Effect Of Prior Knowledge Of Mathematical Language On Secondary School Students' Achievement In Bearing In Delta State

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***Abstract*— The study investigated the effect of prior knowledge of mathematical language (PKML) on achievement of senior secondary school two (SS 2) students in mathematics bearing word problems in Delta State. Two research questions guided the study and two null hypotheses were tested at 0.05 alpha level. The study adopted quasi experimental design, specifically, the pretest, posttest, non-randomized control group. The population for the study comprised 5,818 SS 2 students from both private and public schools in Oshimili South Local Government Area. Multi-stage sampling procedure was used in drawing 84 students from public schools and 62 students from private schools, making a total of 146students. The instrument for data collection was Achievement Test in Bearing (ATB), which comprised of 20 items. ATB was used for both the pretest and posttest to ascertain the achievement level of the participant before and after the treatment. The instrument was validated by three experts. The reliability of the ATB was obtained using Kuder Richardson Formula 20, which yielded reliability coefficient of 0.75. The experimental groups were taught using prior knowledge technique while the control groups were taught without prior knowledge technique. The data collected were analyzed using Mean and Standard Deviation to answer research questions and Analysis of Covariance to test the hypotheses. The findings showed among others that; a significant difference existed in the mean achievement scores of students exposed to PKML and conventional method in favor of PKML groups, gender was not a significant factor in the mathematics overall achievement of students exposed to PKML. Based on the findings, it was recommended among others that the mathematics teachers should expose students to mathematical language in bearing before teaching the unit to improve students' performance in word problems in bearing.**

Keywords—prior knowledge, mathematical language, bearing

I. INTRODUCTION

Science and technology education is particularly important because it enables nations to explore opportunities for scientific and technological breakthroughs which lead to national development. Nigerian educational system prioritized science and technology with policies that are favorably disposed to science and technology education. The National Policy on Education and the National Policy on Science and Technology made good provisions for science and technology education. While adopting education as instrument par excellence, the Federal Government of Nigeria gave premium on the importance of science and technology and in line with global perspectives of science for all, made provisions for science and technology education in the National Policy on Education (NPE). The Federal Republic of Nigeria (FRN, 2014) specified that special provisions and incentives shall be made for the study of the sciences at each level of education system.

In mentioning science and technology, one must not fail to mention mathematics, because the importance of mathematics to scientific and technological development cannot be overlooked. Okigbo and Okeke (2017) stated that Mathematics is the foundation of science and technology and the functional role of mathematics to science and technology is multifaceted and multifarious that no area of science, technology and business enterprise escapes its application. Kolawole and Popoola (2011) defined mathematics as an instrument to ease or facilitate the learning of other subjects. It is a part of human's cultural heritage and a tool for explaining the world of space and number. Mathematics knowledge, principles and theories should be acquired through mathematics education.

There are some concepts in the secondary school mathematics curriculum that students perceived to be difficult thereby leading to poor performance of students at these areas. Okigbo and Ejikeme (2017) identified areas such as geometry and trigonometry as most difficult for teachers to teach and students to learn. These difficult areas need to be identified by the

mathematics teachers so that they will be acquainted with the weaknesses of students in mathematics. This is very imperative since the situation in the achievement of students in mathematics at all levels remain almost unchanged nationwide. Bearing is a concept in mathematics which is studied under trigonometry branch of mathematics.

Bearing could be defined as the clockwise measurement in degrees of the angular relationship between any two points in the same horizontal plane (Soyemi, 2009). Clapham amd Nicholson (2009) defined bearing as the direction of the course upon which an object is set or the direction in which is sighted. The instrument used in finding the direction of bearing is called compass which has the four main directions namely north (N), south (S), east (E) and west (W). When teaching is done without emphasizing the meaning of mathematical language used, especially in bearing, the student may lose communication and this could be responsible for students' poor performance in mathematics. According to Odetola and Salman (2014), such words as finding the bearing of one point from another must be accurately interpreted and translated into diagram and also, the direction of the bearing must be properly located so that students problem in solving bearing problems could be reduced.

From the foregoing, it becomes imperative to determine the effect of prior knowledge of mathematical language on academic achievement of senior secondary school students in concept of bearing. Mathematical language is an essential element of learning, thinking, understanding and communicating mathematics. If students understand mathematical language, it will reduce error in solving mathematics word problems thereby improve the achievement in bearing problems. Mathematical language need to be properly and accurately understood to improve on the skills of students in solving word problems in bearing in mathematics.

Gender is one of such factors also mentioned in literature to have considerable effects on students' academic performances especially in science subjects. Gender is the range of physical, biological, mental and behavioral characteristics pertaining to and differentiating between the feminine and masculine (female and male) population. The importance of examining performance in relation to gender is based primarily on the socio-cultural differences between girls and boys. Adigun, Onihunwa, Irunokhai, Sada and Adesina (2015) showed that even though the male students had slightly better performance compared to the female students, it was not significant. Oluwatoyin (2011) found no gender difference in mathematics performance both in the urban and rural areas though performances of males and females in the rural areas were below average. Akanmu (2015) also indicated that there was no significant difference in the mean achievement scores of male and female students taught mathematics using GeoGebra package. Therefore, there is need for more studies on teaching techniques that could enhance equal achievement among the male and female students.

