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WORD PROBLEM SOLVING SKILLS AS DETERMINANT OF MATHEMATICS PERFORMANCE FOR NON-MATH MAJOR STUDENTS

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Word problem in mathematics frequently leads some students to a challenge as it involves a few strategies to solve the statement. Students are required to read and understand the text of the questions, identify the given information and quantities, transform the information into notation and equation, and finally solve the problem. In order to see the performance of non-major math students in solving mathematical problem, investigation was done in this study. This study took place at one of the universities in Northern Malaysia with 122 respondents of semester one non-math major students from different programs. The methods used were the test of independence and logistic regression in part of seeing at the factors of problem-solving strategies as a whole. These factors were used to investigate if they are related to the performance of the students in mathematics. The results indicated that students who understood the word problem by identifying the correct information and students who prepared problem-solving strategies before answering the questions were three times more likely to be successful in mathematics.

***Keywords*:** attitude, problem solving skill, logistic regression, university students

1. Introduction

Mathematical word problem solving has gotten a lot of attention from researchers to be discussed in the last decades (Campbell, 1992; Hegarty et al., 1992; Hajer, 1996; Depaepe et al., 2010; Hickendorff, 2011; Moreno et al., 2011; Boonen et al., 2013; Swanson et al., 2015) as cited in Boonen (2016). According to Rasmussen and King (2000), and Timmermans et al. (2007), rather than in the form of mathematical notation, mathematical word problems are presented in the relevant information as a text. According to Verschaffel et al. (2020), they defined word problem as an oral description of the problem situation and presented within a scholastic situation. Mathematics students faced this as the most difficult type of problem in mathematics**.** In mathematics classes, the capability of students to solve word-problem tasks is an important part of the learning outcomes of most mathematics subjects. Students should not only be taught how to implement routine procedures or apply algorithms, but also, they should be shown the effectiveness of using mathematics to address daily challenges (Khoshaim, H. B., 2020)

In solving the word problem, students at the first place must understand the meaning of the language and this leads to their understanding before responding the word problem in math. However, students prefer to memorize the steps in solving certain tasks or in other words they only apply the rules and the procedures. Thus, it is unfortunately, shown to be inadequate to understand mathematical concepts (Boonen et al., 2016). Therefore, a key challenge for the solvers is to get an ample understanding of the problem statement (Lee et al., 2009; Thevenot, 2010). Through this understanding, a student might be able to proceed to solve the mathematical word problem using four-stage problem solving process (Polya, 1981). As stated by Polya (1973), 'Students may repetitively change their point of view in finding the solution, and the way of looking at the problem. The position needs to be shifted over and over again. The idea of the problem might be seen to be incomplete at the first stage of work, but it will turn to be different when the progress has started and it is again different when we have almost attained the solution'.

Polya (1945) defines Problem-solving as the process used to solve a problem that does not have an obvious solution. According to Polya (1981) the process of problem solving is at four stages, including understanding the problem, determining the strategy, implementing the selected strategy and assessment. At the stage of understanding the problem, student needs to state about the things that he understood from the problem given. While at the stage of determining the strategy, student is expected to be able to decide which steps to follow in order to solve the mathematical word problem solving. Next, the third stage is implementing the selected strategy where student needs to implement the selected steps and for the last stage, student needs to be able to ensure that the solution chosen is right and meaningful. In the study done by Porntipa (2017) it is found that the mathematics student teachers who have been using Polya's Problem Solving process have posttest mean score was higher than the pretest. It brings the same result to the mathematics achievement where the results show that the posttest mean score was higher than it was in the pretest. According to Porntipa, from the research result, it was found that the Polya's Problem Solving Process can contribute significantly to the outcome of mathematics education.

