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RELATIONSHIP BETWEEN STUDENTS' SCORES ON PLAIN QUESTIONS AND WORDED PROBLEMS IN MATHEMATICS

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Abstract: *This study examined the relationship between students' scores on plain questions and scores on worded problems in Mathematics. The aim was to find out the extent to which students' ability in solving problems involving plain question could predict students' performances in worded problems in Mathematics. The study used a correlational design. Eighty senior secondary schools were drawn through purposive sampling technique from 16 selected public secondary schools from Bayelsa and Delta States. While 5 students were drawn from each of the sixteen schools selected from Bayelsa state, 5 students were chosen from each of the 9 schools drawn from Delta State. One research question and one hypothesis guided the study. With the assistance of some senior Mathematics teachers and colleagues from Measurement and Evaluation, the researcher constructed a ten-item Mathematics test involving arithmetic, algebra, statistics, trigonometry and geometry. The instrument had two sections, namely; A and B. Section A consisted of 5 plain questions and section B, 5 worded problems. The research question was answered through the use of co-efficient of determination while the hypothesis was tested at .05 level of significance using the Product Moment Correlation technique. The finding from the study showed that there was a significant relationship between students' scores on plain questions and scores on worded problems in Mathematics. Forty-six percent of students' ability to solve worded problems in Mathematics was predicted by their skill in handling plain questions in Mathematics. Students had a higher mean score in plain questions. It was recommended that while scoring Mathematics test items examiners and test constructors should take particular notice of responses from test-takers from different sub-groups. This is to guard against differential item functioning.*

Keywords: Relationship, Mathematics Scores, Plain Questions, Worded Problems.

INTRODUCTION

Nigeria is in the quest for scientific and technological development. This feat cannot be achieved outside sound education. In particular, there can be no break-through in science and technology without Mathematics. Besides its significant role in nation building, Mathematics helps in shaping the way people deal with the various spheres of private, social and civil life, Anthony and Walshaw (2009), as cited by Mensan, Okyere and Kuranchie (2013). The national Policy on Education (2004) specifies the status of Mathematics as a core subject which must be offered by pupils and students at the primary and post-primary levels of education across the country. This status of Mathematics must have informed the inclusion of the subject on school's time-table as a subject to be taken every day.

Although, Mathematics plays a significant role in the scientific and technological development of a nation, the performance of students does not justify the place of the subject in nation building. The West African Examinations Council Chief Examiners (2011) reported that candidates who recorded credit passes and above in Mathematics have not been more than 40% of the total number of candidates that wrote the examination from 2009 to 2011. This suggests that there will be a great reduction in the number of applicants seeking admission into Universities and other institutions of higher learning in and outside the country. This is because Mathematics is a compulsory requirement in many courses.

The poor trend in students' performance in Mathematics appears not be limited to Nigeria. In Ghana, Chief Examiners' 2007 report, cited by Mensah, et al. (2013) showed that candidates demonstrated poor understanding of Mathematics concepts, and this led to inability to form the necessary Mathematical models to be tackled with the requisite skills.

The experience of this researcher as a secondary school Mathematics teacher from 1993 to 2007, and as a part-time course tutor at the National Teachers' Institute (NTI/DLS) from 2004 till date, shows that the problems militating against students in Mathematics rest greatly on word problems. Most students appear to have dislike for worded problems in Mathematics. Take for instance, this question from Macrae et al. (2002): "The ages of a parent and child add up to 39 years. In 5 years the parent will be 4 times as old as the

child. Find the ages of the parent and the child", (p. 113). This problem can easily be tackled by assuming the ages of the parent and child to be x and y, respectively. Thus, making x + y equal to 39. The second sentence translates to x + 3 = 4 (y +3). This simplifies to x – 4y = 9. Hence, the two equations to be solved simultaneously are x + y = 39 and x – 4y = 9. If the two linear equations are presented in plain form for students to solve, the task will be very easy. However, this is not the case when the problem is presented in word form as shown. The same thing may apply to the item couched by WAEC (2010) as follows: the sum of 2 consecutive whole numbers is $\frac{5}{6}$ of their product. Find the numbers. Here, test-takers will be confronted with words like "consecutive" and "product" before arriving at x + (x – 1) = $\frac{5}{6}$ of x (x + 1) producing $5x^2 – 7x – 6 = 0$. The test-taker will face the problem of dropping one of the roots of the equation $\left(x = \frac{3}{5}\right)$ since only whole numbers are required. Given this equation, little or no challenge is posed.