Statement of the Problem

The concept of bearing is an aspect of trigonometry and is one of the most frequently asked questions by both WAEC and NECO in objective and essay questions but students manifest poor performance when attempting questions on the concept. For instance, the Chief Examiners' Report (2015) noted that many candidates avoided questions on bearing and those who attempted the questions recorded very low marks. They also observed that students fail to attempt or fail bearing problem in Senior Secondary Examination as a result of their inability to translate the mathematical word expression given into diagrammatical form. This may be as a result of their level of understanding of mathematical terms in the concept of bearing. Hence the problem of this study is what would be the effect of prior knowledge of mathematical language on academic achievement of senior secondary school students in bearing problems?

Purpose of the Study

The purpose of the study was to determine the effect of prior knowledge of mathematical language on secondary school students' achievement in bearing problems in Delta State. The specific objectives of the study are to determine;

(1) Difference between the mean achievement scores of SS 2 students taught word problems in bearing with prior knowledge of mathematical language and those taught with conventional method

(2) Difference between the mean achievement scores of SS 2 male and female students taught word problems in bearing with prior knowledge of mathematical language.

Research Questions

The following research questions were raised to guide the study:

1. What is the difference between the mean achievement scores of SS 2 students taught word problems in bearing with prior knowledge of mathematical language and those taught with conventional method?
2. What is the difference between the mean achievement scores of SS 2 male and female students taught word problem in bearing with prior knowledge of mathematical language?

Hypotheses

The following null hypotheses were formulated to guide the study.

1. There is no significant difference between the mean achievement scores of SS 2 students taught word problems in bearing with prior knowledge of mathematical language and those taught with conventional lecture method.

2. There is no significant difference between the mean achievement scores of SS 2 male and female students taught word problem in bearing with prior knowledge of mathematical language.

Method

The design used for the study is quasi experimental design, specifically, the pretest, posttest, non-randomized control group design was adopted. The study was carried out in Oshimili South Local Government Area (LGA) of Delta State, Nigeria. The population of the study comprised all the 5,818 SS 2 students in Oshomili South LGA. A total of 146 students were purposely sampled from four (4) schools used in the area. Using simple random sampling techniques, two (2) schools in their intact classes were assigned experimental group and two (2) other schools were assigned control group. Experimental group was taught using PKML while control group was taught using conventional method. The instrument for data collection was Achievement Test in Bearing (ATB) developed by the researchers and validated by two experts in science education and one expert in measurement and evaluation. Corrections and suggestions arising from these experts were used to review the instrument before it was used. The reliability of the ATB determined using Kuder-Richardson Formula 20 was 0.75.

The four steps were taken for experimental procedures, they are:

- The mathematics teachers of schools selected underwent training on how to teach mathematical language on the content scope of bearing,
- The ATB was administered to both experimental and control groups as pretest,
- After the pretest, the experimental group was exposed to knowledge of mathematical language before they were taught the concept of bearing while the control group was not exposed to knowledge mathematical language in bearing. Both the experimental and control groups were taught for four weeks by the regular teachers of the schools used for the study.
- For the posttest, the items in the ATB were reshuffled and was administered again to both experimental and control groups to obtain the post ATB scores

Mean and Standard Deviation were used to answer the research questions while the Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.05 alpha level. In taking decision for research hypothesis, if the probability value (p-value) is less than the significant value (α = 0.05), the null hypothesis is rejected, otherwise, the null hypothesis is not rejected.

Results

Table 1: Difference between the mean achievement scores of SS 2 students taught word problems in bearing with prior knowledge of mathematical language (PKML) and those taught with conventional lecture method (CLM)

Gender	N	Mean Pretest	SD Pretest	Mean Posttest	SD Posttest	Mean Gain
Male	73	41.23	9.85	60.62	11.67	19.39
Female	73	36.92	7.15	49.66	9.29	12.74
Mean Difference		4.31		10.96		6.65

Table 1 reveals that the overall average mean achievement score of students exposed to PKML (experimental group) was 60.62 with a standard deviation of 11.67 while the group taught with CLM (control group) had an overall average mean achievement score of 49.66 and standard deviation of 9.29. The mean gain scores of the students exposed to PKML was 19.39 while that of the students taught with conventional lecture method (CLM) was 12.74. This implies that the students exposed to PKML have a higher mean achievement score when compared with that of those of students taught with CLM with a mean gain difference of 6.65

Table 2: Difference between the mean achievement scores of male and female students taught word problems in bearing with PKML

Gender	N	Mean Pretest	SD Pretest	Mean Posttest	SD Posttest	Mean Gain
Male	34	42.65	9.07	57.94	11.29	15.29
Female	39	40.60	10.45	69.95	11.63	29.35
Mean Difference		2.05		12.01		-14.06

In Table 2, the mean gain score of male students taught with PKML is 15.29 while their female counterpart taught the same way had mean gain score of 29.35. This result shows that the female students taught with PKML achieved higher than their male counterparts taught the same way. The difference in their mean gain is -14.06

Table 3: One-way ANCOVA test for significant difference between the mean achievement scores of students exposed to PKML and those exposed to CLM.

