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## EFFECTS OF BRANSFORD-STEIN INSTRUCTIONAL STRATEGY ON STUDENTS' ACHIEVEMENT IN ALGEBRAIC WORD PROBLEM AMONG UPPER-BASIC II IN JIGAWA STATE, NIGERIA

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### Abstract

The study determined the “Effects of Bransford-Stein Instruction Strategy on Students' Achievement in Algebraic Word Problems among Upper Basic II in Jigawa State, Nigeria”. The study adopted a Quasi-Experimental Design with emphasis on Pretest and Posttest Control Group. The population of 4,412 (2,518 male and 1,894 female) students were used for the study. The sample size of 153 (82 males and 71 females) students were used. Two research questions were asked and two Null Hypotheses were formulated. One instrument was used: Algebraic Achievement Test (AAT) with  $r=0.79$  reliability index. Descriptive statistics of mean and standard deviation was used to answer the research questions, while inferential statistics of ANCOVA was used to test the hypotheses at 0.05 level of significant. The findings of the study revealed that the exposure of students' to Bransford-Stein instructional strategy

enhanced students' achievement towards algebraic word problem and there is no gender difference in students' achievement towards algebraic word problem when they are taught using Bransford-Stein instructional strategy. It was however, recommended among others that Mathematics teachers should be encouraged to adopt Bransford-Stein instructional strategy in teaching word problems in mathematics; Pre-service teachers should be trained through workshops on how to use Bransford-Stein strategy to teach mathematical word problem; Mathematics curriculum developers should incorporate Bransford-Stein instructional strategy in the curriculum, in training and teaching of algebraic word problem at the Upper Basic level. This could be done by breaking down the content of the topics into stages as stated by the model.

**Keywords:** Bransford-Stein Strategy, Conventional Method, Achievement and Algebraic Word Problem.

## **Introduction**

Mathematics plays a pivotal role in national development, particularly in advancing science and technology. However, students in Jigawa State, Nigeria, have consistently underperformed in mathematics, especially in algebraic word problems, as evidenced by their poor results in the Basic Education Certificate Examination (BECE) from 2016 to 2024. Conventional teaching methods, which emphasize rote learning and procedural understanding, have been identified as a major contributor to this issue, leading to negative attitudes, low achievement, and poor retention among students.

This study investigates the effects of innovative instructional strategy Bransford-Stein on students' achievement in algebraic word problem-solving. The Bransford-Stein model employs a systematic five-stage problem-solving approach. The method promotes active learning and heuristic problem-solving, contrasting with the passive nature of conventional teaching.

The instructional strategy in the present study is Bransford-Stein teaching strategy, also known as the IDEAL problem solver model, was developed by John Bransford and Barry Stein in their book the Ideal

Problem Solver (1993). It is a teaching strategy designed to help individuals and educators approach mathematical problem-solving in a systematic way. The IDEAL model is an acronym for five stages of problem-solving, the stages are: (1) Identify the problem (2) Defining and representing the problem (3) Exploring possible strategies (4) Acting on those strategies and (5) Looking back. The choice of Bransford-Steins' as a teaching strategy used in this study is to find out whether the five stages enhance better achievement towards algebraic word problem solving. Students' achievement toward mathematics plays a crucial role in learning and teaching of mathematics. Academic achievement depicts students' achievement on a standard of measurement such as achievement test, skill test and analytical thinking test (Nneji, 2016). Thus, academic achievement is the gain in knowledge of students as a result of taking part in a learning activity or programed.

Gender as a variable was considered in this report so as to find out whether male and female students have differential achievement toward algebraic word problem. On gender related achievement reports, quite a number of studies established gender equality and differences in

achievement in mathematics after exposing both sexes to mathematics teaching and learning. Maitama (2021) and Shashaani (2017) report that no significant difference in the achievement between male and female students in word problem solving. Tsebo and Kurumeh (2015) reported in their study that male generally achieved higher than female students in Mathematics contrary to the report of Onwuka and Iweka (2018) were they report that female achieved higher than male in some mathematical word problem solving.

