RESEARCH ARTICLE
published: 26th October 2021
doi: 10.21070/jees.v6i2.1380

Usage of reading comprehension to enhance word problem solving skills in Mathematics

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Thailand's national tests, O-NET, are administered at the 3rd, 6th, and 9th grade levels. Mathematics is one of the tests. Achievement levels in Mathematics are consistently low. Several studies have shown that there is a link between Mathematics achievement and reading comprehension proficiency. Because previous studies were carried out in other jurisdictions, this study aims to correct this situation. Random sampling was used to select the population from a field of 66 grade six students who were enrolled in a special English programme in a private school, Bangkok. 21 students met the sampling criteria. They sat for a pretest and a posttest test in reading comprehension and in word problem-solving skills in mathematics. Treatment was carried out over a period of 8 weeks. Results showed a high positive correlation between reading comprehension skills and achievement in word problem-solving skills in Mathematics. The results can serve as an encouragement to teachers and their supervisors to focus more directly on improving the reading comprehension skills of students as a means to increasing students' scores on Mathematical word-solving tests.

Keywords: word problem-solving, Mathematics, reading comprehension, relationships

OPEN ACCESS
ISSN 2503 3492 (online)

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Received: 28th April 2021
Accepted: 7th October 2021
Published: 26th October 2021

Citation:
Supontawanit, P. and Lertlit, S. (2021). Usage of reading comprehension to enhance word problem solving skills in Mathematics.
J. Eng. Educ. Society. 6:2.
doi:10.21070/jees.v6i2.1380

INTRODUCTION

Literacy and numeracy skills have become increasingly important not only to today's graduates but to the economic well-being of nations (WLF, 2012). More jobs require at least a practical level of both literacy and numeracy skills (European Commission, 2012). People with higher literacy skills are more likely to be healthy both physically and mentally, more productive and satisfied at work, and less likely to live in poverty, be unemployed, and engage in fewer crimes (Wright, 2016). Test results on O-Net, Thailand's national assessment test, has repeatedly shown declining literacy levels in both English and numeracy among students (NIETS, 2018). This has caused concern among many sectors of Thai society as these weaknesses can impact the job futures of Thai students and, indeed, the future economic wellbeing of Thailand.

Word problem-solving questions are the main part of Mathematics tests, due to it could be used to examine students both in literacy and numeracy skills. Fuches et al. (2009) pointed out the four skills required in solving word problems in Mathematics: 1) reading skill, 2) critical thinking skill, 3) computing skill, and 4) solving problem skill. A number of studies have confirmed that students' reading proficiency is an important factor related to their success in Mathematics (Bohlmann & Pretorius, 2008; Capraro, et al., 2012).

This present research aimed to look more closely at the relationship between reading comprehension skills and problem-solving skills in Mathematics, by carrying out an experiment study in which Grade 6 Thai students would receive on-line training in strategies to enhance reading comprehension skills. On-line training was necessary due to governmental restriction owing to the COVID-19 pandemic (UNESCO, 2020).

The Metacognitive Awareness of Reading Strategies Inventory (MARSI) developed by Mokhtari & Reichard (2002) was selected as the treatment programme. The assumption underlying this choice was that reading comprehension skills were important for understanding word problems in Mathematics (Cetintas et al., 2010). Previous research revealed that reading proficiency was to be a link to higher achievement scores in Mathematics (Bohlmann & Pretorius, 2008; Capraro, et al., 2012). Students who had difficulties in solving word problems in Mathematics also had deficits in language and reading comprehension (Morningstar et al., 2015). Mathematics is one of the national achievement tests in Thailand where test scores have dropped steadily over the years. School-level educators are working on a solution to this problem. Although several studies have shown that there is a link between achievement and reading skill, but previous studies have been conducted in other different fields, so this study aims to address the specific Mathematic and reading comprehension skill aspect. The research questions are formulated as follow.

1) Will the usage of reading comprehension be able to enhance word problem-solving skills in Mathematics of Grade 6 students?
2) What are the relationship between reading comprehension skill and word problem-solving skills in Mathematics of Grade 6 students?

METHODS

This study aimed to learn more about the link between reading comprehension skills and word problem-solving skills. The project consisted of a short online training programme which helped students to improve their reading comprehension skills. The pretest and posttest scores were administered to measure the gains, if any, in their word problem-solving skills in Mathematics.

Research population

The participants were 21 Grade 6 Thai students who were selected from a field of 66 students using the statistical software, G*Power 3, by setting input parameters as follows:

Test family:	t tests
Statistical test:	Correlation: Point-biserial model
Tail(s):	Two
Effect size (ρ):	0.5
Significance level (α):	0.10
Power (1-β):	0.80

The parents/guardians agreed to have their children participate in this research project by signing consent forms. Of the 21, some 13 were female, 8 were male.