Some researchers have conducted some studies concerning word problems in Mathematics and students' Mathematics achievement. Bates and Wiest (2004) conducted a study on "Impact of personalization of Mathematical word problems on student performance." A sample of 42 students (22 boys and 20 girls) was drawn from a population of fourth-grade students at Copper Flats Elementary School in Northern Nevada. A quantitative analysis of the effects of personalizing word problems on fourth-grade students' achievement was used. Ten problems were randomly selected from a Mathematics textbook with which the students were familiar. Five problems were personalized while 5 were not. Using a paired samples t-test to compare the two sets of problems, in addition to descriptive statistics of mean and standard deviation, the study revealed that there was no significant increase in student achievement when the personalization treatment was used regardless of student reading ability or word problem type. The researchers concluded that this result may be attributed to the tender age of the subjects used for the study. They asserted that personalization of word problems in Mathematics may be useful in teaching older students.

Kurumeh and Chiawa (2009) carried out a study on "Impact of Students' Interest in Solving Algebraic Word Problems Using Aesthetic Value Approach". A sample of 240 SS1 students was randomly drawn from six

intact classes from three co-educational secondary schools in Makurdi LGA of Benue State. The study which was quasi-experimental used a non-equivalent pretest, posttest control group design. An interest inventory and two lesson plans were used in the study. The hypotheses were tested using AWPSII while mean and standard deviations were employed in answering the research questions. The major finding of the study was that students taught algebraic word problems using Aesthetic Value Approach showed significantly higher interest than those taught the same topics with conventional methods. This present researcher feels that the result is a pointer to the fact that new ways of doing things are likely to produce better results.

Other researches on word problems and Mathematics were conducted by Sepeng and Madzorera (2014) and Esan (2015). Sepeng and Moadzorera (2014) studied "Sources of Difficulty in Comprehending and Solving Mathematical Word Problems" using mixed – methods design. A sample of 60 subjects (29 females and 31 males) was drawn from Grade II learners taking Mathematics in a township high school through purposive sampling. A test of word problems and a questionnaire were administered to the Grade II learners. Data analysis was performed using the analytic frameworks of Garegae (2007) and Latu (2004), as cited by Sepeng and Madzorera (2014). The study revealed that Mathematical language appeared to influence learners' comprehension when solving Mathematical word problems. The study of Esan (2015) centered on "Co-operative Problem – Solving Strategy and Students' Learning Outcomes in Algebraic Word Problems: A Nigerian Case." A sample of 240 Junior Secondary School Students was randomly drawn from six schools in Ilesa Local Government Area of Oshun State in Nigeria. The six schools were randomly assigned to control and experimental groups. The Experimental Group was taught algebraic word problems using Co-operative Problems-Solving Strategy (CPS) while the Control Group was taught using conventional teaching methods. A 16-item questionnaire and 20 item multiple choice achievement tests on algebraic word problems were administered to the participants. The two groups were post-tested at the end of the fourth week. Using a t-test statistics, the result indicated that the overall achievement of students exposed to (CPS) was better than those exposed to the conventional

methods. The researcher recommended the inclusion of the (CPS) in training Mathematics teacher.

The review of the empirical studies seems to suggest that learners of Mathematics have to fully understand Mathematics words before meaningful solutions can be provided. Besides Mathematics vocabulary, the ordinary meaning of words in English Language may be helpful. By way of analogy, phrases or words such as "at least" "at most", "inclusive", "respectively" "regular" and "at random" commonly found in Mathematics word problems require an understanding of the dictionary learning, besides their special meanings in Mathematics vocabulary/register. The understanding of the two is crucial and may lead to a successful attempt at word problems in Mathematics. On the other hand, the inability of students to understand the dictionary meaning and the specialized usage of these words may result in item differential functioning. In other words, the items couched are not unidimensional (do, not measure a single latent trait in Mathematics). This study seeks to compare the achievement of students in plain Mathematics problems and word problems in Mathematics. This appears not to have been covered by researchers, to the best knowledge of the present researcher.