The research aims to determine whether this strategy can enhance students' problem-solving skills, improve their performance in algebraic concepts. Additionally, the study explores potential gender differences in these outcomes. The findings could provide valuable insights for educators, curriculum developers, and policymakers seeking to improve mathematics education in Nigeria and beyond. By addressing the limitations of traditional teaching methods, this study contributes to the broader goal of fostering a deeper understanding of mathematics and equipping students with the skills needed for academic and real-world success.

## **Statement of the Problem**

Despite the critical role that mathematics plays in national development, particularly through its application in science and technology, students' performance in the subject, especially in algebraic word problems, has remained consistently poor. This issue is evident in Jigawa State, Nigeria, where less than 50% of students have achieved satisfactory grades in the Basic Education Certificate Examination (BECE) mathematics section from 2016 to 2024, with significant challenges reported in algebraic and geometric word problems.

The conventional teaching methods predominantly used in Upper Basic Schools have been identified as a major factor contributing to negative attitude, poor achievement towards mathematics. These methods often emphasize rote learning and procedural understanding, leaving students with little conceptual comprehension and problem-solving skills. Furthermore, there are conflicting findings in the literature regarding the role of gender in mathematics achievement, with some studies suggesting male dominance, while others report no significant differences or even female superiority in certain mathematical tasks.

Given the persistent underachievement in algebraic word problem solving, there is an urgent need to explore alternative instructional strategies that could enhance students' problem-solving abilities. The Bransford-Stein model, which promotes active learning and heuristic problem-solving, may offer promising solutions. Therefore, this study investigated the effects of this instructional strategy on Upper Basic II students' achievement in algebraic word problem solving, while also examining potential gender differences in these outcomes.

### **Objectives of the Study**

The main objective of this study is to determine the effects of Bransford-Stein teaching strategy on students' achievement in algebraic word problem among Upper Basic II students in Jigawa State, Nigeria. The specific objectives were set to:

1. determine the effect of Bransford-Stein teaching strategy on academic achievement of students in algebraic word problem.
2. find out the effects of Bransford-Stein teaching strategy on male and female students' achievement when taught algebraic word problem.

### **Research Questions**

This work attempted to answer the following research questions:

1. What are the mean achievement scores of students in algebraic word problems when exposed to Bransford-Stein and conventional method?
2. What are the mean achievement scores of male and female students in algebraic word problems when exposed to Bransford-Stein teaching strategy?

### **Statement of Hypotheses**

In this study, the following null hypotheses were tested at 0.05 level of significance

- H<sub>01</sub>:** There is no significant difference in the mean achievement scores of students taught algebraic word problems using Bransford-Stein strategy and conventional method.
- H<sub>02</sub>:** There is no significant difference in the mean achievements scores of male and female students taught algebraic word problem using Bransford-Stein teaching strategy.

## Literature Review

Salami and Ameen (2016) conducted a study on the comparative effect of two problem solving models, Bransford and Stein and Polya, on senior secondary school students' performance in mathematics word problem. A sample of 180 SS II was used in the study. One instrument, the mathematics performance test (MPT) was used with two instructional guides. The MPT was an essay type adapted from WAEC. The result shows that posttest mean score of the two instructional models is 2.92 at 0.013 significant level. Since 0.013 is less than 0.05 level of significant, it implies significant difference in achievement of students exist between the two instructional models, and also respectively between Bransford and Stein and the other method. Polya and conventional method shows that there exists a significant difference, this was based on the p-value of 0.13 and 0.001 which was less than  $\alpha = 0.05$ . Also, the posttest mean scores of 20.92 and 6.63 indicated significant differences between Polya and Bransford and Stein, and the conventional method respectively when compared with the p-value of 0.013 and 0.000 which was less than 0.05 level of significant.

The result of this study shows that problem solving model of instruction could enhance students' performance better in word problems than the use of conventional method. Although two models were compared with conventional method the result still shows a significant difference in the achievement. The gap in the study was that the study area and the sample use were all in a metropolitan and one different zonal education offices, even though the two aimed at student' improvement in word problem solving.

