INTERNATIONAL JOURNAL OF
SCIENCE ARTS AND COMMERCE

LANGUAGE ISSUES ON MATHEMATICS ACHIEVEMENT

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Abstract

Throughout the world, mathematical competence is necessary for personal fulfillment, active citizenship, social inclusion and employability. Education stakeholders in many countries have expressed increasing concern about achievement in mathematics. Language plays a significant role in mathematical solution to various tasks and may affect achievement. A learner may not perform well in mathematics not necessarily because of weak mathematical ability but due to challenges in understanding the language involved. The purpose of the study was to explore the effects of language-based factors in the assessment tasks on student achievement in mathematics. The study employed descriptive survey research design. The research was carried out in ten secondary schools in Tharaka-Nithi County, Kenya. The subjects were form four students and simple random sampling technique was used to select the participating schools. Mathematics Achievement Tests were administered to provide the needed data. Descriptive statistics were used to analyse the data obtained. Results of the study revealed that solving mathematical problems modified into mathematical expressions had a positive effect on improving student mathematics achievement. The findings gives insights to test developers to provide effective assessment that incorporates a variety of approaches that recognize the strengths of students especially those struggling with English language.

Key words: *Language issues, Achievement, Mathematical word problems.*

Introduction

The importance of mathematical literacy in this technological age is recognized universally for it is a tool for developing a rational personality (Kavkler et al, 2014). In the modern society there are growing needs for mathematical skills and proficiency because students must master advanced skills to stay track for promising careers. Mathematics is used throughout the world as an essential tool in a diversity of fields such as natural science, medicine, engineering, finance,

social science, physical science and commerce. Despite the significance of mathematics there is dismal performance especially in word problems.

In Kenya, mathematics is learned, taught and examined in English which is a global language and the students are English language learners. According to Gaarder (1975), use of English as the language to test is one reason for the low achievement scores of students. Mathematics language consists of ordinary English symbols and specialized language that pose a problem to students ability to interpret and conceptualize mathematical texts especially word problems (Earp & Tanner, 1980). Learners experience difficulties of syntax and semantics that occur frequently when they are trying to make sense of mathematics. According to Verschaffel (1987) the semantic structure of a word problem influences a student's ability to solve word problems. Students also encounter complex mathematics register that is the styles of meaning and ways of presenting arguments within the context of mathematics (Cuevas, 1984). Solving word-problem presents challenges for students of all abilities and age levels. The report of review by COAG (2008) acknowledged that language can provide a formidable barrier to both the understanding of mathematics concepts and to providing students access to assessment items aimed at eliciting mathematical understanding. Language problem is confounded by inherently difficult terminology some of which learners hear only in mathematics class.

Word problems are consistently used throughout mathematics curriculum as practice exercise. According to Langenes (2011) standardized tests in mathematics consist primarily of word problems that students must interpret before they are able to compute answers. Despite the prevalence, many learners have difficulty solving word problems due to lack of comprehending word problems that come from the semantic structure of the problem and its language consistency with the required operations. According to Hart (1996) learners have difficulty converting a word problem into the necessary mathematical form needed to solve the problem. The students seem unable to create a mental representation that links the text of the word problem to appropriate mathematical expression. Bernado (1999) asserts that students have difficulties in word problems for they are unable to decode the words used in a word problem, comprehending a sentence, understand specific vocabulary and have confidence or the ability to concentrate when reading. Yeo (2009) noted that some students have slow progress in solving the word problem due to their inability to translate the problem into mathematical form.

According to Krick-Morales (2006), word problems in mathematics often pose a challenge because they require that students read and comprehend the text of the problem, identify the question that needs to be answered and finally create and solve a numerical equation. Many English language learners may have difficulty reading and understanding the written content in a word problem. The solving of word problems involves combining one's knowledge of sentence structure, mathematical relations, basic numerical skills and mathematical strategies in order to solve a mathematics problem presented in sentence or paragraph structure (Griffin & Jitendra, 2009). Oviedo (2005) revealed that solving word problems requires the abilities to read, interpret and transform the stated words within their context into a symbolic form, before embarking on a

