The Problem in Math Word Problems: Factors Affecting Students' Perceptions toward Math Word Problems

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Abstract

This study aimed to examine Grade 7 students' perceptions toward Math word problems to help improve their problem-solving skills since the said skill is important and essential for all students to possess. This study used a descriptive survey made by the researchers and consisted of 15 statements of feelings regarding Math word problems; the statements were grouped into five clusters (Math Anxiety, Teacher Factor, Self-Efficacy, Reading Comprehension, and Cultural Appropriateness). The survey was administered to 84 students (31 males and 53 females).The results showed that only Reading Comprehension had a low significant positive correlation with the students' Math grades. Furthermore, a significant difference was only evident in gender in the self-efficacy cluster. The findings of the study have profound implications for teaching Math to students. First, the teaching of Mathematical Problem Solving should not only focus on arithmetic and calculations but also integrate reading comprehension. Second, the gap between the self-efficacy of male and female students should be addressed by Math teachers; they should help students increase their math self-efficacy. This study helps contribute to the teaching of Grade 7 Mathematics, giving prominence to the development of Mathematical Problem Solving. From the findings, teachers may start to implement the suggestions of the researchers to help develop the factors that affect students' perception toward Math word problems.

Keywords: Problem Solving, Math Anxiety, Teacher Factor, Self-Efficacy, Reading Comprehension, and Cultural Appropriateness

Introduction

Problem-solving is integral to Mathematics and is at the forefront of mathematics education. "A mathematically competent student does not only know how to compute and perform algorithms but is also able to pose and solve mathematical problems and apply mathematical skills and reasoning in other subjects and everyday experiences" (SEI-DOST & MATHTED, 2011, p. 3). Students must apply what they have learned in the classroom to their everyday lives. Based on the Mathematics Framework for Philippine Basic Education, the goal of Mathematical Empowerment is to develop Filipino students' critical and analytical thinking skills; and these two skills encompass the following skills: Problem-Solving, Communicating Mathematically, Reasoning, and Making Mathematical Connections. The role of problem-solving is crucial in achieving the goals of Mathematics Education in the Philippines. "Mathematical problem-solving can be defined as the ability to apply mathematical knowledge and skills to solve actual or imagined "real life" imaginable problems using mathematical notation, text, and/or pictures" (Kaskens et al., 2020, p. 2). In the results of PISA (Programme for International Student Assessment) 2018, the Philippines had a mean score of 353 in Mathematics, the second lowest among all the participating nations in the study. Filipino students' poor Math performance is alarming because Mathematics is essential to a student's holistic growth. "Central to the teaching of

mathematical problem solving are word problems" (Ng et al., 2017, p. 46). Word problems are necessary for developing the problem-solving ability of students. Fuchs et al. mentioned in their 2018 study that difficulty in word problems can be based on several factors.

In this study, the researchers looked into five factors that might contribute to the student's perceptions of word problems: Math Anxiety, Teacher Factor, Self-Efficacy, Reading Comprehension, and Cultural Appropriateness of the problem.

Math Anxiety

"Math anxiety is characterized as experiencing negative emotions of fear, tension, or nervousness" (Grežo & Sarmány-Schuller, 2018, p. 227). Several studies have shown the negative effect of Math Anxiety on students' mathematical abilities. Ramirez et al. (2016) stated, "Math anxiety may serve as an impediment to children's math performance by reducing their use of advanced problem-solving strategies that are critical for math achievement" (p. 95). Passolunghi et al. (2019) showed that math anxiety negatively affected math performance. The same study showed that difficulty in concentration and perseverance in math tasks are an effect of math anxiety. Orbach et al. (2020) showed that the link between math anxiety and performance is explained by avoidance behavior and deficits in the attention control system. The study by Henschel and Roick in 2017 also supported the idea that mathematics performance is negatively related to math anxiety. In 2019, Jolejole-Caube et al. conducted a study in Leyte and found that math anxiety had a significant negative association with math performance. However, contrary to the previous studies, Kaskens et al. (2020) showed that math anxiety was not a significant predictor of math development.

