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Mathematical Word Problems Translation And Students' Ability In Secondary Schools In Rivers State, Nigeria

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Abstract: This study investigated the relationship between Mathematical word problems translation and students' ability in secondary schools in Rivers State, Nigeria. Three objectives, three research questions and three null hypotheses guided the study. A two-stage simple random sampling technique was employed to select 685 students from ten co-educational public secondary schools from the population of the study. Word Problem Translation Achievement Test (WPTAT) and Word Problem Solution Achievement Test (WPSAT) were used to collect data. The stability of WPTAT (r=.79) and WPSAT(r=.72) was established using the test-retest method. The Pearson Product-Moment Correlation statistic was used to analyse the data at an alpha level of .05. The result showed that there is a strong positive correlation between students' ability to translate the text of a word problem to a mathematical sentence and the actual problem solution. The result also showed a significant relationship between students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution (F1, 683=4629, p< .05). It was therefore recommended that mathematics teachers during classroom teaching should spotlight the translation proper as a necessary step and explicitly teach the skills of translation because an erroneous translation leads to a misconception of the problem and ultimately a failure in solving the word problem.

Keywords: Mathematics, word problem, relational terms, translation, actual solution.

INTRODUCTION

The first impression that people have whenever Mathematics is mentioned is number, formula, x & y, proof, and calculation and react as if Mathematics has nothing to do with language (grammar, syntax, lexis, and structure). Mathematics is deeply rooted in human language and cognition. (Lakoff & Núñez, 2023). The ability of any human problem solver to comprehend the subject matter of Mathematics hinges on the conventional language and the mathematical language. Mathematics indeed deals with numbers, formulae and calculations, but there is little anyone can solve without first understanding the conventional language with which the Mathematics question is posed and secondly, understanding the Mathematics language itself. The conventional language lies in the domain of general, while the Mathematics language lies in the domain-specific. The domain-specific register is the Mathematics register.

A look at the ancient developers of Mathematics from the perspective of the history of Mathematics reveals the findings in mathematical texts when mathematical notations and symbols were not well developed and conventionalised. For instance, the Babylonian mathematical text on Pythagoras' theorem was written thus: If 4 is the length and 5 is the diagonal. What is the breadth? Solution: 4 times 4 is 16, 5 times 5 is 25. Take away 16 from 25, and 9 remains. What number times what number shall be taken to get 9? 3 times 3 is 9. The breadth is therefore 3. (https://wikipedia.org/wiki/Babylonia). Rossi, C. (2020) posited that Ancient mathematical texts, such as the Rhind Papyrus, Babylonian clay tablets, and works of Euclid and Archimedes, showcase the development of mathematical concepts and problem-solving strategies across cultures and centuries.

The writing of Mathematics problems in text form is what is referred to as a word problem. Word problems are described as verbal explanations of problems and situations presented in a scholastic environment in which one or more questions are posed. The answer to these problems can be obtained by applying Mathematical operations to numerical data contained in the problem statement or extracted from it (Verschaffel et al., 2020).

Word problems have been included in Mathematics to teach real situations which can be prepared for what the learners will use in the workplace (Verschaffel et al., 2020). Other than that, word problems have been used to inspire learners to learn, train learners' minds, improve creativity, and find methods to expand problem-solving and thinking abilities (Kwangmuang et al., 2021). Word problem can be said to be any mathematical question that is posed in narrative or text form rather than in notational form. Real-life problems are often presented in the form of word problems, these problems must be solved using Mathematical knowledge. Problems that arise in the real world and can be solved using Mathematics are frequently posed in the form of words or pictorial symbols, which then need to be represented, exploited, and solved. Mathematical word problems often deal with applying real-world conditions. Mathematical principles, such word problems, encourage learners to apply Mathematical skills to everyday problems in specific contexts. Word problems that date back to the early developers of Mathematics are still in use today because they help to develop system modelling skills in students (Seifi et al., 2012).