search for manipulative or computational strategies. The inability of students to solve the word problem is due to the fact that solving such problems demands mathematical computations along with other kinds of knowledge including linguistic knowledge which are required for understanding the problems (Cummins et al, 1988). Word problems are stylized representations of hypothetical experiences and for students to solve them successfully, they need to learn how to read between the lines and understand what they are expected to do mathematically (Barwell, 2005). Solving a word problem can be challenging to students for it is a process of translating words into mathematical expression and then respond appropriately to problems. Wording of mathematics problems has a major influence on comprehension and learners ability to solve them (Staub & Reusser, 1995). According to Laureen (2002), students find word problems difficult to translate because they have difficulties in understanding written or verbal directions or explanations. The learners are not able to identify salient aspects of a mathematical situation, particularly in word problems. Also to the students who are English Language Learners, word problems can present comprehension and transformation difficulties (Meiers, 2010). Mathematical word problems tend to be highly dense and difficult for English language learners to unpack. Due to structural difference between mathematical and English prose text, a difference style of reading needs to be adopted (Pimm, 1987), thus the necessity to assess students using a modified version. Hence there was need to use mathematical expressions for assessment to find out whether there was difference in students' achievement.

Statement of the Problem

In Kenya, mathematics education has faced various challenges that include poor performance in national examinations. Many language challenges have contributed to dismal performance such as poor mastery of specialized mathematical symbols, use of terms that have different meanings, linguistic barrier that leads to poor communication in classrooms and language-based factors in solving mathematical word problems. Although language-based factors have been recognized as having influence on mathematics instruction there is limited knowledge on the role language plays in assessment tasks on mathematics achievement. Hence there was need to investigate whether there was a difference in achievement when students solved mathematical word problems and when assessed using mathematical expressions (modified version).

Objective of the Study

The objective of the study was to investigate the effects of modifying mathematical word problems into mathematical expressions in mathematics assessment tasks on students' achievement.

Methodology

The study involved descriptive survey research design which is used to describe systematically the facts and characteristics of a given population of interest, factually and accurately. The actual

sample size used in the sample was 140 form four students from ten secondary schools that were randomly selected. The instrument used to collect the data was Mathematics Achievement Test in two formats (MATA and MAT B). MAT A was the original questions extracted from the past national examinations papers while MAT B was the modified items written using mathematical expressions. MAT A had word problem written in sentence form using a combination of words and mathematical digits. MAT B was a modified version but maintained all numbers from the original problem and kept the required mathematical operations that is the language complexity was altered by changing the vocabulary and grammatical structure of the word into mathematical expression, while holding the overall count. The language of mathematics assessment tasks (MAT B) was modified to mathematical expressions to reduce their linguistic complexity in order to make the meaning more accessible to all learners. The instrument was expected to show the effects of modifying the test items on student achievement. The MAT A and MAT B each comprised of ten items with a total score of 40. Each item in both MATA and MAT B was given a weight of four marks. In both MATA and MAT B spaces were provided to allow learners to show all their workings. The learners were exposed to MAT A and MAT B at an interval of two weeks to ensure the performance in MAT A does not influence MAT B. Quantitative data comprised of scores obtained by the learners in the two tests. The students work (or scripts) were marked using a marking guideline and coded accordingly for the purpose of data analysis. The results were tabulated, summarized and discussed.

Results and Discussion

A comparison was done on student improvement from MAT A to MATB. Data on Table 1 shows the mean scores obtained by students.

Table 1: Mean Scores obtained by students in the Two Tests.

Test	Number of Students	Mean	Standard Deviation
MAT A	**140**	**47.84**	**13.99**
MAT B	**140**	**64.28**	**17.34**

The results on Table 1 show that the mean score of students in MAT A and MAT B were 47.84 and 64.28 respectively. The mean for MAT B is greater than for MAT A. This shows that there was a difference in achievement when the students were assessed with MAT A (word problems) and when assessed with a modified version that is MAT B (problems with mathematical expressions). There was great gain when the students were examined with a modified version (MAT B). Editing the mathematics word problems into mathematical expressions improved problem solving ability of the learners and results improved. The results of the study are consistent with the findings of Barbu (2010) who found out that performance was poorer for word problems written in more complex language compared to the same problems in easier text. Students' workings for MAT A and MAT B were analysed and coded to which difficulty

challenged the learners and prevented the correct calculation as well as correct answer from being given. A few items were selected for analysis.

Question 1: MAT A. The sum of three consecutive odd integers is greater than 219. Determine the first three such integers.