Teacher Factor

Teacher factor focuses on the relationship between the teacher and the students. Zhou et al. (2020) mentioned that "Attachment helps children establish and maintain closeness and enable them to communicate with adults to satisfy their own needs" (p. 475). In the same study, they found that teacher–student relationships showed a direct and positive effect on the mathematical problem-solving ability of the students. In another study conducted by Liu et al. (2018), the findings showed that teacher support could directly affect the math engagement of students. Muijs and Reynolds (2002) also found that the behavior of teachers was a significant predictor of student progress. Contrary to the previous studies, Mason et al. (2017) found that teacher–student closeness could not predict later math achievement. Teacher factor is not limited to the relationship between students and teachers; another component is the teacher's content knowledge. "With regard to the influence of the teachers' mathematical teaching knowledge, this was indeed found to be the case: it significantly predicted the development of the children's mathematical problem-solving in the present study" (Kaskens et al., 2020, p. 10). Teacher factor also includes teaching and classroom management strategies. Diverse learners have diverse needs, which teachers need to address. Tolentino (2020) looked into the preferences of indigenous and non-indigenous Filipino students, and it showed that the two groups differed in their preferences. Suan (2014) conducted a study in Cebu, Philippines and found no significant relationship between teacher factors and math performance.

Self-Efficacy

Several researches and books provided definitions for the term self-efficacy. "The term "self-efficacy" describes students' belief that, through their actions, they can produce desired effects" (OECD, 2015, p. 1). Zhou et al. (2020) defined it as the extent to which people believe they can successfully perform a specific behavior. In the context of math, Grigg et al. (2018) defined it as students' judgments about their capabilities to perform specific math-related tasks. Bandura, in 2011 said that "efficacy beliefs determine how opportunities and impediments are perceived" (p. 9).

People with low self-efficacy give up easily, while people with high self-efficacy persevere and stay resilient. "Math self-efficacy beliefs positively predicted subsequent math achievement" (Grigg et al., 2018, p. 82). Justicia-Galiano et al. (2017) also found that a lower self-concept would reflect lower performance. In 2010, the academic performance and self-efficacy of Filipino science high school students were studied by Dullas (2010), who found a high positive significant relationship between self-efficacy and math performance. Peteros et al. (2020) conducted a study in a public school in Cebu, Philippines, finding a significant relationship between self-concept and math performance. Similarly, Alpacion et al. (2014) found that Filipino students with positive attitudes regarding Mathematics perform well. Moreover, the study of Kaskens et al. (2020) showed contrary results compared to the other studies where they found that math self-efficacy did not significantly predict math development.

Reading Comprehension

On the 2018 PISA, the Philippines had a mean score of 340 in reading, the lowest among all the participating nations in the study (OECD, 2019). “We define reading comprehension as the process of simultaneously extracting and constructing meaning through interaction and involvement with written language” (RAND Reading Study Group & Snow, 2002, p. 11). Fuchs et al. (2018) found that word problem-solving can be conceptualized as a form of text comprehension. In the same study, text comprehension significantly predicted word problem-solving. Several other studies also agree that reading comprehension is necessary and a part of word problem-solving. In 2017, Fung and Swanson found that understanding the story problem comes first before actual calculations in word problem-solving. In the study of Swanson et al. (2021), they stated that “solving mathematical word problems requires complex processes beyond computation skills such as reading comprehension, using linguistic information, identifying relevant information, and constructing an appropriate problem statement” (p. 2). Mädamürk et al. (2018) mentioned that reasoning and text comprehension are relevant in problem-solving. Vilenius-Tuohimaa et al. (2008) found a strong interrelation between word problems and reading comprehension questions. Similarly, Spencer et al. (2020) revealed that early language skills like language comprehension were significantly associated with word problem-solving. Nicolas and Emata (2018) conducted a study in Davao del Norte; they found that integrating reading comprehension in problem-solving yielded a significant difference in math performance compared to the conventional approach in teaching. “Strong reading comprehension skills enable a student to evaluate in detail what the problem text is asking, resulting in a realistic situation model” (Fitzpatrick et al., 2020, p. 7). Furthermore, according to Brozo and Crain (2018), “problem-solving in math begins and ends with literacy” (p. 12).