Teaching with application of problem based learning models can improve student's performance in mathematical problem solving skill compared to the conventional method (Rusnanda and Safwandi, 2019). It is supported by Perveen (2010) that the students also will have a better achievement in mathematics if they were thought by using problem solving techniques. In the study of Azzam et al. (2019) about the difficulties encountered by students in related rates problem, the major challenges faced by them were unable to understand the idea of word problem thus affecting their abilities to applying the mathematical concepts. There was also a study done by Kusuma and Retnawati in 2019, 6th grade students were tasked in solving mathematical word problems for operations involving integers, fractions, and decimals. It was found that students faced the difficulties with word problems and their understanding concepts of fractional operations. Furthermore, their answers were inaccurate and they also lack of numerical abilities. In addition, students fail to interpret the English language in the word problem to mathematical equation. However, there was a recent study in 2020, finding risk factors for tertiary students' anxiety in mathematics subjects. As a result, it shows that students disagree that too many words and numbers made them confused with mathematics problems. The students believed that although mathematics requires hard work, it allows them to think logically and reasonably (Md Yusof et al.,2020)

Word problem solving in mathematics should be given much attention as many students especially the non-math major students are not really into it. These students still need to take several mathematics classes such as business mathematics course that involved a real world word problem. It is supported by Salemeh and Etchells (2016), the mathematical word problem relates to real life. In addition, Bajuri and Othman (2021) stated that a real-life scenario is presented, pondered upon and resolved in the mathematics concept that improves such skills in the mathematical word problem. It is a regular section in Mathematics and it shows a crucial part of the subject to teach students on how to solve numerical and word problems. They seem to have problems in doing the exercises based on few identified factors like problem solving skills. These will be discussed in this study and the results will be seen whether problem solving strategies is related to their achievement in mathematics.

2. Method

2.1 Data Collection Method

The target population in this study was part 1 non-maths major students in local university in northern Malaysia. The non-math major student including students from office management, banking and public administation program. This study selected a sample of 122 part 1 students using stratified sampling technique.

2.1.1 Problem Solving Skills

To measure the problem solving skills among students, the students were given a self-prepared test question (mathematics word problem) to answer. The students understanding and planning were analysed based on how they answer the pre-test while a questionnaire was given out to describe their reading skills.

Table 1. Description of Problem Solving Skills variable

Variable Name	Variable Type	Description
Reading skill	Categorical	1: Read the whole sentences 2: Jump to the key word
Understanding	Categorical	1: No 2: Yes
Planning	Categorical	1: No 2: Yes

2.1.2 Students' Performance in Mathematics

The target (dependent) variable in this study is the performance of students in mathematics. The performance of the students was measured based on their pre-test marks. The binary response variable, Y, categorised as:

Table 2. Description of Performance of students in mathematics.

Variable Name	Variable Type	Description
Performance based on pre-test	Binary	Marks between 3.5 to 5 coded as 1 1: Success in mathematics problem solving 0: Not Success in mathematics problem solving

2.2 Data Analysis

The data collected was analysed by using two different methods to maximize efficient decision making. The methods were Pearson's chi-square test and logistic regression model using SPSS version 24.0 for windows.

Pearson's chi-square test was used to study the relationship between two categorical variables. The null hypothesis of the test is the variables are independent. The test compares the observed data to a model that distributes the data according to the expectation that the variables are independent. However, to use the chi-square test the expected frequencies in each cell must be greater than 5. When the expected frequencies are too low, the approximation is not good enough, making significant tests of the chi-square distribution inaccurate**.**

The Logistic Regression model was used to handle binary response variable. The independent variable can be categorical or continuous or mix of categorical and continuous. The outcome variables in this study was the performance of the students in mathematics course. In any regression problem the key quantity is the mean value of the outcome variable, given the value of the independent variable

3. Findings

3.1 Student's Profile

The Chi-square test independence was performed in analysing the differences of student's profile towards their performance in mathematics course. The results are shown in Table 3.

