STUDENTS' MISCONCEPTIONS ON MATHEMATICAL TERMS

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ABSTRACT

Translating worded problems is considered as one of the most difficult tasks of a student, and worse, it becomes a big hindrance in learning Mathematics since translation from words into symbols is undeniably one of the solution processes in solving word problems that is critical and vital. This study aimed to identify Students' Difficulties in Mathematizing Word Problems of 2nd year Education students of University of Saint Louis through employing Qualitative Method of research through conducting a test. A pilot test was conducted to test the reliability of the questions. Items with a high frequency of correct answers were disregarded and changed with other sets of questions. The data gathered during the assessment were used to examine the level of performance in Translating Worded Problems of the respondents. The results revealed that the 2nd year Education students are not that good in translating Mathematical Word Problems into Mathematical Expressions. Thus, the following were found out as their difficulties: Lack of Comprehension, Lack of Vocabulary, Incorrect Use of Operation, Interchanging of Values and Carelessness.

Keywords: *Mathematics Word problems, Mathematical Expressions, Translation, Teacher Education Students, Misconceptions*

INTRODUCTION

English is considered as the international language for transactions and communications. It is also used as the medium of instruction in most of the subject areas being taught here in the Philippines. Thus, everyone is expected to be familiar with the language and must have a vast vocabulary to avoid misconceptions as well as misinterpretations.

In the Philippine educational system, mathematics, with English as its medium of instruction, is considered as one of the core subjects across all levels of education due to its numerous benefits. And one of the main important components of mathematics training is for students to develop problem solving (Outhred & Sardelich, 2005; Nelson & Stage, 2007; Cofarelli & Sheets, 2009). Dela Cruz and Lapinid (2014) stressed that problem solving has been and will be a necessary skill in Mathematics. Further, this is also considered as a practical skill (Polya, 2005).

However, it is important to note that a substantial number of studies has been stressing that problem solving skill in mathematics is quite difficult for students to attain due to some factors (Yin, 2009; Bautista, 2003). And one of the factors is on translating word problems into its mathematical forms or equations (Aniano, 2010; Yao, 2009). Barwell (2011) stipulated that to be successful in solving word problems, students need to learn how to read such problems. And this is when mathematical translation comes in. Further, simply decoding words or extracting arithmetic operations is not enough: students must learn to read between the lines and understand what they are expected to do mathematically.

Furthermore, Bardillon (2004) concluded that students' ability in solving word problems depends on how students translate phrases into mathematical symbols. Also, most of the previous studies confirm that translating worded problems is considered as one of the most difficult tasks for a student, and worse, becomes a big hindrance in learning mathematics since translation from words into symbols is undeniably one of the solution processes in solving word problems that is critical and vital (Dela Cruz & Lapinid, 2014; Bardillon, 2004; Yared., 2003; Ku & Sullivan). Meanwhile, Dela Cruz and Lapinid (2014) and Yeo (2009) identified some of the factors why students are having hard time in translating word problems into its mathematical symbols and equations. These include the following: misinterpretation of the mathematical problem, lack of comprehension of the problem posed, incorrect use of operation, carelessness, interchanging of values and lack of vocabulary.

With the different gaps on literatures presented above, it is then timely to conduct a study to determine the different problems on mathematical translations especially among Teacher Education students. Hence, this study was conducted.

Research Objectives

This study aimed to determine the students' difficulties in mathematizing word problems. Specifically, it tried to answer the following objectives:

1. To determine the profile of the respondents along the following variables:
   a. Sex
   b. Program of Specialization
   c. Field of Specialization

2. To determine the difficulties incurred by the students in translating word problems into algebraic expressions**.**

METHODS

The study utilized a content analysis to gather the information needed in the study. The participants of the study were the 60 Second Year Education students of the University of Saint Louis who were actually enrolled during the Summer Term of the Academic Year, 2016-2017.