Cultural Appropriateness

The cultural appropriateness of a given word problem looks into the realness and plausibility of the problem. The problem should be contextualized and experienced by the learner. It also takes into consideration the culture and society the learner belongs to. “In respecting cultural differences and creating a safe environment for diverse learners, educators may gather cultural information unique to each student or family and make deliberate efforts to include that information during instruction” (Luevano & Collins, 2020, p. 146). The previous study examined how effective culturally appropriate problem-solving instruction [CAPSI] was; results showed that using CAPSI improved the students’ problem-solving skills. “For realistic word problems, students have to evaluate the numerical response in the context of the situation described in the problem text” (Fitzpatrick et al., 2020, p. 1). The study of Wijaya et al. (2015) mentioned that daily life contexts can support math learning. Moloi, in 2015 used an indigenous board game to teach Math, and it helped students overcome the challenges they experienced; the learners felt that the math content was within reach and not too distant and complex. The study by Rubio (2016) titled “The Ethnomathematics of the Kabihug

Tribe in Jose Panganiban, Camarines Norte, Philippines" looks into how the tribe relates their culture to mathematical concepts and how it is applied to their everyday lives. It shows the importance of contextualizing the teaching and learning of Mathematics. Similarly, Alangui's (2017) "Ethnomathematics and Culturally Relevant Mathematics Education in the Philippines" studies how math lessons were contextualized and localized. In the said chapter, two examples of contextualized Math were presented. First, the lesson about fractions was related to harvesting rice and honey. The teacher discussed the value of fairness in sharing the harvest equitably, and the harmful effect of greed, then transitioned to fractions and the corresponding operations. The second lesson was about algebraic expressions and related to harvesting cassava. The teacher compared known and unknown values to cassava; the cracks on the ground are known values, while the number of cassava roots below the cracks is unknown.

Research Questions

The study examines Grade 7 students' perceptions of Math word problems. The following are the research questions:

1. Is there a significant relationship between Grade 6 Math grade and the following:
    a) Math Anxiety
    b) Teacher Factor
    c) Self-Efficacy
    d) Reading Comprehension
    e) Cultural Appropriateness
    f) Overall Perception of word problems
2. Is there a significant relationship between the number of hours spent studying Math in a week and the following:
    a) Math Anxiety
    b) Teacher Factor
    c) Self-Efficacy
    d) Reading Comprehension
    e) Cultural Appropriateness
    f) Overall Perception of word problems
3. Is there a significant difference between gender and the following:
    a) Math Anxiety
    b) Teacher Factor
    c) Self-Efficacy
    d) Reading Comprehension
    e) Cultural Appropriateness
    f) Overall Perception of word problems
4. Is there a significant difference between the two sections and the following:
    a) Math Anxiety
    b) Teacher Factor
    c) Self-Efficacy
    d) Reading Comprehension
    e) Cultural Appropriateness
    f) Overall Perception of word problems

Methodology

The study used a descriptive survey made by the researchers and was administered using Google Forms. SPSS and Microsoft Excel were used to analyze students' answers to the survey.

Respondents

The respondents in the study were 84 Grade 7 students from a private Catholic school in Manila, Philippines. The respondents consisted of 31 males and 53 females, and they were grouped into two sections, section A had 41 students, and section B had 43 students.

Instrument

The researchers made the instrument used in the study. The survey consisted of 15 statements of feelings regarding Math word problems where students were asked to express their agreement. The statements were grouped into 5 clusters (Math Anxiety, Teacher Factor, Self-Efficacy, Reading Comprehension, and Cultural Appropriateness), and each cluster consisted of 3 statements. The survey is a Likert scale and used the following scale: 5 – Strongly Agree, 4 – Agree, 3 – Neutral, 2 – Disagree, and 1 – Strongly Disagree.

Results

Table 1

Grade 6 Math grade and number of hours spent studying Math in a week

Variable	Mean	Standard Deviation
Grade 6 Math grade	91.01	4.28
Number of hours spent studying Math in a week	5.41	6.69

Table 1 shows the descriptive analysis of the respondents' Grade 6 Math grade and the number of hours spent studying Math in a week. The data was collected during the first few months of the school year, and Grade 7 students have not received their grades yet for the first quarter. To gauge the students' mathematical ability, the researchers based it on their average Math grade in the previous academic year. The average grade of the respondents during the last academic year was 91.01, while on average, they spent 5.41 hours studying Math in a week.