Sheikh (2015) conducted a study to find the effect of Bransford-Stein problem solving model of teaching on revised Blooms Taxonomy in mathematics at elementary level in Pakistan. A quasi-experiment was performed in a school situated in urban area of Islamabad. Multistage sampling techniques were used for the selection of the school. 132 eight grade students were used in the experiment. Pretest which consists of 60 items of six cognitive processes and was developed. The experimental group was taught using Bransford-Stein problem solving model and the other group were taught though conventional method by research assistant. Forty lessons were taught during the 8 weeks. Posttest was administered and marked according to the

rubric designed for making. The data was analyzed by an SPSS package. One-way ANOVA and t-test were applied in the data. It was found that by teaching through Bransford-Stein problem solving model students perform better compared to the conventional method. Based on the finding the use of Bransford-Stein problem solving model shows significant improvement at all level of knowledge dimension. It also shows that Bransford-Stein problem solving model works better than the conventional method of teaching. This study is closely related to the study at hand in terms of design but both are studies differ in terms of location and content area. The former study was in Mathematics as a whole and was carried out in Pakistan while the present measures the effects of Bransford-Stein instructional strategy on students' achievement in algebraic word problem in Jigawa State, Nigeria.

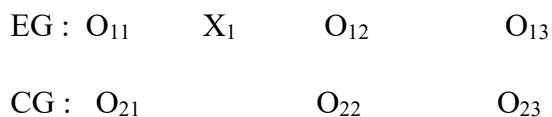
Ruddi (2014) conducted a study in the New York state with the purpose of examining the effect of teaching using Bransford-Stein 5-steps word problem solving model on seventh grade students' perception and level of achievement in algebra word problem. The design adopted was Quasi-experimental design: A total of 200 students constituted the sample of the study. Two seven grade classes participate in the study. One of the

classes serves as control and the other as experimental. Two instruments were used to source data for analysis. Likert scaled and two-tailed for two samples, t-test for two samples assuming unequal variance with ninety-five percent confidence level was used. The results of the study shows that students that were taught with Bransford-Stein word problem solving model significantly improve in their level of achievement compared to those that were not. The result also shows that for the group of students that received the instruction there was a significant improvement in their posttest perception of their problem-solving abilities. The result also shows that there was statistically significant difference between the mean score for the two groups after the intervention. Based on findings, it was recommended that mathematics teachers should adopt Bransford-Stein instructional strategy in teaching mathematics. The study is different with current study in terms of location.

### **Methodology**

A Quasi-Experimental of pre-test and posttest design was employed in the study. Quasi-experimental research design was used because it was not possible to randomize individuals to treatment and

control groups, hence intact classes were used. This represents treatment group and control group (Bransford-Stein and control group). Two intact classes were randomly assigned to experimental and control groups, because it was not possible to randomly assigned subjects to treatment groups, neither the school system nor parents would want a researcher to decide which classroom students were assigned to be (Donald, Christine & David, 2014). The research design was presented in figure 1.



**Figure 1:** Research Design

Where:

EG: Experimental Group (Bransford-Stein Model)

CG: Control Group (Conventional Method)

O<sub>11</sub>: Pretest before treatment for Experimental Group

O<sub>21</sub>: Pretest before treatment for Control Group

X<sub>1</sub>: Treatment for the experimental group

-- : Non-treatment for Control Group

O<sub>12</sub>: Posttest after treatment for Experimental Group

O<sub>22</sub>: Posttest for Control Group

The population of the study consists of all the Upper Basic II school students' in Hadejia Education Zone of Jigawa State. The target population for the study comprised all the 4,412 (2,518 male and 1,894 female) Upper Basic II students in 23 public co-education schools for the 2024/2025 academic session. The sample of 153 Upper Basic II students was used for the study. A simple random sampling technique was used to select two intact classes.

One instrument was used in the study. That is: Algebraic Achievement Test (AAT). The instrument underwent content and face validity by two experts in Mathematics Education with minimum of PhD qualification to see if the test fully represents the content area of algebraic word problem and suitable to it aims. Kuder Richardson (KR-21) was used to analyze the reliability of achievement test as it assesses the homogeneity of the test items, ensuring that they are measuring a single underlying achievement. These reliability values fall within the acceptable region on reliability scale and good for the study.

Data was collected during the normal class hours in two (2) steps in accordance with the

research design used, and with the aid of the instruments. The steps were:

**Step 1:** A pre-test was administered to experimental group before the treatment in order to determine the students' level, just the position of the students before the commencement of the experiment

**Step 2:** Post- test will be administered after treatment to the group in order to determine

the students' achievement in algebraic word problem solving.

