EFFECTS OF ENGLISH LANGUAGE PROFICIENCY AND MATHEMATICAL MODELLING FOR OPTIMAL PERFORMANCE IN MATHEMATICS ON UPPER BASIC TWO STUDENTS IN BAUCHI STATE, NIGERIA

Peter Dogo, Ph.D,[1] Jonah Dashe Ph.D[2] and **Sulai Erasmus Ibrahim[3]**
[1]*Science Education Department, Faculty of Education*
Federal University, Kashere, Gombe State
[2]*Federal College of Education, Pankshin Plateau State, Nigeria*
[3]*Mathematics Unit, SBRS, Gombe State University*
Email: talk2peterdogo@yahoo.com

Abstract
The study was aimed at establishing the effect of English Language Proficiency on Upper Basic two (UB2) Students' Performance in Mathematics, Solomon Four Group design was used as a research design for the study. The targeted population comprised of 2260 Upper Basic two students in Bauchi South Educational Zone of Bauchi State, Nigeria. Purposeful sampling technique was used in chosen four public boarding schools for the study. The sample size of the study comprised of 420 UB2 students. Two research questions were raised for the study and two null hypotheses were formulated and tested. The test instrument, Mathematics Word Problems- Solving Test (MWPST) was validated by two experts in Science Education of Federal University Kashere, Gombe State and a qualified Mathematics teacher from one of the pilot schools for the study. Chronbach Alpha coefficient (α=0.81) was used to measure the reliability of the instrument. Data from the students' performance test of MWPST was analyzed using simple percentage, mean and standard deviation to answer the research questions and t-test, Analysis of Variance (ANOVA) and Scheffes compares were used to test the stated hypotheses at 0.05 level of significance. Analysis of data generated from students' pre-test revealed that, the effect of English language proficiency on students' performance in word problems- solving was insignificant ($t_{(203)}$=0.919, p>0.0). 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 proficiency on performance between the four groups in the post-tests. The study posited that the interventional strategy (Mathematical Modelling Approach) significantly improves the UB2 students' performance and problem solving abilities. Overall results in this study illustrated that students' performance in word problems increased significantly. The result also indicated an increased in students' proficiency of English language instruction and text language increased. In essence, learners' performance was directly related to language use in the mathematics classroom.

***Keywords**: English language, proficiency, modelling, mathematical approach. real word problems, Upper Basic.*

Introduction

Mathematics is an essential tool in the exploration of the world economy and viewed as the science of understanding patterns that exist around humans and solving problems in daily life (Agwu, 2015). Learning of 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 all learners to have asses to advance mathematics courses (Percy & Andrew, 2014). The language of instruction must provide leaners with the proficiency of the text or material that is to be learnt. Thus, if a student is proficient with the language, it is more likely that he or she will perform well in Mathematics and at any level as well (Adegoke, 2013).

Nigeria is a multilingual community where learners at secondary level are learning mathematics in English, recommended as the language of instruction in teaching mathematics and science subject in secondary school (FRN, 2013 & David, 2011). Olanipekun and Shola (2014) also affirmed that English language has provided Nigeria with assess to the international communities, especially in bilateral relationship (Politics and Businesses).

In today's classroom, students learn Mathematics with communication demand (oral and written) which also require participation of learners in Mathematics processes and practices such as explaining

solution process, providing conclusion and making arguments and justifications ((Percy & Andrew, 2014). These processes are also referred to as mathematical modeling approach. As leaners fail to engage in modelling process, they are likely to experience low performance in mathematics. Students' low performance in Mathematics limited their chances in studying advance Mathematics.

Theoretical /Conceptual Framework

In Mathematics word problems learners are challenged to find their own solutions, they are also expected to publicly explain and justify their reasons to their fellow learners and the teachers. Teachers in this direction are required to open up their instruction to students' original ideas and to guide each student according to their developmental stage and term of reasoning. However in learning mathematics, each individual knowledge has a potential asset to move to the higher stages of knowledge acquired and with assistance (Dogo, Maguretie & Odingi, 2018).