Programme

The 21 participants were asked to attend an on-line training programme twice a week for 8 weeks. The topics were factors fractions, and decimals.

Research Instruments (Pretest and posttest)

The treatment was divided into 15 sections; each section was arranged for 40 minutes. Each program section of treatment consists of 5 minutes of discussing about the reading topic before reading, 10 minutes of reading silently, 10 minutes of practicing reading aloud, 5 minutes of discussing the reading passage after reading, and 10 minutes of answering questions, reviewing vocabulary, and writing short self-reflection. The treatment was designed by applying the Metacognitive Awareness of Reading Strategies Inventory (MARSI) created by Mokhtari and Reichard (2002) to track one's reading strategies.

The tests created as the research instruments were set prior to beginning the on-line training programme and the participants were required to take a pretest first. It was designed to challenge the participants by solving 17 word problems. The questions were related to three topics: factors, fractions, and decimals. Some 15 were multiple-choice questions and 2 were long answer questions. Each of the multiple-choice questions had a value of 1 point; the two long answer questions had a value of 2 points each. Thus, the full score for both the pretest and the posttest was 20 points in total. Before conducting the tests, the research instruments were examined the validity and reliability of these tests by three experts, university researchers, using the Index of Item Objective Congruence (IOC). The experts confirmed that the tests matched the research objectives. For data analysis, the basic statistical analyses were used to compute mean scores and standard deviations, and Pearson's correlation coefficient (r).

RESULTS AND DISCUSSION

In this study the participants were Grade 6 students in a private school, Bangkok who were studying in Intensive English Programme. The 21 participants were asked to attend to the study by receiving the treatment on improving reading comprehension online twice a week for 8 weeks. The participants also had to do the online pretest and posttest to examine their skills on word problem-solving and reading comprehension before and after receiving the treatment. This study was taken online due to reduce the risk of the outbreak of Covid-19 which was the critical period in the year 2020. Though the situation of pandemic remained during the data collection, the researcher had a good cooperation from the participants. In all the sample numbers, 21 sixth grade students participated, 13 of them are female and 8 of them are male.

The scopes of the questions are related to the three topics which the participants were taught for the first two months of being Grade 6 students. The three topics are factors, fractions, and decimals. The pretest and posttest are designed to challenge the participants to solve 17 of word problem questions, which consist of 15 multiple-choice questions and 2 long answer questions. Each of the multiple-choice questions shows 1 point. Each of the long answer questions equals 2 points. Thus, the full score of both pretest and posttest are 20 points in total. The frequency distribution table as shown in Table 1 is used to present the pretest and posttest raw scores of the 21 participants in mathematic word problem-solving skills.

TABLE 1 | The Participants' Pretest and Posttest Raw Scores of Word Problem-solving in Mathematics Skills and Mean & Standard Deviation

Pretest		**Posttest**	
Score (20)	**Frequency**	**Score (20)**	**Frequency**
5.0	2	12.0	1
10.0	2	13.0	1
12.0	3	16.0	1
12.5	1	16.5	1
13.0	5	17.0	5
14.0	1	17.0	1
15.0	1	18.0	5
15.5	2	19.0	6
16.0	2		
16.5	1		
17.0	1		
Mean	**Standart Deviation**	**Mean**	**Standart Deviation**
12.81	3.26	17.35	1.85

*Significance level (p): < 0.05

From Table 1, the minimum and maximum of the pretest scores were 5.0 and 17.0, respectively. The median and mode of the pretest scores were 13.0. The mean of the pretest score was 12.81 with the standard deviation of 3.26. Comparing to the posttest score, the minimum and maximum scores were 12.0 and 19.0, respectively. The median of the posttest score was 18.0 and the mode of the posttest score was 19.0. The mean of the posttest score equals 17.35 with the standard deviation of 1.85.

To statistical examine whether the participants had improved in Mathematical word problem-solving skills Paired-sample T Test analysis was used to ensure the progress of the participants.

The average scores in word problem-solving skills in Mathematics were 12.81 and 17.35, respectively. The posttest scores were 4.54 points. From Table 2, Ttest was -7.453 which was lower than the mean shown as -4.5357. This confirms an improvement in word problem-solving skills in Mathematics over the 8-week training period.