Descriptive statistics of mean and standard deviation were used to answer research questions while inferential statistic of Analysis of Covariance (ANCOVA) was used for testing hypotheses at  $\alpha = 0.05$  level of significance

## Result

### Research Question One

What are the mean achievement scores of students in algebraic word problems when exposed to Bransford-Stein teaching strategy and conventional method?

**Table 1: Mean Achievement Scores and Standard Deviation of Students Taught Algebraic Word Problem Using Bransford-Stein and Conventional Method**

Teaching strategy	Type of test	No. Students	Mean score	Std. Dev
<b>Bransford-Stein</b>	Pre-test	46	10.09	4.13
	Post-test	46	17.15	4.10
<b>Control</b>	Pre-test	52	10.44	3.29
	Post-test	52	12.88	3.15

Table 1 shows that the pre-test mean achievement scores and standard deviation of students taught algebraic word problem using Bransford-Stein strategy were (10.09, 4.13) and post-test mean achievement scores and standard deviation were (17.15, 4.10).

While the pre-test and post-test mean achievement scores and standard deviation of students taught algebraic word problem using conventional method were (10.44, 3.29) and (12.88, 3.15).

## Null Hypothesis One

**H<sub>01</sub>:** There is no significant difference in the mean achievement scores of students taught algebraic word problems using Bransford-Stein strategy and conventional method.

**Table 2: Result of Analysis of Covariance of Students' Achievement Taught Algebraic Word Problem Using Bransford-Stein and Conventional Method**

Source	Type III Sum Of Square	df	Mean Square	F	Sig.	Partial Squared
Corrected Model	1387.144 <sup>a</sup>	2	462.381	45.370	.000	.477
Intercept	1501.603	1	1501.603	147.340	.000	.497
Pre-Test	818.654	1	818.654	80.328	.000	.350
<b>Group</b>	<b>581.058</b>	<b>1</b>	<b>290.529</b>	<b>28.507</b>	<b>.000</b>	<b>.277</b>
Error	1518.516	149	10.191			
Total	39959.000	153				
Corrected Total	2905.660	152				

a. R Squared = .477 (Adjusted R Squared = .467)

Table 2 reveals a significant difference in the mean achievement scores of students exposed to Bransford-Stein strategy and control group.  $F_{(2, 149)} = 28.507$  was obtained with associated exact probability value 0.000. Since the associated probability (0.000) is less than 0.05 set as level of significance, the null hypothesis was

rejected. The result implies that the Bransford-Stein teaching strategy produced a significant effect on the post-test achievement scores of students when covariate effect (pre-test) was controlled. Hence, there was a significant difference among the two groups of Bransford-Stein strategy and Control group.

## Research Question Two

What are the mean achievement scores of male and female students in algebraic word problems when exposed to Bransford-Stein teaching strategy?

**Table 3: Mean Achievement Scores and Standard Deviation of Male and Female Students Taught Algebraic Word Problem Using Bransford-Stein Strategy**

Gender	Type of test	No. Students	Mean scores	Std. Dev
<b>Male</b>	Pre-test	27	10.11	3.93
	Post-test	27	17.00	4.45
<b>Female</b>	Pre-test	19	10.05	4.52
	Post-test	19	17.36	3.64

Table 3 shows that the pre-test mean achievement scores and standard deviation of male students taught algebraic word problem using Bransford-Stein strategy were (10.11, 3.93) and post-test mean achievement scores and standard deviation

were (17.00, 4.45), while the pre-test and post-test mean achievement scores and standard deviation of female students taught algebraic word problem using Bransford-Stein strategy were (10.05, 4.52) and (17.36, 3.64) respectively.

### **Null Hypothesis Two**

**H<sub>02</sub>:** There is no significant difference in the mean achievements scores of Male and Female students taught algebraic word problem using Bransford-Stein teaching strategy.