The researchers first conducted a pilot test to 25 Third Year Education students to test the reliability of the questionnaire. The items that were answered correctly by most of the students were removed and changed with more complex problems. Therefore, the assessment which consists of 20 item mathematical word problems was administered to the Education students. This instrument was utilized to determine the difficulties incurred by the students in translating word problems into mathematical expressions. The questions were based on **"Math Worksheets**" (https://www.mathworksheets4kids.com/translating-phrases.php).

The test was administered by the researchers, themselves. Students were instructed to write the mathematical expression of each word problem in the questionnaire. They were tasked to determine which operation could best be performed to solve the word problem. Students were given thirty (30) minutes to answer the entire questionnaire. The statistical data were presented in tables with corresponding qualitative descriptions. Furthermore, the answers of the participants were treated and analyzed through content analysis. The study utilized Dela Cruz and Lapinid (2014) and Yeo (2009) analysis of translating word problems into its mathematical symbols and equations. These include the following: misinterpretation of the mathematical problem, lack of comprehension of the problem posed, incorrect use of operation, carelessness, interchanging of values, and unfamiliar words.

RESULTS

Table 1. Frequency of Most Common Wrong Answers of the Respondents in Translating Word Problems

Question	Most Common Wrong Answer	Frequency
1.Jane spent P420.00 for her dress. This was P14.00 less than twice what she spent for a bag. 2x-14=420	x+2x=420	5
	420=12-2	3
	14-2x=420	3
	420-2(14)	2
	420=14<2x	2
2.Five diminished by three times a number is forty-six 5-3x=46	3x-5=46	13
	5-3(46)	4
	5-3=46	3
	3n-5(46)	3
	5-3(5)=46	2
3.Three is twenty-one divided by the sum of a number and five $3 = \frac{21}{x+5}$	$\frac{3}{21+5}$	3
	$\frac{3(21)}{5}$	3
	3=21/5-3	3
	$\frac{-21}{x+5} = 3$	2
4. Julie has P50.00 which is eight pesos more than twice what John has. 2x+8=50	50+8(2)	6
	50=8 (2)	3
	x-2x=50	3
	50-14=n	2
5. The sum of two numbers is 72, and one of them is five times the other. x+5x=72	$x^5 + x = 72$	5
	5(5)+52=72	3
	a+b=72	3
	72=5x	2
6.There are *b* black balls. This is four more than twice the number of red balls. b=2x+4	b=4 (2r)	3
	4(2b)=6	3
	b=n(4b*2)	3
	$b^4 = r^2$	2
	4 (2)	2
	$b = 4x^2$	2
	4^2	2
	$r = 4 + 4x^2$	2
7. Five years ago, John's age was half of the age he will be in eight years. $(x-5) = \frac{(x+8)}{2}$	5= $\frac{9}{2}$ + 8=b	5
	$\frac{5}{x}$=8	5
	5*8	2
	x=-5/5*8	2
	(6+2/14)*c=3	2
	y=5(5)+8	2
	5(x)= ½ (8)	2
	½+8-5	2
8.One-fourth of the sum of 6 and 2 times c is 3. ¼ (6+2c)=3 or $\frac{6+2c}{4}$ **=3**	¼ (6+2)c=3	9
	6+2 / ¼ (c)=3	4
	¼ =6 *2	3
	¼ =6+2*c=3	3
	¼ = 6*2x+c=3	3
	6+2c=3	2
	6+cx^2=3	2