Table 2

Correlation between Grade 6 Math grade and each cluster and overall perceptions toward Math word problems

	MG	MA	TF	SE	RC	CA	OP
1. Grade 6 Math grade	-						
2. Math Anxiety	-.103	-					
3.Teacher Factor	.019	-.338*	-				
4. Self-Efficacy	.148	-.509*	.401*	-			
5. Reading Comprehension	.261*	-.370*	.313*	.370*	-		
6. Cultural Appropriateness	.087	-.139	.296*	.294*	.563*	-	

7. Overall perceptions toward Math Word Problems	.173	-.237*	.638*	.706*	.728*	.737*	-

Note. Correlation is significant at the 0.05 level (2-tailed)

Grade 6 Math Grade – MG, Math Anxiety – MA, Teacher Factor – TF, Self-Efficacy – SE, Reading Comprehension – RC, Cultural Appropriateness – CA, and Overall perceptions toward Math Word Problems – OP

Pearson's Correlation was used in Table 2. Among the 5 clusters, Reading Comprehension, r (82) = .261, p = .02 showed a low significant positive relationship to Grade 6 Math grade. The overall perceptions toward Math word problems showed no significant relationship to Grade 6 Math grade. All 5 clusters and the overall perceptions toward Math word problems showed significant relationships to one another, except for Math Anxiety and Cultural Appropriateness.

Table 3

Correlation between number of hours spent studying Math in a week and each cluster and overall perceptions toward Math word problems

	HS	MA	TF	SE	RC	CA	OP
1. Hours spent studying Math in a week	-						
2. Math Anxiety	.187	-					
3.Teacher Factor	.054	-.301*	-				
4. Self-Efficacy	-.050	-.491*	.375*	-			
5. Reading Comprehension	.046	-.300*	.276*	.352*	-		
6. Cultural Appropriateness	.077	-.086	.230*	.288*	.506*	-	
7. Overall perceptions toward Math Word Problems	.104	-.189	.574*	.700*	.715*	.714*	-

Note. *Correlation is significant at the 0.05 level (2-tailed)

Hours spent studying Math in a week – HS, Math Anxiety – MA, Teacher Factor – TF, Self-Efficacy – SE, Reading Comprehension – RC, Cultural Appropriateness – CA, and Overall perceptions toward Math Word Problems – OP

Spearman's Rank Correlation was used in Table 3 because of the non-normality of the hours spent studying Math in a week. None of the 5 clusters showed significant relationships to hours spent studying Math in a week. Similarly, the overall perceptions toward Math word problems showed no significant relationship to hours spent studying Math in a week. All 5 clusters and the overall perceptions toward Math word problems showed significant relationships to one another, except for the following: Math Anxiety and Cultural Appropriateness & Math Anxiety and Overall perceptions toward Math Word Problems.

Table 4

Independent Samples T- test (Sex and each cluster and overall perceptions toward Math word problems)

	Male (n = 31)		Female (n = 53)			
	Mean	SD	Mean	SD	t(82)	p
Math Anxiety	3.42	0.52	3.43	0.58	-0.12	0.91
Teacher Factor	3.97	0.62	4.01	0.58	-0.34	0.74
Self-Efficacy	3.49	0.83	3.09	0.90	2.06	0.04
Reading Comprehension	3.54	0.62	3.43	0.69	0.69	0.49
Cultural Appropriateness	3.67	0.52	3.62	0.62	0.38	0.71
Overall perceptions toward Math Word Problems	3.62	0.34	3.52	0.36	1.25	0.22

Among the variables in Table 4, a significant difference was only observed regarding male and female self-efficacy; $t(82) = 2.06$, $p = 0.04$. The rest of the variables regarding sex did not show any significant difference.

Table 5

Independent Samples T- test (Section and each cluster and overall perceptions toward Math word problems)

	Section A (n = 41)		Section B (n = 43)			
	Mean	SD	Mean	SD	t(82)	p
Math Anxiety	3.45	0.57	3.41	0.55	0.30	0.77
Teacher Factor	3.93	0.63	4.06	0.54	-1.05	0.30
Self-Efficacy	3.13	0.90	3.34	0.87	-1.09	0.28
Reading Comprehension	3.46	0.76	3.49	0.57	-0.23	0.82
Cultural Appropriateness	3.69	0.61	3.58	0.55	0.86	0.39
Overall perceptions toward Math Word Problems	3.53	0.38	3.58	0.34	-0.60	0.55

None of the variables in Table 5 significantly differed with respect to the participants' sections.