Due to both word problem-solving skills and reading comprehension skill should be examined separately. Each of the tests was consisted of one reading passage, 10 multiple choice questions and 5 true-false questions. The total score of the reading comprehension test was 15 points. Each of the raw scores was multiply by 4 and divided by 3 to prepare the collected scores to compare with the Mathematical word problem-solving skills which its total score was 20 points. The frequency distribution table as shown in Table 3 presented the pretest and posttest scores of the 21 participants in reading comprehension skill.

TABLE 2 | The Paired-Sample T Test of the Pretest and Posttest on Word Problem-solving Skills in Mathematics

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
PreMath-PostMath	-4.536	2.7887	.6085	-5.805	-3.266	-7.453	20	.001

TABLE 3 | The Participants' Pretest and Posttest Raw Scores of Reading Comprehension Skill and Mean & Standard Deviation

Pretest		**Posttest**	
Score (20)	**Frequency**	**Score (20)**	**Frequency**
less than 5	2	13.3	1
9.0	1	14.7	1
12.0	1	16.0	2
13.0	3	17.3	4
14.5	4	18.7	4
16.0	4	20	9
17.0	5		
18.0	1		
Mean	**Standart Deviation**	**Mean**	**Standart Deviation**
14.21	3.85	18.29	1.99

*Significance level (p): < 0.05

From Table 3, the minimum and maximum of the pretest scores were 4.0 and 18.7, respectively. The median and mode of the pretest scores were 14.7 and 17.0, respectively. The mean of the pretest score was 14.21 with the standard deviation of 3.85. The minimum and maximum of the posttest scores were 13.3 and 20.0, respectively. The median

of the posttest score was 18.7 and the mode of the posttest score was 20.0. The mean of the posttest score was 18.29 with the standard deviation of 1.99.

To statistically examine whether the participants had improved in reading comprehension skill 'Paired-sample T Test' analysis was used to assess the focused skill's progress of the participants.

TABLE 4 | The Paired-Sample T Test of the Pretest and Posttest on Reading Comprehension Skills

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
PreRead-PostRead	-4.071	3.5634	.7776	-5.695	-2.449	-5.236	20	.001

The average scores in reading comprehension skill of all the 21 participants before and after receiving the treatment in developing reading strategy were 14.21 and 18.29, respectively. The posttest score was higher than the pretest score by 4.07. From Table 4, Ttest was -5.236 which was lower than the mean shown as -4.0714. This meant there was an improvement in reading comprehension skill of the participants.

Pearson's correlation coefficient (r) ranges between -1 to 1. The closer the coefficient is to 1 the stronger the correlation will be between the variables (Gay & Airasian, 2003). Pearson's correlation coefficients were calculated using SPSS to determine if the differences between word problem-solving scores and reading comprehension scores were statistically significant. The Pearson's correlation coefficients (r) of the pretest and posttest are shown in Table 5 and Table 6, respectively.

TABLE 5 | Pearson's Correlation Coefficient of the Relationship between Word Problem-solving Skill and Reading Comprehension Skill of the Pretest

Correlations

		PreMath	PreReading
PreMath	Pearson Correlation	1	.839**
	Sig. (2-tailed)		.001
	n	21	21
PreReading	Pearson Correlation	.839**	1
	Sig. (2-tailed)	.001	
	n	21	21

** Correlation is significant at the 0.01 level (2-tailed).

The Pearson's correlation coefficients shown in Table 5 and Table 6 show the relationship between Mathematical word problem-solving skills and reading comprehension scores. The Pearson's correlation coefficients of pretest and posttest are 0.839 and 0.875, respectively. Due to the size of correlation are in the range of 0.70-0.90, they can be interpreted as 'high positive correlations' between the two variables. The coefficient of determination (r2) of the pretest and posttest of the two tests was 0.70 which suggests that reading comprehension scores could be used to predict the Mathematical word problem-solving scores by 70%.

TABLE 6 | Pearson's Correlation Coefficient of the Relationship between Word Problem-solving Skills and Reading Comprehension Skill of the Posttest

Correlations

		PreMath	PreReading
PreMath	Pearson Correlation	1	.875**
	Sig. (2-tailed)		.001
	n	21	21
PreReading	Pearson Correlation	.875**	1
	Sig. (2-tailed)	.001	
	n	21	21

** Correlation is significant at the 0.01 level (2-tailed).

This study was established to examine on the 2 objectives. The results of the study were discussed as follows.

Objective 1 - To assess the usage of reading comprehension on improving of word problem-solving skills in Mathematics of Grade 6 students in a private school, Bangkok.

After data analysis was completed and the hypothesis was tasted, the findings indicated important result that there was improvement of the posttest scores comparing to the pretest scores in both reading comprehension skill and word problem-solving in Mathematics skills when examined by the Paired Sample T-test. The usage of reading comprehension was set as the treatment of this study to investigate on the improvement of the participants' Mathematical word problem-solving skills.

