Transactions of the Nigerian Association of Mathematical Physics
Vol. 6 (Jan., 2018), pp. 355 -367

In honour of Prof. Ekhaguere at 70

Effects of English Language proficiency on junior secondary school students' performance in Mathematics in Bauchi State, Nigeria

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Abstract. The study was aimed at establishing the effect of English language on the Nigerian junior secondary schools two students performance in mathematic. Solomon Four Group design was used as a research design for the study. The target population comprised of junior secondary school students in Bauchi Southern educational zone of Bauchi State, Nigeria, who were in Boarding schools. The accessible population was Junior Secondary two students in the same types of schools and in the same educational zone of the state. Purposeful sampling technique was used in chosen the four boarding schools for the study. The exact number of JSS2 students found in each school formed the sample in the study. The study being quasi-experimental, student were classified as experimental groups (n=210) and control groups (n=210), making a total of 420 student. The researcher trained the teachers in the experimental groups where the language of instruction was English language The use of Mathematical modelling approach (MAA) in the mathematics lesson was necessary, as it was used as an English Supportive Programme. Pre-test was administered before treatment and a post-test after three weeks treatment. The instrument used for the study was students achievement test (MWPST) and was pilot tested to ascertain the reliability. The reliability coefficient α was 0.82. Experts ascertained their validity before being used for data collection. Data from the students achievement test (MWPST) was coded and analyzed using Statistical Package for Social Sciences (SPSS) version 17. Analysis of Variance (ANOVA) and independent t-test were used to test hypothesis at 0.05 level of significant. Analysis of data generated from students pre-test revealed that, the effect of English on students' performance in word problems was insignificant ($t(203) = 0.919$, $p > 0.0$). This revealed that students' performance in word problems was the same before the commencement of the treatment. The result from the study showed a significant difference ($F(417) = 48.63$, $p = 0.00$, $p < 0.05$) in the effect of English language on performance between the four groups in the post-tests. The interventional strategy (Mathematical modelling) has significantly improved the performance and problem solving abilities of those groups (experimental) that were given treatment 'more than those groups (control) who were not given the treatment. Results of the post-test means score between the treatment (experimental groups) and controlled groups show a significant difference ($p < .05$).. Overall results in this study illustrate that students' performance in word problems has increased significantly. The result also indicated an increased in their proficiency of the language of instruction and text language. In essence therefore learners seem to be directly related to language use in the mathematics classroom.

Keywords: English language, proficiency, modelling, mathematical approach, real word problems, junior secondary schools.

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1. Introduction

Mathematics is a subject which is a continuous process, that is to say that it specify how an individual can view a problem and provide solution to the problem. It defines a situation and gives the reason for the existence of the problem situation. In essence therefore it develops knowledge and understanding which can be applied to solve relevant problems or situations (Uchechi, 2013). Mathematics is an essential tool in the exploration of or world and viewed as the science of understanding patterns that exist around us and solving problems in our daily life (Agwu, 2015).

Learning mathematics especially at the secondary level of education is guided by language polices that is universally or globally accepted and is recognize, this is to pave way for learners to have asses to advance mathematics courses (Perez& Andrew, 2014). The language of instruction must provide leaners with the proficiency of the text or material that is to be learnt. In Nigeria English language has been recommended as the language of instruction in teaching mathematics and science subject in secondary school (NPE, 2004& David, 2011). Olanipekun (2013), Olanipekun and Shola (2014) also affirmed that English language has provided Nigeria with assess to the international communities.

Nigeria is a multilingual community where learners at secondary level are learning mathematics that is not in their first language. Research indicated learning mathematics that is not in the learners main language makes the learning difficult to understand or to comprehend (Setati, etal., 2009). In mathematics, there are specific registers which are English group of word with different interpretation (mathematical meaning) and may not have the same meaning in the real English language. Example of such registers may include; sum (+), difference (-), product (x), of (x), quotient (÷), take away (-), etc. These have to be learnt and understood by learners when leaning mathematics, especially algebraic word problems (Sepeng, 2010).