Data on Table 2 show the percentage of students on various possible marks on question one on MAT A.

Table 2: The Percentage of Students who Scored each of Possible Marks on Question One MAT A.

Marks	**0**	**1**	**2**	**3**	**4**
Percentage	**66**	**01**	**03**	**16**	**14**

A total of 67% of the students scored less than half of the marks in the question while 16% scored three marks and 14% scored all the four marks. Majority of the students could not provide mathematical meaning of the terms consecutive odd integers in the word problem to fully comprehend how to formulate the correct mathematical expression in order to successfully solve the problem. Most students could not form mathematical equation from the given situation hence they were unable to perform calculation correctly. The learners were able to identify the key word (sum) for addition and so they identified the appropriate mathematics operation involved. The students had inability to easily connect the abstract aspects of the word problem with reality that is, they had difficulty figuring out the relationship between the words and the symbols in the mathematical word problem. The students found difficulty due to complexity created through semantic structuring of the word problem rather than the mathematics involved. This implies that the students must be able to understand the language in the word problem, interpret that language so that they can identify the mathematical relations and understand what the problem is asking and change the language and the mathematical relations to mathematical expression then solve successfully. The findings concur with Bernado (1999) who found out that students were not able to decode the words used in word problems, not comprehending a sentence and not understanding specific vocabulary.

Question1 MAT B: The sum of three consecutive odd integers is given by $x+(x+2)+(x+4)$. Determine the first three such integers for the sum to be greater than 219.

Data on Table 3 show the percentage of students on various possible marks on question one on MAT B.

Table 3: The Percentage of Students who Scored each of Possible Marks on Question One MAT B.

Marks	**0**	**1**	**2**	**3**	**4**

Percentage 18 02 02 36 42

A high percentage of 42% of students scored the total (4) possible marks while 36% scored three marks. A total of 78% of students scored more than half of the total marks for the question while 20% scored less than half. Majority of the students were successful at solving the problem in all its aspects because with the mathematical expression the actual mathematics involved was fairly simple. This indicates when mathematical expression was used the students had minimal barrier to comprehending the problem. This agrees with Foong (2009) who discovered that students' failure to solve word problems was not due to their lack of arithmetic ability but their inability to construct an appropriate problem representation as a result of the way the problem was structured.

Question 2 MAT A: The product of the matrices [201] and [the value of p. -1 .5 p -0 .5 p- 2] is a singular matrix. Find A very large percentage of 89% of the students scored a zero while 3% scored the maximum possible score of four. The mathematics vocabulary singular matrix seemed to complicate learners understanding in word problem. It became an obstacle for the students to make sense of the problem statement even though the learners were able to identify the key word (product) for multiplication. The phrase paused complexity of working since the word singular has different meaning between the context beyond mathematics classroom that it take on a specific meaning within the context of mathematics (the product of leading diagonal is equal to the product of the other diagonal). The question had semantics difficulties since the word singular has mathematics meaning. This implies the student did not require to translate the English word singular into mathematics but should be familiar with the mathematics vocabulary. The findings are in line with Verschaffel et al (2000) who found out that phrases seem to complicate learners understanding in word problem solving.

Question 2 MAT B: Find the value of p given that [20 p1] [-1. 5 -0 .5]=[a c] given that ad=bc. p p- 2bd Students who scored three marks were 30% and 45% scored the four possible marks. A total of 75% scored more than half of the total marks in that question. The students did not find it difficulty to solve the word problem for they were able to fully comprehend and understand the demands of the question. The significant information on the question was presented in mathematical notation and the students were able to perform the calculation correctly. This implies that it was easy for the students to complete multiple steps to solve the problem.

Question 3 MAT A: Three quantities P, Q and R are such that P varies directly as Q and inversely as the square root of R. when P=8, Q=10 and R=16. Determine the equation connecting P, Q and R.

Data on Table 4 show the percentage of students on various possible marks on question three on MAT A.

Table 4: The Percentage of Students who Scored each of Possible Marks on Question Three MAT A.