Learning mathematics is viewed as gradual process of learning as leaners master the mathematics contents as proceed in their level of education. Constructivist theorem viewed that an individual person does not learn in isolation but rather within clear and organized familiar environment (Hemberry & Jacobber, 2012). Construct's theory believes that an individual person develops his reasoning with pattern he sees (Major & Mangappe, 2012). Mathematical modeling therefore functions as an intellectual tool during the process of learning Mathematics and particularly word problems where a learner is expected to pose the skills of reading, comprehension, selection, computing and reasoning as steps toward getting solutions to given problems. The learning process if properly inculcated and monitored would enable leaners to retrieve and apply the relevant knowledge in learning Mathematics. Constructivism theory, therefore forms the bases for this study since its primary aim is to inculcate in the learner skills and abilities to relate abstract with reality of life through mathematical modelling procedures.

The conceptual framework for this study explains the relationship between variables for determining the effects of Proficiency of English language on UB2 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).as shown in Figure 1

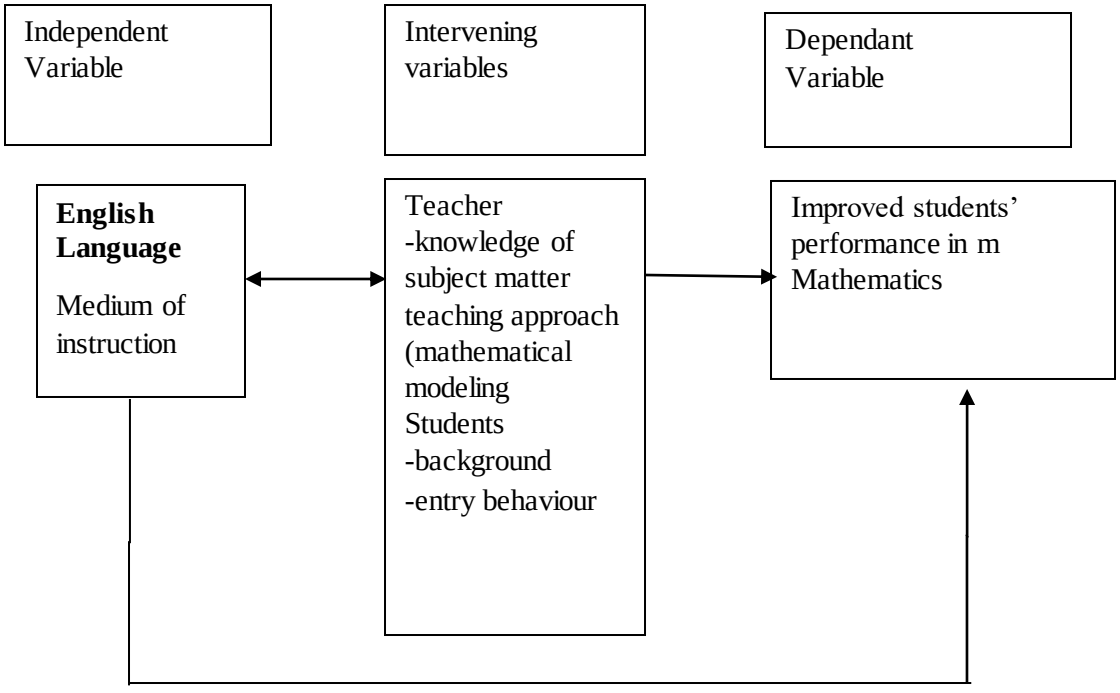

Figure 1: Conceptual Framework (Researcher)

Statement of the Problem

The level of Proficiency in English as a language of instruction in the Nigerian Mathematics classroom can determine good or low performance of students in Mathematics. Ladele (2013) found that, as students were given a task in word problem at UB2 and were required to translate the problem into the required equation and obtain the solution to the problem, it was reported that 25% pass in the algebraic word problems component, indicating the need for a focus on algebraic word problems teaching and learning. Inadequate grasp of the language of instruction was a major source of students' poor performance in Mathematics. Thus, limited students' chances in studying Further Mathematics could not enhance students' proficiency of the language of instruction in the Mathematics classroom in Nigeria. The problem of the study is therefore put in a question form as; what effect does English language proficiency have on UB2 Students' performance in Mathematics

Objectives of the Study

The aim of the study was to assess the effects of English Language Proficiency on the UB2 two students' performance in Mathematics. Specifically, the study sought to:

1. investigate the level of acquisition of UB2 students' in Mathematics problem-solving skills prior to intervention.
2. determine the performance of UB2 students in solving Mathematics word problems after intervention.

Research Questions

Two research questions were raised to guide the study;

1. What is the level of acquisition of UB2 students on Mathematics problem-solving skills prior to the intervention?
2. What is the performance of UB2 students in solving Mathematics word problems after the intervention?