STATEMENT OF THE PROBLEM

Mathematics is crucial to advancement in science and technology. The emphasis given to Mathematics at the primary and post-primary levels of education in Nigeria has prompted governments at all levels and other stakeholders in the education industry to encourage the study of the subject by providing the necessary resources. The poor performance of students seems not to justify the attention being given to Mathematics. Majority of our secondary school students cannot solve simple problems in Mathematics. The situation becomes worse when such students are made to solve simple word problems in Mathematics. This is simple application of what has been taught.

Not only is it important for students to learn Mathematics concepts, it is also needful that students should be able to relate Mathematics to real life situations. The problem for this study is "What is, the relationship between students' scores on plain Mathematics questions and scores on word problems in Mathematics?"

Research Question

The following research question directed the study:

1. What is the extent of relationship between students' scores on plain questions and scores on worded problems in Mathematics?

Hypothesis:

The following hypothesis was tested at .05 level of significance:

1. There is no significant relationship between students' scores on plain questions and scores on worded problems in Mathematics.

METHODOLOGY

The study used a descriptive correlational survey design. The population consists of final year students from selected public Senior Secondary Schools in Bayelsa and Delta States. Judgemental sampling technique was employed in drawing a sample of 80 students for the study. The instrument used in the study was ten Mathematics questions (five plain questions and five word problems). The questions were adopted from the May/June West African Senior School Certificate Examination (WASSCE) General Mathematics/ Mathematics (Core) 1 for 2009, 2010 and 2011. The areas covered were arithmetic, algebra, statistics, trigonometry and geometry. Respondents were provided with plain answer sheets for solutions to the Mathematics items. A time duration of 1½ hours was given to the respondents. With the help of some Mathematics teachers, the researcher developed a marking scheme having a maximum score of 40 marks (20 marks for the 4 plain questions, and 20 marks for the word problems). The questions carry equal marks. Students' responses were scored by senior Mathematics teachers. Each respondent had two sets of scores, one for plain questions and the other for word problems. The resulting scores were subjected to a correlational analysis using the Product Moment Correlation technique at .05 level of significance.

DATA ANALYSIS AND PRESENTATION OF RESULTS:

Research Question One

What is the extent of relationship between students' scores on plain questions and scores on worded problems in Mathematics?

Table 1 showing the extent of relationship between students scores on plain questions and scores on worded problems in Mathematics.

Variables	N	□	r-calculated	r^2
Plain Questions	80	9.1		
Word Problems	80	3.8	0.68	0.46

Table 1 shows that r-calculated is 0.68. The co-efficient of determination r^2, is 0.46; the mean scores for plain questions and word problems are 8.1 and 3.8 respectively. The r^2 value of 0.46 indicates that 46% of the performance in word problems can be predicted or accounted for by performance in plain questions.

Hypothesis One

There is no significant relationship between students' scores on plain questions and scores on worded problems in Mathematics.

Table 2 showing the analysis of the relationship between students' scores on plain questions and scores on worded problems in Mathematics.

Variables	N	□	r-calculated	r - critical	Remark
Plain Questions	80	9.1			
Word Problems	80	3.8	0.68	.217	Sign

Table 2 shows that r-calculated value is 0.68 while r-critical is .217. The mean scores for plain questions and word problems are 9.1 and 3.8 respectively. The null hypothesis of no significant relationship is rejected since the r-calculated value of 0.68 is greater than the r-critical value of 0.217; hence, there is a significant relationship between scores on Plain Mathematics questions and scores on word problems in Mathematics.

