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FEATURE

Determinants of Problem-Solving Performance in Mathematics 7: A Regression Model

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Abstract. *The twin goal of mathematics education is the development of critical thinking and problem-solving. Despite many strategies conducted by the teachers, many students are experiencing problems in understanding and applying mathematics concepts in real-life problems. This study aimed to determine the different factors that influenced the problem-solving performance of the students with the end view of formulating plans and intervention program. Descriptive-correlational design with regression modeling was employed to investigate which among the presented variables determine the problem-solving performance of the respondents. The respondents of the study were the 100 randomly selected Grade 7 students from public secondary schools in MIMAROPA region. The results showed that grades in Mathematics and English, attitude towards mathematics, and comprehension skills of the students as well as gender and teaching loads of the teachers affect students' problem-solving performance. However, only students' grade in English and comprehension skills were known determinants of problem-solving performance.*

Keywords: problem-solving performance, Mathematics, regression model, MIMAROPA, Philippines, Grade 7 students, public schools

Introduction

Mathematics is essential not only in related fields like engineering but also in other fields such as fashion, sports, economics (Andayan, 2014), music, astronomy, medicine, and agriculture, among others. To cater to the demands of various disciplines in mathematics competence, the high school mathematics in the Philippines under the K to 12 curriculum is of spiral progression approach (Department of Education, 2013) and is integrated in other subjects and in real life contexts. Mathematics, in each year level under the new curriculum, is composed of number sense, patterns and algebra, measurement, geometry, and statistics and probability but with an increasing level of difficulty. In this sense, students are expected to master the skills in lower mathematics so that they could learn the concepts of higher mathematics.

The majority of high school students are still experiencing difficulties and problems in their mathematics subjects. They view math as boring, difficult, abstract, and not too practical (Ignacio, Nieto, & Barona, 2006). The Department of Education is exerting so much effort to uplift the performance of the Filipino learners that is why mathematics in the present curriculum is not merely abstract representation and tedious computations. Standards and principles of the K to 12 curriculum are learner-centered, relevant and responsive, and research-based. It is also contextual and integrative (K to 12 toolkit, 2012). The lesson is expected to be integrated with the daily lives of the students so that they could apply the knowledge and skills they have gained for them to be lifelong learners.

Mathematics in the 7th Grade is not only about numbers and computations, but also a tool for understanding structures, relationships, and patterns needed to solve complex real life problems. It is connected in all subjects and in all fields of endeavor. High school math is also taught in such a way that it can help students develop their critical thinking and problem-solving skills as well as communication, collaborative, and technological skills—the components of the 21st century skills.

Mathematics is all about devising solutions to problems. Problem-solving is an important cognitive activity applied in real life context (Aljaberi, 2015) that requires training, effort, styles (Soancatl, Lèon, Martinez, & Torres, 2010), mathematical and arithmetic skills, metacognitive skills, and determination with aspiration (Mayer, 1985). Its main function is to make decisions on what and how a problem may be answered (Jansen, Schmitz & van der Maas, 2016; Tella, 2008).

Most students may have mastered the math concepts but struggle when they are applied in real life and when stated in a form of word problems (Angateeah, 2017; Bernardo, 2002). Since the real importance of learning math is not memorizing its concepts but its application, the ability of the students to solve a wide variety of problems in mathematics needs a thorough analysis and critical thinking. To help the students improve their problem-solving performance, it is important to know what would affect their performance. The main purpose of this study was to determine the contributing factors for problem-solving performance of Grade 7 students.

Review of Related Literature

Mathematics has become a necessity for individuals to succeed in this modern era. To be successful in this 21st century, students should possess creativity, critical thinking, technological skills, communication skills, collaborative skills and mathematical skills. The main reason for learning mathematics is to be able to solve real-life problems no matter how abstract they are for the learners. That way, the learners could develop critical thinking, problem-solving skills, creativity and become lifelong learners.

Mathematics is useful in daily life; however, most high school students struggle and performed poorly in their math subjects. Math performance is afected by interrelated variables (Singh, Granville, & Dika, 2002) such as personal, teacher-related, and environmental factors. Among the personal factors that have contributed to mathematics performance the researchers found are age (Zacariah, Kibet, Muthaa, & Nkonke, 2012), gender (Kaahwa, 2012; Ochwo, 2013), attitude towards mathematics (Balbalosa, 2010; Effandi & Normah, 2009; Guven & Buket, 2012; Mohamed & Waheed, 2010; Villanueva, 2009), and individual study (Seltzer, 2000). For environmental factors, parents' socioeconomic status (Israel, Beaulieu, & Hartless, 2001), parents' role and social environment (Jensen & Seltzer, 2000) directly affect math performance of the students. Finally, when it comes to teacher-related factors, the teaching practices (Aplaon, 2015; Tingley, 2012), teachers' pedagogy, and content knowledge (Candelario-Aplaon, 2017), workload (Gwambombo, 2013; Ramos, et al., 2015), qualification and field of specialization (Sanchez, 2012), teaching experiences (Kupari, 2011), and professional development were found to be factors affecting mathematics performance.