Hypotheses of the Study

Two null hypotheses were formulated and tested at 0.05 level of significance.

Ho_1: There is no significant difference in the mean performance of UB2 students on Mathematics problem solving skills before and after intervention.

Ho_2: There is no significant difference on UB2 students' performance in solving Mathematics word problems between control and experimental groups after the intervention.

Methodology

Research design

The study used Quasi-experimental design. Quasi-experimental design and in particular Solomon Four-Group design which requires the researchers to used two controlled and two experimental groups but does not randomly assign participants to groups. The design gives room 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.

Pre-test and post-test were administered to both groups, but only the experimental group received treatment. The procedures for the experiment was in such a way that Group E_1 (Experimental group) received pre-test (O_1), treatment (X_1) and post-test (O_2). Group E_2 (Experimental group) received no pre-test but received treatment (X_2) and post-test (O_4). Group C_1 (Control group) received pre-test (O_5), no treatment and post-test (O_6). Group C2 received post-test (O_7), no treatment and post-test (O_8). The post-test O_7 and O_8 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 allowed the researchers to ensure that confounding variables and extraneous factors not to influenced the results (Spector, 1981) [33]. The Research design is shown below in Table 1.

Table 1: Solomon Four Group Design

	Group	Pre-test	Treatment	Post-test
R	E_1	O_1	X_1	O_2
R	E_2	O_3	X_2	O_5
R	C1	O_5	-----	O_6
R	C2	O_7	-----	O_6

Source: Borg and Gall (2003).

Population

The targeted population for this study was the upper basic two students (JSS2). As of the time of this study, it was found that the total enrolment of the upper basic two students was 2260 (MoE, 2015). The choice of this category of students was due to the fact that, they have learnt about the beginning of algebra and that at this level, they have a certain proficiency level of English in their daily school interactions.

Sample and Sampling Procedures

Purposeful random sampling procedure was used to get variety of schools to participate in the study. The use of purposeful random sampling was due to the fact that the four selected schools were public boarding institutions. All the schools were also located within the same Bauchi South Educational Zone of the state. The sampled schools were General Hassan Usman Unity College, Government Girls College Bauchi. Government Science Secondary School Dass and Government Girls College Kafin Madaki.

The total sample size for the study was 420 upper basic two students. The study being an experimental, the total number of students found in each class was used and being from intact class, this is allowed in experimental research. The table below presents the sampling grid for the study.

Table 2: Sampling Grid for Boarding Schools

Schools	Total	Sample Size	%
Experimental Group (EG)			
Boys Schools	108	108	100%
Girls Schools	102	102	100%
Control Group (CG)			
Boys School	110	110	100%
Girls School	100	100	100%
Total	420	420	

Table 2 indicates the frequency count of all students found in each school. The study used the intact number of students found in the selected four schools. This kind of sample is allowed in experimental research and hence represent the entire population (Baugmgratner, 2013).

Instrumentation

A Mathematics Word Problem Solving Test (MWPST) was used as an instrument for the study. It was a performance test focusing only on word problems pattern. The students who participated in the test were experimental group E_1 and control group C_1. This was in accordance with the design procedures of the study. Most of the questions were adopted from the most common Nigerian Mathematics book series, multiple questions or items were not included in the test items. The study employed only essay test items as they allowed leaners to employ problem solving strategy (Mathematical modelling), the method provide learners with the best ability of problem solving.

The test instrument used was adopted from Newsman performance strategies (Newsman, 1983). The instrument required students to strictly follow the Mathematical Modeling Approach (MMA) in getting the solutions to the algebraic word problems. The instrument involved 10 items drawn from students' UB2 Mathematics syllabus. The test instrument was pilot tested to ensure its reliability using a Cronbach Alpha coefficient at 0.05 which was found to be 0.81 and was thus accepted as a reliable measuring tool.

Method of Data Collection

After the pre-test and the treatment, the same test (MWPST) was administered to all the groups as post-test to assess possible changes in pupils' level of problem solving ability in word problems. The performance 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 was between 0 and 5 marks per item. The researchers scored the pre-test and post-test and generated quantitative data that were used.

Data Analysis

Data were analyzed using both descriptive and inferential statistical tools. Percentages, mean and standard deviation were computed to answer the two research questions for the study. t-test, Analysis of variance (ANOVA) and Scheffes Compares were used to analyse the two stated hypotheses. Differences in means of the post-test scores for both control and experimental groups were investigated. It was used to determine whether the differences were significant. A t-test was used to test when dealing with two means because of its superior power to detect differences between two means at 0.05 level of Significance.