Table 6

Summary of each cluster and overall perceptions toward Math word problems

Variable	Mean	Standard Deviation
Math Anxiety	3.43	1.11
Teacher Factor	4.00	0.93
Self-Efficacy	3.24	1.12
Reading Comprehension	3.47	1.25
Cultural Appropriateness	3.63	1.00
Overall perceptions toward Math Word Problems	3.55	1.12

Note. Scale: 5 – Strongly Agree, 4 – Agree, 3 – Neutral, 2 – Disagree and 1 – Strongly Disagree

Table 6 shows the descriptive analysis of the responses per cluster and overall perceptions toward Math word problems. Among the five clusters, Teacher Factor ($\underline{x}$ = 4.00) had the highest mean, while Self-Efficacy ($\underline{x}$ = 3.24) had the lowest mean. In terms of standard deviation, Reading Comprehension (s = 1.25) was the most dispersed, and Teacher Factor (s = 0.93) was the least dispersed. The overall perceptions toward Math word problems revealed a mean of 3.55 and a standard deviation of 1.12.

Discussion

Research Question 1:

Based on the findings of this study, Reading Comprehension showed a low significant positive relationship to Grade 6 Math grade. Several studies have shown the relationship between problem-solving and reading comprehension (Vilenius-Tuohimaa et al., 2008; Fung & Swanson, 2017; Brozo & Crain, 2018; Fuchs et al., 2018; Mädamürk et al., 2018; Nicolas & Emata, 2018; Spencer et al., 2020; Swanson et al., 2021). A higher score in the reading comprehension cluster does not only equate to a positive perception of language and reading but also of math word problem-solving. The study also showed a negative relationship between Math Anxiety and Grade 6 Math grade, but it was insignificant. The negative relationship between the two factors is supported by previous studies (Ramirez et al., 2016; Henschel & Roick, 2017; Grežo & Sarmány-Schuller, 2018; Jolejole-Caube et al., 2019; Passolunghi et al., 2019; Orbach et al., 2020).

Research Question 2:

The findings indicated that none of the 5 clusters showed significant relationships to hours spent studying Math in a week. Similarly, the overall perceptions toward Math word problems showed no significant relationship to hours spent studying Math in a week. The findings agreed with Nonis and Hudson (2006), which showed that studying time had no direct effect on academic performance.

Research Question 3:

A significant difference was only observed regarding male and female self-efficacy; this finding is similar with previous studies. Huang (2013) and Parker et al. (2018) found in their separate studies that math self-efficacy in male and female students was different, mainly that males had higher math self-efficacy than females. However, this is

contrary to the findings of Peteros et al. (2020) and Alpacion et al. (2014), which showed no difference in the self-efficacy of male and female students. Male and female math anxiety in the study showed no significant difference, which is supported by the study of Erturan and Jansen (2015) and Jolejole-Caube et al. (2019). Nevertheless, this finding is contradicted by Hill et al. (2016) and Primi et al. (2014), in which both studies showed that females had higher math anxiety. Another finding is that male and female reading comprehension showed no significant difference, contrary to the study of Vilenius-Tuohimaa et al. (2008), which showed that females had better linguistic skills than males.

Research Question 4:

Lastly, no significant difference was found in any of the variables regarding the responses of the two sections. This finding is supported by the fact that sectioning in the school was done heterogeneously.

Implications

The study has two main implications for teaching Mathematics. First, the relationship between reading comprehension and problem-solving. Math teachers should integrate reading comprehension during the teaching of mathematical problem-solving. It is essential to focus not only on the math aspect of problem-solving but also on the language aspect. To fully develop their problem-solving skills, students should understand the Math word problem for them to make connections among the given information and be able to answer correctly. After which, students will further improve their understanding of the concept by making meaning of their answer based on their understanding of the word problem.

Second, the gap between the self-efficacy of male and female students should be addressed by Math teachers. They should not only teach content but also develop students' self-efficacy. Math is a subject intended for males and females; therefore, teachers should help students with self-efficacy, especially among female students, because studies have shown that they have lower math self-efficacy than their male counterparts.

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