Source	Type 111 Sum of Square	Df	Mean Square	F	Sig.	Decision at p< 0.05
Corrected Model	11587.358[a]	2	5793.679	94.041	.000	S
Intercept	3537.443	1	3537.443	57.419	.000	S
PRE_TEST	7203.796	1	7203.796	116.930	-000	S
METHOD	1885.883	1	1885.883	30.611	.000	S
Error	8809.902	143	61.608			
Total	464250.000	146				
Corrected Total	20397.260	145				

a. R Squared = .568 (Adjusted R Squared = .562)

Table 3 shows that there is a significant difference between the mean achievement scores of students exposed to prior knowledge of mathematical language (PKML) and conventional method, (F(1, 143) =

30.611, p = 0.000 < 0.05). Therefore, the null hypothesis is rejected at 0.05 level of significance. This implies that there is a significant effect of treatment on students' achievement in word problems in bearing in favor of experimental group

Table 4: One-way ANCOVA test for significant difference between the mean achievement scores of male and female students exposed to PKML

Source	Type 111 Sum of Square	Df	Mean Square	F	Sig.	Decision at p<.05
Corrected Model	455.480[a]	1	455.480	3.462	.067	NS
Intercept	265460.960	1	265460.960	2017.574	.000	S
PKML	4383.562	1	4383.562	39.418	.000	S
Gender	455.480	1	455.480	3.462	.067	NS
PKML * gender	987.647	1	987.647	19.537	.000	S
Error	9341.780	71	131.574			
Total	278025.000	73				
Corrected Total	9797.260	72				

a. R Squared = .046 (Adjusted R Squared = .033)

Table 4 shows that there is a significant difference between mean achievement scores of male and female students exposed to prior knowledge of mathematical language (PKML) and conventional method, (F(1, 71) = 19.537, p = 0.000 < 0.05). Therefore, the null hypothesis is rejected at 0.05 level of significance. This implies that there is a significant effect of treatment on students' achievement in word problems in bearing based on gender which is in favor of the females

Discussion

The study shows that PKML technique was more effective in improving students' achievement in word problems in bearing (mean posttest score =60.62) than conventional lecture method (mean posttest score =49.66). The findings show that there is a significant effect of treatment on students achievement in word problems in bearing (F (1,145) = 30.611, with p = 0.000 < 0.05). The findings were in agreement with Benson (2015) who reported that there was a positive association between mathematical vocabulary instruction and students achievement in mathematics. The findings of this study also agreed with Odetola and Salman (2014) who reported that students commit errors in bearing word problems based on mathematical language and this contributed to students' poor performance in mathematics. The researchers also asserted that the errors were attributed to inadequate understanding of mathematical language used in bearing problems. The findings of this study also agreed with Ebisine (2012) who reported that improving mathematical vocabulary has helped students solve multi-step problems and word problems.

The study revealed that the male students taught with conventional lecture method recorded greater mean achievement (49.96) than their female counterparts (49.47). Meanwhile, the female students exposed to PKML had greater mean achievement (62.98) in comparison to their male counterparts (57.94). The findings show that there is a significant difference in the mean achievement scores of male and female students taught word problems in bearing using PKLM technique. The findings contradict that of Oluwatoyin (2011) which showed that there was no gender difference in mathematics achievement of male and female students. The study also disagree with Akanmu (2015) who assessed the influence of gender on the performance of learners taught with Geogebra package and found that there was no significant difference in the sampled students' performance based on gender. The findings concur with Odetola and Salman (2014) who found a significant difference in the errors committed by the students in the experimental group and control group in the pretest and posttest respectively. They also discovered that gender had significant influence on the errors committed by the students in bearing problems as the male students committed more errors than their female counterparts

Conclusion

Based on the findings, the study concludes that the use of PKML in teaching word problems in bearing is effective in improving the achievement of students in bearing. However, PKML enhanced achievement of female students more than the males.

Recommendations

Based on the findings of this study, the following recommendations were made:

1. Mathematics teachers should expose students to mathematical language in bearing before teaching the topic to improve students' performance in word problems in bearing
2. The Mathematics teachers should be sensitized on the use of PKML in teaching bearing (mathematics) through workshops, seminars, and conferences organized by Ministry of Education, professional associations like Mathematical Association of Nigeria (MAN) and Science Teacher Association Nigeria (STAN)
3. Mathematics teachers should adopt the use of PKML technique in teaching bearing aspect of mathematics so as to improve the performance of students through reducing the abstract nature of bearing topic.

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