Results

Question 1: What is the level of acquisition of UB2 students on Mathematics word problems solving skills prior to the intervention?

Table 3: Percentage of Students' Acquisition Level of Problem-Solving Skills Prior to the Intervention

Marks Range	Description	No. of Students	Percentages (%)
60-Above	Very High Extent	12	2.9
50-59	High Extent	16	3.8
40-49	Moderate Extent	46	11
Below 40	Low Extent	346	82.3
Total		420	100

Table 3 indicates that 346 representing (82.3%) of the students have low extent acquisition of Mathematics problem-solving skills compare to 46 (11%) of the same students. The table also indicates that 16 (3.8%) of the same students have high acquisition level compare to the very high extent level of acquisition 12 (2.9%) of the same students. This reveals that most students have low proficiency level of English as the language of instruction prior to the intervention in the mathematics class.

Question 2: What is the performance of UB2 students on mathematics word problems- solving after the intervention? The research question was set to determine students' performance status after the intervention.

Table 4: Means Performance of Students on Mathematics Word Problems-Solving after Intervention

Mean	SD	No. of Stdts Above mean	No. of Stdts Below mean	Total
35.3	14.5	160(38.1%)	260(61.9%)	420(100%)

Table 4 indicates majority 260(61.9%) of the students scored marks below the mean while less than half 160 (38.1%) score marks above the mean. The implication here is that students' ability in solving word problems is generally low and this requires a new strategy that can enhance their proficiency level of instruction in learning mathematics.

Hypothesis 1

Ho_1: There is no significant difference in the mean performance of UB2 students' level of acquisition on word Problems solving prior to the intervention. The study employed the Solomon four-group design. These enabled the researchers have two groups set for pre-tests as recommended by Borg and Gall (2003). The two groups were Experimental group (E_1) and Control group (C_1).

The results in MWPST pre-test mean scores between Experimental group (E_1) and Control group (C_1) was statistically insignificant, $t_{(203)} = 0.919$, $p>0.05$ with E_1 having higher mean score and higher standard deviation than C_1. Thus, the hypothesis which states that, there was no significant difference on students' level of acquisition in word problems solving was then retained.

Hypothesis 2

Ho_2: There is no significant difference on UB2 students' mean performance in Mathematics word problems-solving between control and experimental groups after the intervention. A post-test of MWPST was also administered to the four groups (E_1, E_2, C_1 and C_2) to determine whether there was any significant difference on students' performance in Mathematics word problems being exposed to the treatment (MMA), analysis of variance (ANOVA), was carried out.

Table 5: ANOVA Post-test results of MWPST between the 4 groups (E_1, E_2, C_1 and C_2)

	Sum of Squares	df	Mean score	F	P-value
Between groups	155.14	3	51.71		
Within groups	427.46	420	1.06	48.63	.000
Total	582.29	420			

Source: Field Survey, 2015

An analysis of variance for the post –test MWPST scores, as shown in table 5 indicates that there was statistically significant difference on performance between groups at $F_{(420)}=48.63$, $p=0.00$, $p<0.05$. This implies that learning word problems through mathematical modelling shows a significant increase on students' performance in mathematics. Thus, enhances their proficiency of the language of instructions. 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 6: Scheffe Comparisons of the MWPST Post- Test means Score

	I Group	J Group	Mean Difference (I-J)	P-value
Scheffe	E_1	E_2	.49571*	.009
		C_1	1.19066*	.000
	E_2	E_1	.49571*	.009
		C_1	.69495*	.000
		C_2	1.10000*	.000
	C_1	E_1	-1.19066*	.000
		E_2	-0.69495*	.000
		C_2	.40505	.053
	C_2	E_1	-1.59571*	.000
		E_2	-1.10000*	.000
		C_1	-0.40505	.053

Source: Field Survey, 2015

Table 6 shows a Scheffe post hoc comparisons which indicates that there was significant means differences between experimental groups $E_1$and E_2 (ρ =.009) and also between experimental group E_1 and control group C_2 (ρ = .001). It also reveals that there was a significant difference between experimental group E_2 and E_1 (ρ = .009) and between experimental group E2 and control group C_1 (ρ =.001). It further reveals that there was a significant difference in experimental group E_2 and control group C_2 (ρ =.001) and also between control group C_1 and experimental group E_1 (ρ =.001). The means significant difference also reveals between control group C_2 and experimental group E_1 (ρ = .001) and between control group C_2 and experimental group E_2 (ρ =0.001) in the performance of Post-test MWPST. In addition, it reveals that there

was no statistically significant difference between experimental groups C_1 and C_2 (ρ =0.053) and between control groups C_2 and C_1 (ρ =0.053) in performance of post-test MWPST.