Awofala, Nneji & Fatade (2012. pp. 117) in their studies on importance of language policy in the learning of science, technology and mathematics (STM) in Nigerian secondary schools also recognized English Language as a medium of instruction in STM classes at the secondary school level. They maintained that it has positive effects on students' performance in mathematics. The discussion was supported with the report of a study in which students' performance in English Language, and in each of mathematics, biology, chemistry, physics, technical drawing, further mathematics and agricultural science in the West African Senior Secondary Certificate Examinations (WASSCE) were correlated.

Abedi (2001) assessed the effect of the proficiency of the medium of instruction on students' performance in mathematics and revealed that students' performance may be connected with their proficiency level of the text language. This is a clear indication that proficiency in the language of instruction by students learning mathematics can influence their performance in the subject. Ladele (2013) in Nigeria found that, as students were given a task in word problem at JSS1 and where required to translate the problem into the required equation and obtain the solution to the problem, his result reported a 30% pass in the algebraic word problems component, indicating the need for a focus on algebraic word problems teaching and learning. This clearly shows that most Nigerian students could not comprehend most of the text language which are English written statement. An inadequate grasp of the language of instruction is a major source of underachievement in school mathematics, denying access to full curriculum in mathematics and the resulting opportunities for higher level of educational experience in mathematics (Perez & Andrew 2014).

In carrying all learners along during mathematics lesson and especially algebra word problem lesson, teachers should emphasize class discussion, communication and reading habit as these will improve learners' proficiency in both the text language and the language of instruction

(PSSM, 2000: 60, NCTM, 2009). Such efforts can provide an opportunity for second-language learners overcome those differences that can affect their ability to communicate mathematically" (NCTM, 2000). Thus, if a student is proficient in English language, it is more likely that he or she will perform well in mathematics and vice versa (Adegoke 2013). This agreed with the findings of Clarkson and Galbraith (1992); Adegoke & Ibode, (2007); Moschkovich, (1996) linking language and mathematic achievement.

In today's classroom, students learn mathematics with communication demand (oral and written) which require participation in mathematics process and practices such as explaining solution process, providing conclusion and making argument and justification (Percy & Andrew, 2014). These processes are also refers to as mathematical modelling approach The procedures relate to acquiring technical vocabulary, developing comprehension skills necessary to read and understanding various mathematical facts in solving word problems (Lesh & Zawojewski, 2007). As leaners engage in modelling process, they are likely to communicate with the data in given problem and solve the problem as well. In essence they can examined, evaluate and paraphrase or refined the problem thereby by developing an equation or algebra to solve the problem (Him & Kim, 2011).

Proficiency in the language of instruction and ability to formulate or mathematize by the Nigerian junior secondary school students and beyond will make word problems easier to be solved. This has becomes necessarily for country like Nigeria which is becoming a multilingual community to see that learning mathematics through English as a language of instruction is highly improved by setting Language support programs for students whose level of proficiency in English Language is low.

Evidence to this Students' low achievements in mathematics were observed in both national and external exterminations in which 31.8% of the Nigerian secondary school students who scored a credit in Mathematics and English language with only two 2% of the students in Bauchi State (WEAC, ,2014), while at JSSCE level with 38% (Mohammed, 2012). This initiative should be taken to fill such gap and stands as a step in this direction.

1.1 Purpose of the Study

The purpose of the study was designed to assess the effects of English Language on the junior secondary school performance in mathematics

1.2 Hypothesis of the Study

A null hypothesis was tested in this study at significance alpha level of 0.05.
Ho1: There is no statistically significant difference in the effect of English Language on junior secondary school students' performance on word problem.

1.3 The Conceptual framework

The Conceptual framework to guide the study was based on the Constructivism theory (Piaget, 1967) which believes that an individual develops his reasoning with the pattern he sees. Students individually construct their pattern of reasoning which leads to the action they take. Teachers work and provide all avenues for learners to acquire a new concept through a gradual and continual process (Driver & Erickson, 1993).