Marks	**0**	**1**	**2**	**3**	**4**
Percentage	**47**	**08**	**04**	**19**	**22**

Students who scored null were 47% while 22% scored all the four possible marks. A total of 55% scored less than half of the total marks in the question. The learners were not able to write down the mathematical operations necessary for completing the task. The students were not able to understand the meaning of the words and sentences in that they had difficulties in comprehending word problem. Some students were not able to extract arithmetic operations or select an appropriate operation to come up with a computable mathematical expression. It was difficulty for learners to develop and follow a plan for solving the word problem. The students were not able to translate from words to mathematical symbols hence they were not able to work out the word problem successfully. The students could not use the problem narrative to develop a problem model and generate a mathematical expression in order to solve the mathematical equation correctly. The findings are consistent with English (1998) who asserts that learners appear to find it harder to form a number sentence for some word problems structures. These difficulties can result in students not being able to select a calculation to perform or selecting an incorrect calculation. Also Langenes (2011) posits that students are unable to translate the words into number sentences in order to calculate the answers to mathematics word problem. The results are in line with Bardillion (2004) who noted that translation from words to symbols is undeniably one of the solution processes in solving word problems that can be considered critical.

Question 3 MAT B: Given that P=kQ where k is a constant and that P=8 when Q=10 and R=16. vR

Determine the equation connecting P, Q and R.

Data on Table 5 show the percentage of students on various possible marks on question three on MAT B

Table 5: The Percentage of Students who Scored each of Possible Marks on Question Three MAT B.

Marks	**0**	**1**	**2**	**3**	**4**
Percentage	**12**	**10**	**01**	**18**	**59**

From Table 5, it can be observed that 59% of the students scored the total maximum score for the question while a total of 77% scored more than half of the possible marks. It is evident that

when the word problem was expressed as a mathematical expression, the students had conceptual understanding of what was being asked as well as what strategies to use to solve the problem and so they were able to compute correctly. The students were able to use accurate methods for calculating. This implies that information was presented to students in a way that made the problem less difficult to comprehend hence the learners were more successful in computation.

Question 4 MAT A: The first term of an arithmetic progression (AP) is 2. The sum of the first 8 terms of the AP is 156.

a). Find the common difference of the AP.

b). Given that the sum of the first n terms of the AP is 416, find n.

A total of 50% of the students scored less than two marks out of the maximum possible four marks. Students who scored two marks were 15% while 12% scored three marks. The problem has mathematics register which includes styles of meaning and ways of presenting arguments within the context of mathematics. The terms in the problem are more precise and the meanings of the terms are much narrower in scope. The students were required to understand the mathematical terms such as arithmetic progression, common difference and sum as used in mathematics. The expression, sum of 8 terms of the AP is an expression adapted from English language which the students were not able to decode.

Question 4 MAT B: Given that Sn=n/2{2a+ (n-1) d} and that a=2, n=8 and Sn=156, a). Find the value of d

b). Given that Sn=416, find n.

Around 21% of students scored three marks while 36% scored four marks. A total of 57% of the students scored more than half of the maximum possible score. Students who scored less than half of the total possible marks for the question were 26%. The students were able to identify salient aspects of mathematical situation in the mathematical expression that is they had no difficulties in comprehending the problem. This implies that the learners had ability to see quickly and accurately the mathematical structures of the problem. The students were more successful in solving the problem leading to higher achievement since they had no difficulty understanding directions.

Conclusion

From the study, it can be observed that; Presenting word problems using mathematical expressions positively affected the students' ability to solve the problem. The results showed that students found the problems with mathematical expressions (MAT B) significantly easier than MAT A. Students were able to compute MAT B with more accuracy than they were able to comprehend and solve word problems (MAT A). The learners were not able to correctly translate the word problems into mathematical expressions containing numbers, variables and operations.

Thus language skills are important for understanding and solving mathematical word problems. The learners had inability to describe the question being asked, rather than lack of knowledge of mathematical concepts necessary to solve the problems. The students demonstrated knowledge of basic concepts, mastery in general information about mathematics and principles. The learners were able to apply basic mathematical operations to work out problems meaning they have computational skills and their mastery. Students had ability to use a variety of mathematical methods effectively to solve problems. This means that learners have made progress in computational skills that are an essential component of children's mathematical achievement. High order thinking skills and communication skills can be emphasized since students have ability to carry out computations and have mastered basic mathematical operations and procedures. Most linguistically complex items were those that contained syntactical, discourse and semantics difficulties in grammatical structures that were central to comprehending the items. Teachers should use strategies that teach students the language of mathematics and ways to read and interpret word problems. The learners need to recognize the grammatical structures and apply accurate methods.

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