A Mathematics question posed in narrative form can only be solved when it is translated into a Mathematics sentence. Word problems, therefore, demand translation from the text form into mathematical notation. Schoenfeld (2024) views mathematical problem-solving as a cognitive process involving two main stages: problem representation and problem execution. Highlights of problem-solving involve two main stages:

1. **Problem representation**: Understanding the problem, interpreting its meaning, and identifying relevant mathematical concepts.
2. **Problem execution**: Applying mathematical operations, strategies, and techniques to solve the problem.

Schoenfeld emphasises that these stages are not mutually exclusive, and individuals may oscillate between the two stages during the problem-solving process. Effective problem-solvers must also monitor their progress, assess their understanding, and adjust their strategies as needed.

Successful execution of mathematical word problems requires a sound knowledge of the conventional English Language and mathematical language (vocabulary). Mathematics has its own language or register that explicitly defines mathematical concepts, different from the way mathematical languages are used in our everyday activity. The narrative of a word problem can range from simple to complex or one-step to multiple steps. It is therefore a prerequisite for students to possess the skills and strategies that will help students decipher the important, necessary, unnecessary, and extra information of a word problem, since this will help translate correctly.

Word problems cut across all other topics in the different themes of Mathematics. For instance, topics such as, but not limited to, age problems, work problems, simple linear & simultaneous equations, percentages, numbers, distance, investments, mixture, inequalities, calculus, mechanics, bearings, statistics & probability. Even though it cuts across all other topics in the different themes, less emphasis is laid on developing students' skills in how to successfully solve word problems. Solving word problems is a challenging and complex task for students (Van de Walle et al., 2022). This is because it is a prerequisite for students to first translate the word problem to a mathematical sentence before proceeding to the actual problem solution. A wrong translation jeopardises the success of the actual problem solution. The above assertion was confirmed in the finding of Boonen, de koning, Jolles & van der Schoot (2016) who carried out a study on word problem solving among sixth grade students in contemporary Realistic Mathematics Education curriculum which depicted that even successful word problem solvers that performed well in less semantically word problems had a low performance on semantically complex word problem. This implies that reading

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comprehension skills are a prerequisite for the translation of word problems. A sufficient instructional strategy for tackling word problems is therefore vital at all levels of Mathematics education. Some of the sufficient instructional strategies are the use of visual representations, which are powerful strategies to concretise abstract mathematical ideas to students.

In the translation of a word problem to a mathematical sentence, it is a prerequisite for the students to be equipped with the following:

1. Understand the conventional language
2. Understand the Mathematics vocabulary
3. Identify the keywords in the text
4. Have knowledge of the mathematical symbols and notation
5. Connect the relationship between the symbols and notations.

The findings of Gooding (2009) on children's difficulties with mathematical word problems indicated that the difficulties in tackling word problems in Mathematics arise from the students' inability to:

1. Read, comprehend, and decode the vocabulary in word problems
2. Completely read all the information
3. Identify distracting information
4. Picture the context of the word problem
5. Write a number sentence
6. Embark on the actual problem solutions
7. Interpret the answer in the context of the question.

The ability to translate word problems into mathematical symbols is crucial for solving them, and a study indicated that 40% of respondents struggled with this translation due to carelessness and a lack of comprehension of unfamiliar words. Van de Walle et al., (2022) posited that prior to attempting to solve mathematical word problems, students should acquire a thorough understanding of relevant keywords, terminology, and vocabulary to effectively interpret and translate problem statements into mathematical expressions.

To improve students' skills in translating and solving word problems in mathematics, several key strategies can be employed.

1. Contextual Learning

Incorporating real-world scenarios into math problems helps students understand the relevance and application of mathematical concepts. This approach makes math more engaging and enables students to develop the skill to translate everyday situations into mathematical expressions.

2. Explicit Instruction

Teachers should model problem-solving strategies, breaking down word problems into manageable steps, identifying key information, and choosing appropriate mathematical operations. This scaffolding enables students to develop a systematic approach to tackling complex problems.

3. Diverse Practice Opportunities

Exposure to a wide range of word problems, including varying levels of complexity and context, helps students build critical thinking and problem-solving skills. This diversity in practice prepares students for the unpredictability of real-world problems.