The framework is represented diagrammatically in figure 1. This shows the relationship of variables for determining the effects of English language using mathematical modelling approach

on junior secondary school students' performance in mathematics. These variables are; English language, the medium of instruction for independent variable, teachers' approach and knowledge of the subject matter, students background and entry behaviour, for intervening variables, students' performance in mathematics (dependent variable). The type of school used was boarding schools to control the effect of the classroom environment. Junior secondary two students who are approximately of the same age were involved in the study. In this study therefore the teaching method used influenced the learning outcomes.

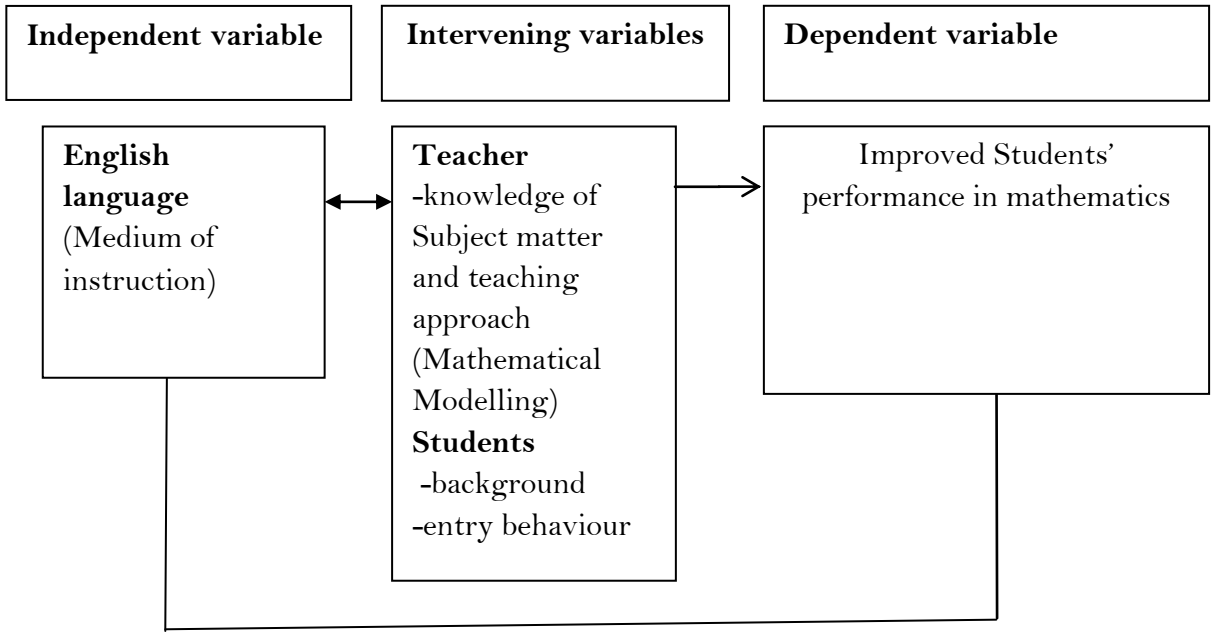

Figure 1: Conceptual framework (researcher)

2. Methodology

2.1 Research design

The study used Quasi-experimental design. Quasi-experimental design and in particular Solomon Four-Group design require the researcher used two controlled and two experimental groups but does not randomly assign participants to groups (Creswell, 2009). This design has advantage over others since it controls the major threats to internal validity except those associated with interaction and history, maturity and instrumentation (Cook &Campbell, 1979). The design allowed for a rich analysis and description of the effect of the treatment on teachers and students. The schools were randomly assigned to the control and experimental groups

A pre-test and post-test was administered to both groups, but only the experimental group received treatment. The procedures for the experiment was in such a way that Group E1 (Experimental group) has received pre-test (O1), treatment (X) and post-test (O2). Group C1 (Control group) have received pre-test (O3), no treatment and post-test (O4). Group E2 have received no pre-test but have received treatment (X) and post-test (O5). Group C2 have received only post-test (O6). The post-test O5 and O6 have ruled out any interaction between testing and treatment. Within each treatment condition, there was a group that was pretested (E1) and the one that was not (E2). The various combinations of tested and untested groups with treatment and

control groups will allow the researcher to ensure that confounding variables and extraneous factors have not influenced the results (Spector, 1981).

