
Error	2086.848	29	71.960			
Total	93596.000	32				
Corrected Total	2217.875	31				

a. R Squared = .059 (Adjusted R Squared = -.006)

Table 2 showed an F-ratio of 1.500 for groups with a P-value of .231, which is greater than the significant value of .05. The null hypothesis of no significant difference is therefore not rejected, which indicates that there is no significant difference between the mean achievement scores of male and female students taught mathematics using the Bransford problem-solving model instructional strategy.

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Table 3: Mean retention score and standard deviation of male and female students taught using Bransford-Stein problem-solving model instructional strategy

Variable		**Posttest**		**Retention**		**Retention**
Gender	**N**	$\bar{X}$	**SD**	$\bar{X}$	**SD**	**mean gain**
Male	29	54.07	8.44	55.10	7.10	1.03
Female	33	51.52	8.08	50.73	6.65	-0.79

Table 3 shows the mean achievement score and standard deviation of male and female students taught mathematics using the Bransford-Stein problem-solving model instructional strategy. Male students had a posttest mean score of 54.07 with a standard deviation of 8.44, and a retention score of 55.10 with a standard deviation of 7.10, and a retention gain of 1.03. Female students had a posttest mean score of 51.52 with a standard deviation of 8.08, and a retention mean score of 50.73 with a standard deviation of 6.65, and a retention gain of -0.79. The standard deviations were closely spread, which indicates low variability of the scores. This indicates that male students taught using the Bransford-Stein problem-solving model instructional strategy retained more than their female counterparts taught with the same Bransford-Stein problem-solving model instructional strategy.

Hypothesis 2: There is no significant difference between the mean retention scores of male and female students when taught using Bransford-Stein problem solving model instructional strategy?

Table 4: Analysis of Covariance (ANCOVA) of male and female students mean retention scores when taught mathematics using Bransford problem-solving model instructional strategy

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision
Corrected Model	2638.665[a]	2	1319.332	160.770	.000	S
Intercept	239.277	1	239.277	29.158	.000	S
POSTEST	2343.061	1	2343.061	285.518	.231	NS
GENDER	89.821	1	89.821	10.945	.402	NS
Error	484.174	59	8.206			
Total	175800.000	62				
Corrected Total	3122.839	61				

a. R Squared = .845 (Adjusted R Squared = .840)

Table 4 shows an F-ratio of 10.945 for groups with a P-value of .402, which is greater than the significant value of .05. The null hypothesis of no significant difference is therefore not rejected, which implies that there is no significant difference between the mean retention scores of male and female students taught mathematics using the Bransford problem-solving model instructional.

The results show that both male and female students in the experimental group have higher achievements in Trigonometry than those in the control group. The male students scored a little higher than their female counterparts in the experimental group. The results are consistent with the work of Effiom and Abdullahi (2021), which states that boys generally achieve higher than girls on standardized mathematics tests.

Furthermore, the results show that the mean retention scores of the students in the experimental group were significantly higher than those in the control group. Thereby, agreeing with the findings of Ajai and Imoko (2015), Egara and Mosimege (2023), and Mahaweruimana and Mutarutinya (2023). Male students had a higher mean retention than their female counterparts among those taught Mathematics using BSM.

The results of the mean Achievement scores of male and female students taught Mathematics using the BSM show that there was no significant difference between gender and strategy since the probability level 0.231 was greater than the significance level of 0.05. The results of the retention showed no significant difference between gender and strategy since the P-value of 0.402 is greater than the table value of 0.05. The null hypothesis of no significant difference is therefore not rejected.

CONCLUSION

Based on the findings of the study, it was concluded that Bransford-Stein problem-solving model has a more positive effect on students' 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-centered, are more educationally rewarding than the traditional (Lecture) method, which is more teacher-centered.

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 Mathematics concepts in school, and more attention should be given to the female students.
- Mathematics curriculum developers, educators and teachers should incorporate the Bransford-Stein Model among others in the curriculum, in training and teaching of mathematics at the senior secondary school levels.

REFERENCES

Ajai, J. T. & Imoko, B. I. (2015). Gender Differences in mathematics Achievement and Retention Scores: A case of Problem-Based Learning Method. *International Journal of Research in Education and Sciences* 1(1).

Allahnana, K. M., Akande, M. T; Vintseh, I. M. U., Alaku, E. A. & Alaku, M. E. (2018). Assessment of gender and interest in mathematics achievement in Keffi Local Government Area of Nasarawa State, Nigeria. *International journal of operation Research in management, social sciences and education,* 4(1), 127 – 140.

Bhat, D. S. (2017). Problem faced by students in learning sets. Unpublished Masters' Degree Thesis, T. U. Kathmandu.

Courtney, S. (2016). Developing meaning in Trigonometry. *Journal of Educational Research in Mathematics Education 28* (3), 258 – 277

Effiom, W. A. & Abdullahi, A. (2021) Effect of Polya's problem-solving strategy on senior secondary school students' performance in Algebraic word problem in Katsina metropolis, Katsina State, Nigeria. Sapientia Foundation *Journal of Education, science and Gender studies*; 3(2), 344-351.

Egara, F. O. & Mosimege, M. D. (2023). Gender difference in secondary school student's retention in algebra: A computer stimulation approach. *Eurasia Journal of Mathematics, Science and Technology Education,* 19 (7). https://doi.org/10.29333/ejmste/13280.

Ginsburg, H. P (2016). Mathematics learning disabilities: A view from developmental psychology. Journal of learning disabilities 30, 20 – 30. Retrieved from https://journals.sage.epub.com/home/idx

Maruta, S. I. (2018). Effect of Polya and Bransford-Stein models on Attitude, Retention and Performance in Trigonometry among Senior Secondary School Students in Kano State. Unpublished PhD dissertation, Ahmadu Bello University, Zaria, Nigeria.

Maruta, S. I. & Magaji, A. A. (2022). Effect of Polya model on senior secondary school student's retention in trigonometry in Kano State, Nigeria – AJSTME, 8 (2), 117 – 122. Retrieved: https://www.ajstme.com.ng.

Maruta, S. I., Mohammed, M. S. & Magaji, A. A. (2023). Effects of Bransford-Stein model on Gender Academic retention in trigonometry at Senior Secondary Schools level in Kano State, Nigeria. *Rima International Journal of Education, 2*(2), 118 – 126.

Muhawenimana, P. & Mutarutinya, V. (2023). Impact of Gender Differences on Students' Performance in Mathematics within selected Secondary Schools of Gicumbi District, Rwanda. *Journal of Research Innovation and Implications in Education,* 7(1), 188 – 199.

Ogunsola, O. A., Adelana, O. P. & Adewale, K. A. (2021). Effect of Problem-Based Learning Approach on Students' Academic Performance in Senior Secondary Mathematics.Journal of Science and Mathematics Letters, 9(2), 75-85. https://doi.org/10.37134/jsml.vol9.2.8.2021

Oribhabor, C. B. (2020). The Influence of Gender on Mathematics Achievement of Secondary School Students in Bayelsa State. *African Journal of Studies in Education, 14*(2). 196-206

Seun, O. A, Onocha, C. O. & Oluwatoyin, A. J. (2022). Value-Added Measures as predictors of student' Achievement in mathematics. *Journal of Education and Society*. *12* (1), 2418 – 2429.

Shear, B. R. (2020) Mathematics Achievement. Encyclopedia of quality of life and well-being Research. Living reference work entry.