4. Technology Integration

Utilising digital tools and platforms provides an interactive and immersive learning experience, offering immediate feedback, multiple representations of problems, and a self-paced learning environment. This can be particularly beneficial for students requiring additional support or preferring a more autonomous learning approach.

By incorporating contextual learning, explicit instruction, diverse practice opportunities, and technology integration, educators can significantly enhance students' ability to translate and solve word problems in mathematics, developing mathematically literate and problem-solving proficient students.

However, Ogbu (2025) assesses the difficulties secondary school students encounter in translating algebraic word problems into algebraic equations. The study was carried out in Nsukka Local Government Area, Enugu State, Nigeria. Survey research approach was used in the study. The research questions answered were two, and one hypothesis was tested. A sample of 140 participants was selected using a stratified proportionate random sampling technique. The tool for gathering data constructed by the researcher was the Algebraic Word Problem Test (AWPT). The AWPT was validated by professionals; thereafter, an inter-rater reliability was obtained using Kendall's correlation of concordance (W) that yielded a reliability index of 0.81. The findings showed that students did not find it difficult to represent unknown variables with letters. However, students find it difficult to: (i) create linear algebraic expressions, (ii) generate linear algebraic terms, (iii) equate two algebraic expressions to obtain the require equations, (iv) generate two distinct simultaneous equations as required by the questions, (v) create quadratic terms, (vi) generate quadratic algebraic expressions, and (vii) create and write the final quadratic equation. More so, there was no gender influence on difficulties encountered by students in translating word problems to equations.

Nurrahmawati et at (2021) had a study on assessing students' errors in Mathematical translation, starting from symbols to verbal and graphical representations. Translation skills are very important skills for students to possess, but presently, many students still have difficulties in translating symbols to verbal and graphical representations. The essence of this study is to analyse students' errors in translating from symbolic representations to verbal and graphic representations. The study was a descriptive study with a qualitative approach. Tests were administered to students of a junior high school. From the data analysis, it showed that in translating from symbolic to verbal forms, i.e., problems in daily life that follow a given system of equations, students were still unable to make representations correctly. When students were asked to translate into graphical form, students were still unable to draw complete graphs and errors made by students were misinterpretation and implementation errors, which implies students cannot maintain the semantic congruence between source representation and target representation. Hence, it is important to make a lesson plan that will improve students' ability to translate and interpret word problems.

Laciste and Capua (2021). Opined that students have trouble solving word puzzles, even when the students are taught to carry out other mathematical activities. The aim of this study is to enhance the students' ability to solve word problems. A questionnaire was used for data gathering, and the descriptive survey-correlational design was used. The data was treated using frequency, ratio, weighted mean, and correlation analysis. A sample of 286 junior high school students of the University of La Salette, Santiago City. Majority of students were female. The findings of the study indicated that choosing or writing an appropriate equation and using it to solve a given problem is mostly difficult for students in word problems. More so, the results showed that students were uncertain of what to feel when confronted with a complex word problem. Furthermore, the study showed that the school teachers did not use different strategies in solving word problems. The correlation analysis showed that the different factors, such as understanding word problems, students' attitude towards solving word problems, prior knowledge about the basic concept of Mathematics and Teacher's instructional strategies are correlated. The results implied that the teachers should be encouraged to integrate digital teaching methods and other significant emerging Mathematics teaching and learning to enhance Mathematics outcomes.

Boonen & Jolles (2015) investigated the performance of 47 second-grade students on word problem-solving skills (combine, change, and compare) and the findings indicated that the problems which students experience are associated with the difficulty in processing relational terms on the text of the word problem.