Objective 2 - To find out the relationship of the reading comprehension skill and word problem-solving skills in Mathematics of Grade 6 students in a private school, Bangkok.

The simple scatter plot was used to examine on the relationship between the 2-focused skills before finding the Pearson's Correlation Coefficient (r). The simple scatter plots of the reading comprehension skill scores and word problem-solving scores in Mathematics showed the trend of the trade line in linear line. The results of the Pearson's Correlation Coefficient showed that the relationship of reading comprehension skill and word problem-solving skills in Mathematics was ranged in 'high positive correlation' at the coefficient of determination (r2) was 0.70.

An achievement in Mathematics was highly depended on literacy (Bohlmann & Pretorius, 2008). However, there were few studies exploring on the relationship between numeracy and literacy skills in Thailand. The conceptual complexity and problem-solving in Mathematics extensively required on the reasoning, critical thinking, computing, and reading comprehension. In addition, English reading was extensively supportive of Mathematics achievement. In this regard, both of English and Mathematics are universal languages (Kachru & Nelson, 2001; Smith, 2004); both contain rules and structures and require critical thinking to interpret and analyze them (Dekeyser, 2007). There are a few differences between English and Mathematics; English language is more subjective using emotive description and a 'sentence' may have different interpretations while language in Mathematics is more objective and a 'sentence' might have only one interpretation (Leshem & Markovits, 2013).

Readers with higher motivation gained better score in reading comprehension tests, owning to it is an important factor in one's reading comprehension (Ahmadi, Ismail, & Abdullah, 2013).

The 'reading strategy' used as the treatment of the study was also designed to enhance the participant's working memory as a significant factor in information processing which is used in reading comprehension, learning, and problem-solving skills (Haberlant, 1999). There was large amount of study which show the importance of working memory which is the significant link in reading comprehension ability and word problem-solving skills in Mathematics (Bolt & Thurlow, 2007; Bull, Espy, & Wiebe, 2008; Geary et al., 2007; Smith et al., 2016; Swanson et al., 2009, Swanson, 2015; Welsh et al., 2010).

Working memory is a significant skill in academic achievement. Children who show low achievement at reading comprehension or at solving word problems in Mathematics were poor in working memory to recall of important information to solve a task (De Beni, Palladino, Pazzaglia, & Cornoldi, 1998; Passolunghi, Cornoldi, & De Liberto, 1999). Good working memories provide children good performances in Mathematics and reading which are important since the first few year of primary schooling (Bull, Espy, & Weibe, 2008).

CONCLUSION

This study of Grade 6 Thai students demonstrated that it was possible to improve their word problem-solving skills in Mathematics by improving their reading comprehension strategies through an intensive 8-week online training programme. This research was done to investigate and reveal the relationship between reading comprehension skill and word problem-solving skills in Mathematics. It was found that the two-focused skills had a 'high positive correlation' as shown statistically in the Pearson Correlation Coefficient (r) of 0.839 and 0.875. A lot of factors might relate to the word problem-solving skills in Mathematics which needed to be improved in Thai students. The reading comprehension skill was chosen from other related skills due to it was the skill that could be developed by several activities both inside and outside a Mathematics class.

Several previous research studied in this topic was not intended to develop a treatment or tools to develop student's reading comprehension skill, there was only measuring on students' skills both in reading comprehension and word-problem solving in Mathematics. This study provided the results that these two-skill were positively related and the improvement on reading comprehension skill could induce the development in word problem-solving skills because they both were affected by working memory as an essential key factor. To improve students' reading comprehension skill in order to enhance the better performance in Mathematical word problem-solving was shown clearly in this study to point out the significance of reading to parents, teachers and school's administrators. Providing stress-free reading environments and activities could be an interesting option to improve student's word problem-solving skills in Mathematics.

This study was conducted during the critical time from the spreading of Covid-19. Conducting the research and collecting the data were done online to make social distancing in order to safe all the participants from contacting the virus which might affect the results of the study. To improve reading comprehension skill in primary students, face-to-face activities to enhance interactions between them and the instructor was significant which should be provided for the further study.

ACKNOWLEDGEMENTS

I would like to express my sincere appreciation to my advisor for all guidance, comments, and suggestions; no words can adequately describe my deep gratitude. Also, I would like to thank all research participants and parents for their time during the difficult situation due to the COVID-19 outbreak. Additionally, this research would not have been possible without the love, support, and encouragement I received from my mother, family, and friends.

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.