The Research design may be represented as shown in table1.

Table 1. Showing the Solomon Four Design procedures

Group	Pre-test	Treatment	Post-test
R 1	O1	X1	O2
R 2	O3	O4	
R 3		X2	O5
R 4			O6

Source: (Braver & Braver 1988).

2.2 Sampling procedures

A sample is a collection of some (or subset) of elements of population. The sample elements represent the population (Amin, 2005). Gibson & Brown (2009) argued that, in a study, the generalization about any study is always a matter of concern, where the issue of result from the study can play the role of sample and is used to represent a larger population considered in the study. A purposeful sampling procedure was used to get a variety of schools to participate in the study. A purposeful sampling procedure is one of the examples of non-probability sampling procedures (Kombo & Tromp, 2006; Babbie, 2010). Two out of the four boarding schools were assigned to the treatment (one boy and one girl schools).

2.3 Sample Size

The sample of four the selected boarding schools in the zone were obtained. The schools in each group are shown below.

Group 1 (Experimental group) N= 108
Group 2 (Control group) N= 110
Group 3 (Experimental group) N= 102
Group 4 (Control group) N= 100

Fraenkel & Wallen (2000) recommend at least 30 subjects per group. Hence this number was adequate for the study

2.4 Instrumentation

A Mathematics Word Problem Test (MWPST) instrument with ten structured items (Appendix) was used to collect data from the sample of students. The test items were considered as English written statement and developed from the junior secondary school two mathematics syllabus with emphasis on word problems (numerical and symbolic). The researcher also carefully selected part of the items from students' termly examinations. The test was scored with a maximum score of 5 marks

per items using Newsman performance strategies. The instrument was given to three experts in mathematics education for validation. The test was pilot tested using two schools that were not included in the study but had similar characteristics as the sample schools. This was to ensure its reliability. The Cronbach alpha reliability test was carried out for the test instrument to establish its internal consistency (Cohen et al., 2011). An alpha coefficient of 0.82 was obtained for the Mathematics Word problem Solving Test (MWPST). This method is suitable to draw inferences that are accurate enough.

2.5 Training and treatment period

Out of10 mathematics teachers found in the four selected schools for the study, five from experimental schools were selected and trained by the researcher .The participating teachers in the experimental schools were introduced and trained in the strategy (Mathematical Modeling). The training was done 5 hours daily for 5working days in August, 2015.After the pre-test, the treatments were administered on jss2 students in the experimental groups only. In administering the treatments, teachers in the experimental groups taught students (JSS2) word problem using the MMA for 70 minutes every working day for three weeks. In all the groups, the focus of the study was on word problems that involved combine, compare, group word problems of one and two steps as aspects of mathematics content. Teaching in this group was interactive with the teacher's use of the questioning and explanation techniques which were required in the modelling approach. At the modelling approach, teachers included students' activities during learning process (Appendix II). Digital cameras and tapes were used to record the conversations and then transcribed by the researcher himself.

In the control groups, the setting and instructional process was predominantly the traditional classroom which emphasizes teacher centred instructional process which relies on Mathematics textbook and teacher's explanations. In most cases, teacher's explanation of the lesson content required little or no input from the pupils.

2.6 Data collection

After the pre-test and the treatment, the same test (MWPST) were administered to all the groups as post-test to assess possible changes in pupils' level of problem solving ability in word problems. The achievement test was scored using Newsman performance strategies. In this strategy, students were required to follow steps in their solutions to all the 10 items in the instrument. By this strategy, each step in the five steps was awarded 1 mark for the correct answer (step) and 0 marks for a wrong step. In this procedure the rating ranged is between 0 and 5marks per item. The researchers scored the pre-tests and post-tests and generated quantitative data, which were analysed.