**Table 4: Result of Analysis of Covariance of Male and Female Students' Achievement Scores Taught Algebraic Word Problem Using Bransford-Stein Strategy**

Source	Type III Sum Of Square	df	Mean Square	F	Sig.	Partial Squared
Corrected Model	199.286 <sup>a</sup>	2	99.643	7.697	.001	.264
Intercept	940.415	1	940.415	72.645	.000	.628
Pre-test	197.772	1	197.772	15.278	.000	.262
<b>GenderBran</b>	<b>1.767</b>	<b>1</b>	<b>1.767</b>	<b>.137</b>	<b>.714</b>	<b>.003</b>
Error	556.649	43	12.945			
Total	14289.000	46				
Corrected Total	755.935	45				

a. R Squared = .264 (Adjusted R Squared = .229)

Table 4 reveals that, there was no significant difference in mean achievement scores of male and female students exposed to Bransford-Stein strategy  $F_{(1, 43)} = .137$  was obtained with associated exact probability value 0.714. Since the associated probability (0.714) is greater than 0.05 set as level of

significance, the null hypothesis was not rejected. The result implies that there is no gender difference in students' achievement in algebraic word problem when they are taught with Bransford-Stein teaching strategy.

### Discussion of Results

On the achievement of students towards word problem, it was found that a significant difference in the mean achievement scores of students exposed to Bransford-Stein strategy and control group in favor of Bransford-Stein strategy. The findings on students achievement in the Bransford-Stein strategy group compared to those using conventional method group are in agreement with the

findings of Aliyu (2020) and Maitama (2021) whose finding revealed Bransford-Stein had better achievement score than those exposed to the conventional method. In similar vein, the findings of Kajuru, Bolaji and Kauru (2015) who stated that there was significant difference in the achievement of the students taught trigonometry concepts due to treatment. The findings revealed the efficacy of the use of Bransford-Stein model

in enhancing students' achievement in word problem solving. However, the result of the present study contradicts Visser (2015) who found that students in the conventional group performed significantly better than the treatment group in word problem solving.

The result from this study revealed that, there is no significant difference in mean achievement scores of male and female students exposed to Bransford-Stein instructional strategy. The result implies that there is no gender difference in students' achievement in algebraic word problem when they are taught with Bransford-Stein teaching strategy. This finding is in agreement with the findings of Shafi (2016), Unodiaku (2018), Agha (2019) and Iji (2015) who showed no significant difference between students exposed to problem solving strategies and those exposed to conventional methods. The result is in disagreement with the findings of Abubakar and Ogugue (2011) and Wbuke (2013) who found there is significant difference in sciences achievement of boys and girls exposed to activity-based method of instruction. The findings of this study was at variance also with the findings of Anchor, Imoko and Jimin (2012) who reveals that male and female students mean scores in the group

thought with active learning strategy did significantly differ.

### **Conclusion**

It is evident from the findings of this study that the use of Bransford-Stein instructional strategy could provide a good way for students to learn algebraic word problem solving. The students maintain the eagerness for long period of time and participate effectively in group activities. The results also indicate that students under Bransford-Stein model work through a series of steps and utilize mathematics reasoning skills to organize their thinking and better prepare for problems solving.

From the result of the study Bransford-Stein strategy showed great promise in helping students to improve their algebraic word problems solving skills, increase achievement and developed confidence in solving word problems. If the strategy proposed by this study is adopted in algebraic word problem solving teaching and learning it will boost the achievement of students in skills acquisition, problem solving.

These results implies that the learning approaches employed by mathematics teachers in teaching might have been partly responsible for the persistent

underachievement and low retention ability of students in mathematics since they were using the conventional methods, most of the times. The implications of this study hinges on the development of more virile teaching approaches for teaching mathematics

### **Recommendations**

The following recommendations are made based on the findings of the study:

1. Mathematics teachers should be encouraged to adopt Bransford-Stein instructional strategy in teaching word problems in mathematics
2. Pre-service teachers should be trained through workshops on how to employ the use of Bransford-Stein strategy to teach mathematical word problem.
3. Mathematics curriculum developers should incorporate Bransford-Stein instructional strategy in the curriculum, in training and teaching of algebraic word problem at the Upper Basic level. This could be done by breaking down the content of the topics into stages as stated by the models.
4. Periodic and regular training through seminars and workshops should be organized for in-service teachers to update their knowledge on current and

innovative teaching strategies at lower and upper levels of education by state government.

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