Wang, Y., et, al. (2025) carried out a survey study on the difficulty level of students' ability to translate word problems to

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Mathematics sentence and found out that the difficulty level was highest in the ability of students to indicate the mathematical operations of the words in the word problem. For instance, the addition can be expressed as increased by, more than, total of, added to, sum, plus, or combined. Subtraction: decreased by, minus, less, difference, less than, fewer than. Multiplication: of, times, multiplied by, product of, Division: per, out of, ratio of, quotient of, percent (divide by 100). Equal: Is, are, was, were, will be, gives, yields. Mathematics teachers are supposed to go the extra mile to develop the skills of tackling word problems in students early to equip these students with what it takes to translate and solve such problems. The researchers have observed with dismay that the majority of students do not excel in mathematical word problems. There are students who outrightly skipped any word problem question. There are also some students who read the text of a word problem successfully but struggle with the information in a bid to translate from text form to notational form. Since the solution to any word problem entails a two-stage activity (i.e., the translation stage and the actual problem-solving stage), the researcher, therefore, sought to investigate the correlation between mathematical word problem translation and students' ability.

Objectives of the Study

The purpose of this study was to investigate the relationship between students' ability to translate the text of a word problem to a mathematical sentence and the actual problem solution. Specifically, the following objectives guided the study:

1. Ascertain if there is any relationship between students' ability to translate the text of a word problem to a mathematical sentence and the actual problem solution.
2. Determine the relationship that exists between the female students' ability to translate the text of a word problem to a mathematical sentence and the actual problem solution.
3. Determine whether any relationship exists between the male students' ability to translate the text of a word problem to a mathematical sentence and the actual problem solution.

Research Questions

The following were the research questions that guided the study:

1. What is the relationship between students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution?

2. Is there any relationship that exists between the female students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution?

3. What relationship exists between the male students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution?

Hypotheses

Three null hypotheses were posed and tested at an alpha level of .05

1. There is no significant relationship between students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution.
2. There is no significant relationship between the female students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution.
3. No significant relationship exists between the male students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution.

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METHODOLOGY

Research Design

The study adopted the co-relational research design.

Population of the Study

A total of 7,236 junior secondary three (JS3) students in all the junior co-educational public secondary schools in River's State made up the population.

Sample & Sampling Technique

A two-stage simple random sampling technique was employed to select 685 students from ten junior co-educational public secondary schools across the state.

Instrument for Data Collection

Two instruments were used to collect data. They were

1. Word Problem Translation Achievement Test (WPTAT).
2. Word Problem Solution Achievement Test (WPSAT).

The test items of WPTAT were generated from three topics, namely fractions, percentages and linear equations in one variable. WPTAT consisted of 10 (ten) short essay questions. WPTAT required students to translate each word problem into a mathematical sentence, while WPSAT required students to solve (by showing working details) for the actual problem solution of the translated word problems in WPTAT. Each correctly translated word problem in WPTAT attracted 5 marks, while each correct actual problem solution in WPSAT attracted 5 marks. This made each corresponding test item of WPTAT and WPSAT to be 10 marks. This therefore gave a total of 100 marks for both instruments. A table of specifications was prepared by the researchers to aid in the allocation of questions with respect to topics and cognitive levels. A marking guide was also prepared by the researchers to aid in the allocation of Method Mark and Accuracy Mark for WPSAT items.

Validity of the Instrument

The instruments WPTAT and WPSAT were validated by two experts from Mathematics education to ensure they preserve their face and content validity.

Reliability of the Instrument

The stability of WPTAT and WPSAT, which was established using the test-retest method was found to have a reliability of 0.79 and 0.72 respectively.

Method of Data Collection

The researchers prepared the lesson plans based on the three topics. The intact class mathematics teachers taught the students word problems with respect to the three topics. After the teaching, the students were administered the WPTAT followed by WPSAT. The scripts were collected, marked and graded. The test scores of each student in WPTAT were collated alongside with the scores in WPSAT for subjection to correlational analysis.

Method of Data Analysis

The Pearson Product-Moment Correlation statistic was used to analyse the data at an alpha level of .05

RESULTS AND DISCUSSIONS

RQ1: What is the relationship between students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution?

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Ho1: There is no significant relationship between students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution.

Table 1: Summary of linear regression on the relationship between students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution.