9. Kate spent P1000.00 on books. This was *k* pesos less than five times what she spent on lunch.	1000 (k)-5	4
	1000=k<5x	3
	1000=k=5x	3
	1000-5x	2
5k-k=1000	1000-k	2
	5a-1000=b	2
10. In three more years, Miguel's grandfather will be six times as old as Miguel was last year.	6x+3=y	7
	6x+3	3
	3*6=x	2
	x=3+$3x^6$	2
(x+3) =6(m-1)		
11. The value of x is at most 8.	X=8	37
x≤ 8	x=>8	7
	x<8	5
12. The value of r is at least 6.	r=6	30
r≥6	r=- 6	7
	r=^6	7
	r≤6	4
13. Sum of 5 times z and 4 divided by two is 7	5-z+4/2=7	4
	(x+5)x(24/2)=7	4
5(z)+4/2=7	5xzx4÷2+7	3
	5xz+4÷2=7	3
14. 5 times together of 6 and 4 multiplied by g is equivalent to 50	5(6).4(g)+50	8
	(5x+6)(4g)	6
	(5x+6+4)g=50	6
5(6+4)g=50	5(6+4)g=50	4
	(5x6)(4xg)=50	4
15. Quotient of 8 lowered by 2 times t and 3 is two	8÷2(t+3)=2	5
	8÷2tx3=2	4
8-2t/3=2	8÷2x3=2	3
	8-2(t+3)+2	2
	8÷2(2x3)=2	2
	8-(2xt+3+x)	2
16. Three fourths of x added to twice of x gives 11	¾ x+x²	8
	3/4x²=11	2
¾ x+2x=11	3/4x+11x²	2
	3(x)+2(x)	2
	2x+3/4x=11	2
17. The quotient of x and 4 is greater than or equal to 6	x÷4=6	9
	x÷4≤6	6
x÷4≥6	x=4<6	4
	4/x≥6	3
18. Altogether of 9 and two-thirds of k alike 13.	9⅔k=13	5
	9⅔=13	4
9+⅔k=13	⅔k(13+9)	3
	9⅔k+13	2
	9+(k/⅔)=13	2
19. 7 raised by thrice of c dropped by factor of five is 2.	7^3(^{c})-5=2	4
	7^3c	4
7^{3c} =-(x) 5=2	7^3	3
	$3c^7$÷5=2	3
	(7^3)c-5=2	3
20. 8 divides total of 3 times f and six equals 3.	8÷(3.f)+6=3	7
	8÷3f(6)=3	7
$\frac{3f+6}{8}$ =3	8÷3x6f=3	2
	$\frac{3(f+6)}{8}=3$	2
	$\frac{3(f)+6=3}{8}$	2
	8÷3x6f=3	2
	$\frac{fx^3+6}{8}$ =3	

Table 2 presents the frequency of most common wrong answers of the respondents in translating word problems. It can be gleaned in the table that the items which have the highest frequency of students getting them incorrect are 11, 12, 2, 17, 8, 16 and 14 wherein the frequencies are 37, 30, 13, 9, 9, 8 and 8 respectively. This means that most of the respondents failed to translate the word problems into mathematical expression correctly since only few got the right answers.

Table 2. The Frequency of the Most Common Wrong Answers and the Errors Incurred

Question	Most Common Wrong Answer	Frequency	Difficulties Incurred
1.Jane spent P420.00 for her dress. This was P14.00 less than twice what she spent for a bag.	x+2x=420	5	Incorrect Use of Operation
	420=12-2	3	Lack of Comprehension
2x-14=420	14-2x=420	3	Interchanging of Values
11. The value of x is at most 8.	X=8	37	
x≤ 8	x=>8	7	Lack of
	x<8	5	Vocabulary
16. Three fourths of x added to twice of x gives 11	¾ x+x²	8	
	3/4x²=11	2	Lack of Comprehension
¾ x+2x=11	3/4x+11x²	2	

14. <u>5 times together of 6 and 4 multiplied by g is equivalent to 50</u> 5(6+4)g=50	5(6).4(g)+50	8	Lack of Comprehension and Incorrect Grouping of Variables
	(5x+6)(4g)	6	
	(5x+6+4)g=50	6	
20. 8 divides total of 3 times f and six equals 3. $\frac{3f+6}{8}$ =3	8÷(3.f)+6=3	7	Lack of Vocabulary
	8÷3f(6)=3	7	Lack of Vocabulary
	$\frac{3(f)+6=3}{8}$	2	Carelessness

Table 3 presents the different errors incurred by the respondents when translating word problems into mathematical expression. It shows that problems were grouped according to similarity, and it can be put together having five questions left. It can be gleaned in the table that there are six kinds of errors incurred by the respondents; namely: lack of comprehension, interchanging values, incorrect use of operation, unfamiliar words, incorrect grouping of variables, and carelessness. This means that the ability of the students to translate word problems into mathematical expressions depends on the complexity of the problem, their ability to comprehend and familiarity of the terms being used.