3. Data analysis

Analysis of variance (ANOVA) and Scheffes Comparism were used to analyse differences in the four means of the post-test scores. It was used to determine whether the differences were significant. A t-test was used when dealing with two means because of its superior power to detect differences between two means. Significance level of 0.05 was used to test the null Hypotheses.

3.1 Results

Result on effects of English language in teaching and learning word problems were observed and scored on the five stages of mathematical modelling adopted from Newsman (1983b, p. 2) performance strategies. The study employed the Solomon four-group design. These have enabled the researcher have two groups sat for pre- tests as recommended by Borg and Gall (1989). The two groups were Experimental group (E1) and Control group (C1), a MWPST was therefore administered to JSS2 in groups E1 and C1 prior to the experiment. The pre-test contained 10 items that sought to test students understanding of the word problems, which was the focus of this study. The mean scores for each group were compared using t-test statistics for independent samples to establish if there were any statistical differences in their performance.

The results in MWPST pre-test mean scores between Experimental group (E1) and Control group (C1) was statistically insignificant, $t(203) = 0.919$, $p > 0.05$ with E1 having higher mean score and higher standard deviation than C1. This is a clear indication that generally students' performance in the pre-test was similar and their level of understanding word problem was also the same. Thus, the hypothesis which states that, there was no significant difference on the effect of English language on students' performance was then retained.

A post-test MWPST was also administered to the four groups (E1, E2, C1andC2) using the same design. The means scores performance for the four groups were analysed as shown in table 2.

Table 2. MWPST post-test mean score obtained by the students in the 4 groups

Group	N	Mean score	Std. De
E1 (1)	108	2.69	1.17
C1 (2)	105	1.50	.87
E2 (3)	102	2.19	1.10
C2 (4)	100	1.09	1.05

Source: Field Survey, 2015

Result in table 2 indicated that, students of group E1 showed the highest means score (2.69), followed by E2 (2.19). This is a clear indication that students understanding of word problems involving mathematical modelling has increased. Result also indicated that group C2 has the lowest means score (1.09) followed by C1 (1.50). The implication here is that when learning word problem through mathematical modelling, students' performance in learning mathematics will increase.

To determine whether there was any significance difference on the effect of English language in word problems, the same post-test was also used on the same categories of students. To analyse the post-test, analysis of variance (ANOVA), was also carried out. Table3 present the result.

Table 3: ANOVA Post-test results of MWPST between the 4 groups

	Sum of squares	df	Mean score	F	p-value
Between groups	155.14	3	51.712	48.63	.000
Within groups	427.46	417	1.063		
Total	582.594	420			

An analysis of variance for the post –test MWPST scores, as shown in table 3 indicates that there was statistically significant difference in effect of English between groups at $F(420)=48.63$, $p=0.00$, $p<0.05$.This implied that learning word problem through mathematical modeling shows a difference in effect of English language on students' performance in mathematics. It was also necessary to carry out further tests on the various combinations of means using Scheffe compares, to find out where the difference really occurred, table 4 gives the Scheffe post comparisons.

Table 4: Scheffe comparisons of the MWPST post- test means

	I Group	J Group	Mean Difference (I-J)	P-value
Scheffe	E1	E2	.49571* .	.009
		C1	1.19066*	.000
		C2	1.59571*.	000
	E2	E1	-.49571*	.009
		C1	.69495*	.000
		C2	1.10000*	.000
	C1	E1	. -1.19066*	.000
		E2	-.69495*	.000
		C2	.40505.	.053
	C2	E1	-1.59571*	.000
		E2	-1.10000*	.000
		C1	-.40505 .	.053

Source: Field Survey, 2015

Table 4 shows a Scheffe post hoc comparisons which indicated that there was significant means differences between experimental groups E1and E2 (ρ =.009) and also between experimental group E1 and control group C2 (ρ = .001). It also revealed that there was a significance differences between experimental group E2 and E1 (ρ = .009) and between experimental group E2 and control group C1 (ρ =.001). It when further to revealed that there was a significant difference in experimental group E2 and control group C2 (ρ =.001) and also between control group C1 and experimental group E1 (ρ =.001). The means significance difference was also revealed between control group C2 and experimental group E1 (ρ = .001) and between control group C2 and experimental group E2 (ρ =0.001) in the performance of Post-test MWPST. In addition it revealed that there was no statistically significant difference between experimental groups C1 and C2 (ρ =0.053) and between control groups C2 and C1(ρ =0.053) in performance of post-test MWPST.