DISCUSSION OF FINDINGS

The first finding from the study showed that there is a positive relationship between scores on plain questions and scores on word problems in

Mathematics. In other words, there is a direct relationship between students' scores from the two sets of problems in Mathematics. Knowledge of plain questions in Mathematics accounted for 46% of ability in word problems. By implication, 54% of ability in word problems must have resulted in students' exposure to word problems in Mathematics.

The finding resulting from the test of significance revealed that there is a significant relationship between scores on plain questions and scores on worded problems in Mathematics. Besides the significant relationship between the two variables, students' mean performance in plain questions was much higher than their corresponding mean performance in the word problems. In other words, students did much better in plain questions than in word problems. This finding is in line with the studies of Sepeng and Madzorera (2014) and Esan (2015). The work of Sepeng and Madzorera (2014) showed that Mathematics language appeared to influence the comprehension of learners when solving Mathematical word problems. This is buttressed by the study of Esan (2015) which revealed that the students who were exposed to problem solving using co-operative problems – solving strategy (CPS) out – performed those exposed to the conventional method.

The finding from this study seemed not to be in agreement with the research conducted by Bates and Wiest (2004). Bates and Wiest (2004) reported in their study that there was no significant increase in student achievement when Mathematical word problems were personalized. The researchers noted that the trend could be attributed to the tender age of the subjects employed in the study. Probably, a different result could be obtained when subjects who are older are studied.

The low achievement of the subjects of this study in worded problems seems to suggest that language must have played a major role. Take item one (Section B), for instance; this is just a combination of simple statistics and inequality $\left(\frac{2+5+2x+7}{4} \leq 5\right)$. If this question were to be in plain form, responses to the item would have been better. Combining knowledge of mean and inequality posed the problem. The same thing applies to item 2 from the same section. Students required knowledge of arithmetic (directed numbers) and simple algebra (factorization of a quadratic expression) to be able to solve the problem. The word "smaller" in the question constituted the

problem. Majority of the students could not decide on $-5\ or\ -2,$, the roots of the equation $x^2 + 7x + 10 = 0.$ Many of the students either ended their work as $x = -5\ or\ -2,$ or simply concluded that x = -2. There was the difficulty in deciding which root was smaller.

This trend appears to be in consonance with the observation made by the present researcher that most students provide poor responses when problems in Mathematics are worded. This situation poses challenges to Mathematics teachers and test constructors who must guard against item differential functioning in Mathematics tests.

CONCLUSION

Ability in solving problems involving plain questions in Mathematics directly relates to problem-solving skill in worded problems in Mathematics. Students had higher mean score is plain questions in Mathematics compared to the mean score obtained in worded problems in Mathematics.

RECOMMENDATIONS

Based on the findings of this study, it is hereby recommended that:

i) Mathematics teachers should drill students in Mathematics vocabulary; this will keep them abreast with words that are commonly associated with Mathematics questions.

ii) Examiners/test constructors should take note of the responses to worded problems by different sub-groups (gender, location, socio-economic status) of testees.

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APPENDIX 1

MATHEMATICS FOR RESEARCH

Instruction: The following are some mathematics questions designed for research purpose. Please provide detailed solutions that lead to the answers.
ANSWER ALL QUESTIONS TIME DURATION: 1 Hour

SECTION A:

1. Correct .002473 to 3 significant figures.
2. What is the median of the following numbers: 22, 41, 35, 63, 82, 74?
3. If $27^x = 9$, find x
4. Solve $\frac{2x+1}{6} - \frac{3x-1}{4} = 0$
5. Factorize the expression am + bn – an – bm.

SECTION B:

1. The mean of the numbers 2, 5, 2x and 7 is less than or equal to 5. Find the range of value of x.

2. A regular polygon of n sides has each exterior angle equal to 45^0. Find the value of n.
3. The sum of 6 and one-third of x is one more than twice x. Find x

4. An arc of a circle subtends an angle of 60^0 at the centre. If the radius of the circle is 3cm, find, in terms of π, the length of the arc.

5. A boy looks through a window of a building and sees a mango fruit on the ground 50m away from the foot of the building. If the window is 9m from the ground, calculate, correct to the nearest degree, the angle of depression of the mango from the window.

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