A Scheffe post hoc test revealed that there was a statistically significant mean difference between the experimental groups $E_1$and control group C_2 (ρ =.001). The first hypothesis (H_{01}) result shows that, there was no significant difference on effect of English language between students' performance using mathematical modelling and it 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 (E_1 and E_2) and control (C_1 and C_2) then running the test.

Categorizing the four groups into two groups of experimental (E_1 and E_2) and control groups (C_1 and C_2), t-test independence sample was used to compare students' performance in the MWPST post-test.

Table 7: Independent Sample t-test Post-test Mean Score on MWPST between experimental group and control groups

Group	N	Mean	Std, Dev.	Df	T-value	P-value
Experimental	210	2.44	1.12	414	31.20	.000
Control	210	1.30	1.00			

Results in Table 7 indicates that the difference in MWPST post-test mean scores between experimental and control groups was statistically significant, t (418) = 31.20 = 0.000, p <0.05 with the experimental group having higher mean score than control group. Mathematical modeling approach (English language proficiency) therefore has a positive effect on UB2 students in teaching and learning word problems.

Discussion

Findings reveal that majority of students have low word problems- solving skills acquisition. Result further indicates that majority of students with low performance have below the mean score. Almost all students who participated in the study have similar and low performance in word problems prior to the intervention. Further findings reveal a statistically insignificant difference in the mean scores of pre-test MWPST for the experimental (E_1) and control groups (C_1) at $t_{(203)}$ =0.919, ρ = .326, α = .05 where p>0.05. Thus the hypothesis which states that there is no significant difference on the effect of English language on UB2 students' performance using modelling in Mathematics word problems -solving was retained. This reveals that the level of performance between experimental group E_1 and control group C_1 prior to the intervention was similar. This findings show that such result is to be expected since the students in the public schools have experienced of one to two years of learning in English and therefore would have had limited to English proficiency. In agreement with this finding also were Namasaka, Mondoti & Keraro, (2013) who reported a pre-test result that showed insignificant means different in performance between control and experimental groups involved in the study. The implication was that the two groups are homogenous in their learning abilities.

Results on MWPST post-test of the null hypothesis (H_{01}) in the study which states that there is no significant means difference on effects of English language proficiency between students' performance in teaching and learning word problems-solving using mathematical modelling at UB2 school level, the test of the means significant different of students on MWPST post-test using ANOVA, Scheffe's Comparism and Independent Sample t-test reveal a significant mean difference ($F_{(417)}$ = 48.63 p = .01, α = .05 where p<0.05). By implication the result indicates that using mathematical modelling in learning algebra word problems increase students proficiency of English language as a language of instruction and the text language. This finding agreed with David (2011) who found that there was a significant relationship between English language Proficiency and performance in Mathematics.

Conclusion

Based on the results of this study it can be concluded that proficiency in English language facilitate UB2 students' performance in mathematics word Problems. The study which revealed a positive increase on students' performance in mathematics, the strategy is an effective way of teaching and learning algebraic

word problems among learners in multilingual community like Nigeria. An effective mathematical vocabulary instruction can be used to promote students' attitude toward the teaching and learning of mathematics generally.

Implications of the study

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 significant increase in the overall students' performance in word problems- solving, then it has shown that students understanding of English as the language of instruction has positive effect on their performance in mathematics. Therefore if Mathematical Modelling Approach (MMA) as a teaching method is effectively used mathematics teachers in secondary schools, more students would have better knowledge in mathematics and would have access to advanced mathematics courses which are useful for the Nigerian economic growth and stability.

Recommendations

Based on the findings of this study, recommendations are made as follows and some areas of further study are suggested.

1. The Junior Secondary Levels Mathematics textbook writers should be sensitized on the effects of English language on students learning of Mathematics.
2. The integration of Mathematical Modelling Approach in the teaching and learning of Mathematics is learner centered approach that would enhance high proficiency of the text language and lead to relational understanding of Mathematical concepts.
3. Junior Secondary school Mathematics teachers should be acquainted with this new strategy through attending conferences, seminars and workshops which would also enhance their Proficiency of the medium of instructions.

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