Variable	N	Mean	SD	R	F	P-value
WPTAT	685	35.68	11.21	.86	4629	.00
WPSAT	685	32.14	10.37			

From table 1, the correlation coefficient (r) of students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution was .86, which indicated a strong positive relationship. Table 1 also showed that there was a significant relationship between students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution ($F_{1, 683}=4629$, $p< 0.05$). Null hypothesis one was therefore rejected, and the alternative hypothesis one upheld.

RQ2: Is there any relationship between the female students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution?

Ho2: There is no significant relationship between the female students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution.

Table 2: Summary of linear regression on the relationship between the female students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution.

Variable	Gender	N	Mean	SD	r	F	P-value
WPTAT	Female	373	28.53	8.54	.91	1483	.003
WPSAT		373	25.63	8.41			

Table 2 showed that the correlation coefficient (r) of the female students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution was .91, which indicated a strong positive relationship. Table 2 also showed that there was a significant relationship between the female students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution ($F_{1, 371}=1483$, $p< .05$). Null hypothesis two was therefore rejected and the alternative hypothesis two upheld.

RQ3: What relationship exit between the male students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution?

Ho3: No significant relationship exists between the male students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution.

Table 3: Summary of linear regression on the relationship between the male students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution.

Variable	Gender	N	Mean	SD	r	F	P-value
WPTAT	Male	312	29.34	10.01	.87	2640	.00
WPSAT		312	26.92	9.58			

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Table 3 showed that the correlation coefficient (r) of the male students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution was .87, which indicated a strong positive relationship. Table 3 also showed that there was a significant relationship between the male students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution ($F_{1, 371}=1483$, $p< .05$). Null hypothesis three was therefore rejected and the alternative hypothesis three upheld.

Summary of Findings

The result showed that there is a strong positive correlation between students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution. The result also indicated a significant relationship between students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution. This means that teaching students only problem-solving skills is not enough to equip them with word problem-solving skills. This is in line with the findings of Boonen and Jolles (2015), which indicated that the difficulty students experienced in translating relational terms in the text of a word problem made them achieve lower grades. When students are exposed to the rudiments of reading through a word problem with understanding, there is yet a higher-level task which awaits the tackling of the word problem. The higher-level tasks are being able to translate from words to mathematical expressions or equations, and finally resolving the translated problem. A positive high correlation between these variables indicates that a student who understands the word problem and fails to translate correctly will also fail in the actual problem solution. The identification of keywords, the meaning of keywords, mathematical symbols and notations, and their connectivity leads to success in the first phase, which is the translation phase. Solving word problems without these skills frustrates the students. The result also revealed that there was a significant relationship between the female students' ability to translate the text of a word problem to mathematical sentence and the actual problem solution ($F_{1, 371}=1483$, $p< .05$). Null hypothesis two was therefore rejected and the alternative hypothesis two upheld. The result was also the same for the male students.

Conclusion

Translating mathematical word problems into solvable equations remains a significant challenge for secondary school students. Research indicates that students often struggle with identifying relevant information, representing unknowns with variables, and formulating appropriate equations, particularly in complex problems involving simultaneous or quadratic equations. These difficulties are compounded by limited reading comprehension skills, inadequate exposure to diverse problem-solving strategies, and a lack of confidence in tackling unfamiliar problem types. Addressing these issues is crucial for enhancing students' mathematical proficiency and overall academic performance. Therefore, targeted interventions focusing on improving comprehension, fostering positive attitudes towards Mathematics, and equipping students with effective problem-solving strategies are essential.

Recommendations

The following are recommended:

1. Teachers should employ techniques such as the Three Reads Protocol and K-W-C (Know, Want, Compute) to help students better understand and interpret word problems.
2. Teachers can offer step-by-step guidance on identifying variables, constructing algebraic expressions, and setting up equations, particularly for complex problems involving simultaneous or quadratic equations.
3. Teachers should incorporate visual aids, diagrams, and real-life scenarios to present mathematical concepts for conceptual understanding.
4. Teachers can create a supportive learning environment that encourages students' confidence in tackling word problems.

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