A Scheffe post hoc test thus revealed that there was a statistically significant mean difference between the experimental groups E1and control group C2 (ρ =.001). The first hypothesis, H_{01} that, there was no significant difference on effect of English language between students' performance using mathematical modelling was rejected. To further test on the rejection or acceptance of the same hypothesis H_{01}, the design used in the study also allowed for general combination of the four groups into two groups to compare students' performance in the post-test MWPST. This was done by categorizing the four groups into two groups of experimental (E1 and E2) and control (C1 and C2) then running the test. Table 4.3.10 presents the result.

Categorizing the four groups into two groups of experimental (E1 and E2) and control groups (C1 and C2), t-test independence sample was used to compare students' performance in the MWPST post-test, table 5 present the result.

Table 5. t-test independent sample on mean score in MWPST for the two groups

	N	Mean	S. D	df	t-value	p-value
Experimental	210	2.44	1.12	418	31.20	.000
Control	210	1.30	1.0			

Source: Field Survey, 2015

Results in table 5 indicate that the difference in MWST post-test mean scores between experimental and control groups was statistically significant, t (418) = 13.1 = 0.000, $p<0.05$ with the experimental group having higher mean score than control group. Mathematical modelling approach therefore has a positive effect on students in teaching and learning word problems which are English written task.

3.2 Discussion

3.2.1 Effects of English language on students' performance in algebra word problems

The hypothesis H01 in the study was that there was no significance means difference on effects English language between students' performance in teaching and learning word problems using mathematical modelling at junior secondary school level. The hypothesis was pre-tested and post-tested using the design of the study. Result revealed a statistically insignificant difference in the mean scores of pre-test MWPST for the experimental (E1) and control groups (C1) at t (203) =0.919, $\rho = .326$, $\alpha = .05$ where $p>0.05$. Thus the hypothesis which stated that there was no significance difference on effect of English language on students' performance using modelling in word problem at JSS2 was retained. This revealed that the level of performance between experimental group E1 and control group C1 prior to the intervention was similar. This finding is to be expected since the students in the public schools have experienced one to two years of learning in English and therefore would have had limited English proficiency. In agreement with this finding also were Namasaka, Mondoh & Keraro (2013) who reported a pre-test result that shows insignificance means difference in performance between control and experimental groups involve in the study. The implication was that that the two groups are homogenous in their learning abilities.

Results on MWPST post-test on the hypothesis H01 in the study which stated that there was no significance means difference on effects English language between students' performance in teaching and learning word problems using mathematical modelling at junior secondary school level, the test of the means significance difference of students MWPST post-test using ANOVA, Scheffes Comaprism and independent sample t-test revealed a significant means difference (F (417) = 48.63 p = .01, $\alpha = .05$ where $p<0.05$). By implication result indicated that using mathematical modeling in learning algebra word problem increase students proficiency of English language as a language of instruction and the text language. This findings agreed with David (2009) who found that there was a significant relationship between English language Proficiency and academic achievements in mathematics.

4. Conclusions

Based on the results of this study it can be concluded that MAA facilitates students proficiency of the language of instruction among Nigerian junior secondary school students specifically who are attending public schools. The study which revealed a positive increase students' performance in mathematics, the strategy is an effective way of teaching and learning algebraic word problems among second language learners who are at their junior secondary school levels. Students' proficiency of English is a challenge which makes them difficult to comprehend the text language in word problems. These are also English written statement which requires proficiency of the text language. The Mathematical Modelling approach was shown by this study to be an effective way of teaching and learning algebraic word problems at junior secondary school levels. An effective mathematical vocabulary instruction can be used to promote students' attitude toward the Mathematics.