DISCUSSION

This study aimed to determine the difficulties of the students in mathematizing word problems. Since English is the language used in Mathematics courses, learners must be acquainted with the different terminologies used in mathematical word problems to avoid misconceptions. The results revealed that many of the respondents got items 5, 16 and 18 wherein the common terminologies used in each of the items were all about addition. This implies that the respondents understood the terms about addition such as sum, added to and altogether. On the other hand, this negates the study of Dela Cruz, et. al. (2014) wherein he stressed that incorrect operations and unfamiliar words are some of the common difficulties encountered by the respondents in translating worded problems. They interchanged the operations such as from addition to subtraction and subtraction to multiplication.

In the first item, the word problem is, “Jane spent 420.00 for her dress. This was 14.00 less than twice what she spent for a bag” where in the answer is **2x-14=420**. Five of the respondents answered it as **x+2x=420** which implies that they associated the phrase “less than” with addition. This means that they misinterpreted the problem’s goals and contents since incorrect operation was used. As mentioned in the study of Haghverdi, et. al. (2012) that students most repeated error was "Error in the use of operation," meaning they had used the incorrect operation for their solutions. This means that they didn’t comprehend well with the given problem. The result of the study is parallel to the study of Zentall & Ferkis (1993) when they stressed that lack of comprehension is one of the main reasons why students fail in translating word problems into mathematical expression. They regarded reading comprehension as an important factor contributing to students' word problem translation performance. Also, the respondents did not include some of the variables present in the problem. Instead, they changed it with a different one which is not mentioned in the problem. This is manifested in the answer of three of the respondents which is **420=12-2.** This was supported in the study of Dela Cruz (2014) wherein the respondents made careless mistakes, specifically in the writing the given. He mentioned that they got the correct structure of the equation, however they have written values which are not placed in the problem. Thus, both of the incorrect answers are due to the student’s lack of comprehension. There were also three who answered **14-2x=420.** The phrase “less than twice” was misunderstood since they interchanged 14 and 2x. This implies that they just translated the word problem according to how it was structured. This coincides to the study of Yeo (2009) that interchanging the values given will lead to an incorrect answer to the problem. This implies that they know that the phrase “less than” denotes subtraction, however they were not aware that the values should be interchanged when it will be translated into a mathematical expression.

In item number 11, the phrase that must be translated was: “The value of x is atmost 8” where in the answer is **<u>x≤ 8</u>**. The most common incorrect answers were **X=8, x=>8** and **x<8** which were answered by 37, 7 and 5 of the respondents respectively. The respondents had an assumption that the word “atmost” corresponds to equal, greater than or less than. This means that the respondents lack vocabulary since they do not know the translations of these words in mathematics. The result of the study is in congruence with the study of Haghverdi (2012) that semantic knowledge is not seen among the respondents since mistakes are due to the misinterpretation of terms which led them to construct predictably incoherent problem representations and choose incorrect solution strategies. This was also supported by Maikos-Diegan (2000) that students instantly give up if the vocabulary were too difficult. Also, Blessman and Myszczak (2001) pointed out that one of the main causes of confusion in mathematics is vocabulary. Students need a stronger understanding of mathematical vocabulary to be successful in mathematics. Understanding of mathematical vocabulary influences the comprehension of lessons, tasks, various tests especially in solving word problems, so a lack of understanding of mathematical terms affects capabilities to solve problems (Amen, 2006). On the other hand, the

result of the study was negated by Sullivan, et. al. (2002) wherein he stated that students have familiarity of the terms used in the word problems which enhanced the meaningfulness of the contexts and served as motivation for them to answer the problems. The result of the study implies that the respondents lack semantic knowledge since they were unable to form the meaning of the words (Cummins, 1998). This kind of knowledge allows the students to know and understand the words or phrases used in certain contexts.