Table 3. Students' Profile and Performance

Variables		Student's Performance				Chi-square	p-value
		Excellent		Others			
Gender	Male	14	(15.2%)	6	(20.0%)	0.378	0.539
	Female	78	(84.8%)	24	(80.0%)		
SPM Math Result	A	55	(59.8%)	4	(13.3%)	24.474	<0.001**
	B	22	(23.9%)	9	(30.0%)		
	C and Below	15	(16.3%)	17	(56.7%)		
SPM English result	A	24	(26.1%)	7	(23.3%)	3.36	0.186
	B	44	(47.8%)	10	(33.3%)		
	C and below	24	(26.1%)	13	(43.3%)		

Most of the respondents were female 102 (83.6%) compared to 20 (16.4%) male students. There were 78 (84.8%) female students who excelled in mathematics subject compared to 14(15.2%) male students. The null hypothesis for the test of independence was the students' profile and their performance is independent. The analysis showed that a gender and English SPM result were not significantly related to students' performance since the $p>0.05$ (fail to reject null hypothesis). However, their mathematics results in SPM during their secondary school were significantly related to their mathematics performance in university ($\chi^2 = 24.474$, $p<0.05$).

3.2 Problem Solving Skills towards Students' Performance

Logistic regression was used to evaluate the relationship between students' solving skills in mathematical word problem and their performance. There are 50% (61 out of 122) students excelled in answered the mathematical word problem during their self-prepared test. Table 4 until Table 7 demonstrates the findings. The problems solving skills investigated were students' understanding, students' planning and their reading skills.

Table 4. Omnibus Test of Model Coefficients

	Chi-square	df	Sig.
Step	18.741	3	.000
Block	18.741	3	.000
Model	18.741	3	.000

Table 5. Model Summary

-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
150.387[a]	0.142	0.190

Table 6. Classification Table

		Performance		Percentage Correct (%)
		Not Success	Success	
Performance	Not Success	41	20	67.2
	Success	20	41	67.2
Overall Percentage				67.2

The probability of the model chi-square is less than 0.05. It indicated the model in this study was significant fit better than model with no predictor. The variation of students' performance was between 14.2% and 19.1% and the correct classification rate was 67.2%.

Table 7. Predictive Table of Students' Performance

Variables		Odds Ratio	95% Confidence Interval		p-value
			Lower	Upper	
Reading Skill	Read the whole sentences	1.000			
	Jump to the key word	1.378	0.608	3.121	0.442
Understanding	No	1.000			
	Yes	3.150	1.367	7.258	0.007**
Planning	No	1.000			
	Yes	3.249	1.486	7.107	0.003**
	Constant	0.247			0.002

From Table 7, the probabilities for understanding and planning are 0.007 and 0.003 which are less than or equal to the level of significant of 0.05 It can be concluded that students' understanding and planning has significant contribution to the students' result while reading skills was insignificant. This indicates the relationship that students with better understanding and made a planning in word problem solving are more likely to perform well in mathematics subject. The odd ratio values presented in the above table imply that students who understood by identifying the right information from the derivation of the word problem was 3.15 times more likely to be successful in mathematics. In addition, planning strategies by illustrating a diagram before solving a mathematical word problem would increase the odd of students' performance in mathematics by 3.249 times.

4. Conclusion and Discussion

The aim of this study was to investigate the students' problem-solving skills towards their performance in mathematics. This study showed that half of the students had succeeded in doing their self-prepared tests. Mathematics word problem solving is considered as a challenging task since it involved many steps. Students who stated the information that they understood and made a diagram and planning were three times more likely to be succeeded and gotten a correct solution compared to those who did not. These steps correspond to (Polya, 1981) first two stages of problem-solving strategy namely understanding the problem and determining the strategy. By using problem solving methods, students' achievement in mathematics were higher and better.

There were studies done about the effectiveness of problem-solving techniques in general. However, this research contributed the results for each stage of problem-solving strategies in the first two stages of (Polya, 1981). As a conclusion, these skills can be implemented during learning process and students are advised to use the strategies to increase their performance in mathematics.

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