4.1 Implications of the study

Generally, the performance of students in mathematics at WAEC/SSCE and JSSCE over the years continue to remain very low and below fifty per cent. Since findings from the study indicated significance increased in the overall students' performance in word problem, then it has shown that students understanding of English as the language of instruction has positive effect on their performance in mathematics. Therefore if MAA teaching method is introduced in secondary schools more students will better understand mathematics and will have access to advanced mathematics courses.

4.2 Recommendations

From the conclusions of the study, recommendations were made and areas of further study were suggested.

i. The Junior Secondary Levels Mathematics textbook writers should be sensitized on the effects of English language on students learning of Mathematics. They should lay emphasis on the exposition of mathematical vocabulary in their textbooks before their use in mathematical text and questions. They should include the mathematical modelling approach in explaining the terminologies that learners would encounter in every section of their textbook. This would enhance students' understanding of Mathematics.

ii. The integration of Mathematical Modelling approach is the best method since it is learner centred, it would enhance high proficiency of the text language and lead to relational understanding of mathematical concepts.

iii. Understanding and solving word Problems through Mathematical Modelling supports English Limited Language (ELL) students with the additional feature of cooperative learning. "Guide individual, small-group, and whole-class work.

iv. Students proficiency of the modelling approach and then try it on their own, the approach would be available for reference.

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APPENDIX I

Mathematics Word Problem Solving Pre-test Questions
Instructions

Students are required to write their exams number on the answer sheet provided. You should answer all the questions on your answer sheets. Remember to write how you arrive at your answer clearly.

1. I think of a number, 7added to the number gives 9. What number am I thinking of?
2. A woman is 30 years old, what was her age in 10 years ago?
3. Gambo is 4 years older than Sadiq. Basira is 5 years younger than Sadiq. How old is Gambo when Sadiq 15 years.
4. Mary has 20 oranges. Naomi has x oranges less than Mary. How many oranges has Naomi?
5. If s is the number of students and t is the number of tables, write in algebra: There are

three students for every table

6. If d is the number of dogs and c is the number of cats, write in algebra: There are four more dogs than cats.
7. A squirrel made a pile of nuts. It carried away 55 nuts up to its nest. Now, there are 38 nuts in the pile. How many nuts were in the pile at the beginning?
8. Farmer Usman has 88 animals on his farm. He only has horses and goats. There are 49 horses on the farm. How many goats are on the farm?
9. Adamu saw a pine tree in the forest. Later, he saw a maple tree that was 9 feet tall.
10 The maple tree was 5 feet shorter than the pine tree. How tall is the pine tree?

APPENDIX II

Mathematics Word Problem Solving Post-test Questions

The students were asked to answer the questions in the space provided after each one. Remember to write how you arrive at your answer clearly.

1 Farmer Usman has 88 animals on his farm. He only has horses and goats. There are 49 horses on the farm. How many goats are on the farm?

2 Gambo is 4 years older than Sadiq. Basira is 5 years younger than Sadiq. How old is Gambo when Sadiq 15 years.

3 If s is the number of students and t is the number of tables, write in algebra: There are three students for every table

4 I think of a number, 7added to the number gives 9. What number am I thinking of?

5 A ball costs ten naira and a shirt costs y naira more than the ball. How much does the shirt cost?

6 A student has x sweets. She gives 20 to her friends. Find the original number of sweets.

7 A woman is 30 years old, what was her age in 10 years ago?

8 Mary has 20 oranges. Naomi has x oranges less than Mary. How many oranges has Naomi?

9 Craig saw a pine tree in the forest. Later, he saw a maple tree that was 9 feet tall. The maple tree was 5 feet shorter than the pine tree. How tall is the pine tree?

10 Write in algebra: There are twice as many books as pens (let b be the number of books and p be the number of pens).