In item number 16, the statement was, "Three fourths of x added to twice of x gives 11." The correct answer is **3/4x+2x=11.** Eight of the respondents answered it as **¾ x+x².** This implies that the respondents misinterpreted the phrase "twice of x" because they wrote x^2 instead of 2x for the sake of having an answer. This is now parallel to the study of Seifi (2012) where in students weren't able to arrive with the correct answer because they didn't understand the problem well, thus they just extracted some key numbers and operation from its text. This implies that the difficulty incurred falls under lack of comprehension since they came up with incorrect values. Other answers include **3/4x²=11** and **3/4x+11x²** which show that the respondents lack comprehension since they disregarded other values present in the problem. This was supported by Yeo (2009) wherein he mentioned that incomplete answers were given by the respondents because of misinterpretation of the problem and unfamiliarity of the words that were utilized.

In item 14, the given is: "5 times together of 6 and 4 multiplied by g is equivalent to 50." The expected answer is **5(6+4)g=50.** Eight of the respondents answered **5(6).4(g)+50.** Moreover six among the respondents answered **(5x+6)(4g)** and another six answered **(5x+6+4)g=50**. This suggests that the respondents were not able to comprehend the problem since incorrect operations and incomplete values are evident on their answers. This was consistent with Braselton and Decker's (1994) findings that students' ability to read and comprehend the mathematics text is necessary before they can apply mathematical skills. They concluded that reading in a mathematics class is a complex mixture of words, numbers, letters, symbols and sometimes graphics.

In item 20, the given was, "8 divides total of 3 times f and six equals 3." In this item, the correct answer is $\frac{3f+6}{8}$**=3.** Seven of the respondents answered **8÷(3.f)+6=3,** another seven answered **8÷3f(6)=3.** In these answers, the difficulty incurred was lack of vocabulary. The respondents equated the word "divides" to "divided by" which are completely opposite in meaning. As a result, the divisor was misplaced and became the dividend. This study supports that of Dale and Cuevas (1987) as well as reports by Latu (2004), wherein the confusion in meanings of words is evidence of restricted meanings where new vocabulary is associated with the exact context in which it is learnt and not the more general concept. On the other hand, two of the respondents answered $\frac{3(f)+6=3}{8}$ which is almost correct. However, they have placed the equal sign on the dividend which is supposed to be placed on a separate area next to the dividend and divisor. This means that they understood the problem, only that they were careless on the placement of the answer. The result of the study is parallel to the study of Dela Cruz (2014) as he stressed that the students were able to translate the word problem into its mathematical expression, but they missed out an operation, added new value or wrote a different value.

Results in the analysis reveal that students have difficulties in translating worded problems into mathematical expressions and these can be classified into 5 categories: lack of comprehension, lack of vocabulary, incorrect use of operation, interchanging of values and carelessness.

CONCLUSION

The study concluded that the 2nd year Education students lack vocabulary and comprehension in translating Mathematical Word Problems into Mathematical Expressions. The different terminologies that were utilized in the word problems were misunderstood and misused. The respondents lack semantic knowledge because they did not decode the meaning of the words correctly. Hence, it led them to wrong answers from the given assessment. Moreover, the following are the terms that the respondents misconceived in translating word problems into mathematical expressions: less than, atmost, twice of x, together and divides.

RECOMMENDATIONS AND IMPLICATIONS FOR FURTHER RESEARCH

In the light of the findings and conclusion derived from the study, the researchers highly recommend the following:

The 2nd year Education students must involve themselves in different drills and activities that are aimed in uplifting their cognitive skills. These drills and activities can be facilitated by a teacher.

The Teacher Education department must implement Course Enrichment activities to enhance their ability in translating word problems to mathematical expressions.

Teachers need to have a greater awareness of language issues in the teaching and learning of Mathematics.

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