Problem-solving is an important skill needed not only in mathematics class but in everyday living as well. Worded problems have been a major part of mathematics education for they provide students with opportunities to apply mathematical tools by promoting a link between mathematics and real-life context, using Problem-solving heuristics and developing a new concepts and skills (Verschaffel, Greer, & Corte, 2000). Problem-solving is not an easy task. It requires effort, styles, proper teaching methods, and appropriate teaching approaches (Soancatl et al., 2010) to help the students succeed in problem-solving.

The mathematical problem is a question or situation that is not only related to numbers (Crulikshank & Sheffield, 1992; Phonaphicat & Wongwanich, 2014). Problem-solving does not only require the mastery of mathematical concepts and skills but also requires translating word problems into a mathematical equations (Dela Cruz & Lapinid, 2014) by interpreting information, planning on how to carry out the solution, and methodical working, checking results, and trying alternative strategies (Intranos, Inprashita, & Srisawadi, 2014; Muir, Beswick, & Williamson, 2008).

The problem-solving approach may be the best application of Bruner's (1961) theory of representation. He proposed three modes of representation such as enactive (action-based) representation, iconic (image-based) representation, and symbolic (language-based) representation. In mathematics, it is important to present the concept in terms of concrete examples such as real life objects and scenario for the students to have a clearer understanding of what is being asked. Then from the concrete example such as a worded problem, illustrations, diagrams or charts may be drawn for easier formulation of mathematical equation. Finally, the symbolic representation which is the abstract part of problem-solving is formulated. It is now the mathematical expression. The proposed modes of representation of Bruner is of great importance in this study.

Polya's (1957) problem-solving approach is also relevant in this study. It was cited that solving problem is a practical skill. Students can learn how to solve problems by observing and imitating others on how they solve the problems. Polya distinguished four phases in solving a problem. First, it is about understanding the problem. Second, it is about devising a plan to solve the problem. The third phase about is carrying out the plan, and in the last phase is about looking back at the completed solution and assess its effeciency and effectiveness. As stated by Silver (1985), problem representation strategies are important to process linguistic and numerical information in mathematical problems. More so, the learners need to comprehend the information from the problem to formulate logical solution plans (Heller & Hungate, 1985; Mayer, 1985).

Many scholars have studied mathematical problem comprehension. Numerous studies claimed that there are factors that greatly affect the students' understanding and skills in solving mathematical problems. Tella (2008) found that mathematics achievement was influenced by teachers' self-efficacy, interest and teaching experiences.

However, according to Ajaberi (2015), learning styles affect the students' ability to solve math problems. Various studies were also conducted regarding the students' difficulties in Problem-solving. Among the identified difficulties affecting mathematical performance are lack of reading (Fuschs, et al.,, 2000; Helwig, Rozek-Tedesco, Tindal, Heath, & Almond, 2010; Jiban & Deno, 2007; Lamb, 2010), problem representation and strategies (Mayer, 1985), computational and mathematical skills (Suydam & Weaver, 1977). Further, poor problem-solving performance could also be attributed to ineffective instruction (Xin, Lin, Zhang, & Yan, 2007), lack of linguistic knowledge (Bernardo, 1999), reading difficulty in terms of word recognition (Jordan & Hanich, 2000), poor reading comprehension (Salma & Rodrigues, 2012; Yeo, 2009), decoding the problem (Tsai, Hou, Lai, Liu,

& Yang, 2001), prior math knowledge (Kiwanuka & Damme, 2015), and lack of knowledge about principles, rules and processes in mathematics (Suydam & Weaver, 1999).

Problem-solving becomes more challenging when worded in the learners' second language (Bernardo, 2002). Further, studies reported that it is more difficult to obtain the right answer if more steps are involved (Littlefield & Rieser, 1993). Moreover, students do not like to read very long problems. They find it difficult to understand the keywords in the problem that result to difficulty in interpreting words into mathematical symbols (Phonapichat et al., 2014).

Based from the findings of the study by Angateeah (2017), students face difficulties in decoding the language and visualizing the problem. Further, almost all students could read and understand what is being asked in the problem, but they find it difficult to develop the correct structure of the problem (Angateeah, 2017; Montague, 2003). It was also found by Yeo (2009) that misconception, poor procedural skill (Heller & Hungate, 1985), and inability to translate worded problems into mathematical symbols (Dela Cruz & Lapinid, 2014) lead to the wrong answer.

Because of the presented factors and importance of problem-solving, the researchers felt the pressing need of conducting this study. More so, there is a gap in the literature as the studies only relate the profile with mathematics performance but do not directly relate with the problem-solving skills. Having an in-depth understanding of the role of the determinants in mathematics problem-solving performance helps provide a better discernment of the range of each learner and the status as mathematical learner. The predictive model could be of great help in determining the students' problem-solving performance. Based on its determinants, teachers can develop resources and tools that shape the status and positioning of students in their classroom that lead to equitable access to mathematics.

This study aimed to determine the factors that could affect the problem-solving performance of Grade 7 students in selected public schools in Pinamalayan, Mindoro Oriental, Philippines.

Specifically, it aimed to do the following:

1. Determine the different student-related factors in terms of profile, previous performances in Mathematics and English, comprehension level, and attitudes towards mathematics.
2. Determine the teacher-related factors in terms of profile.
3. Determine the level of problem-solving performance of the student respondents.

4. Determine the relationship between the student-related factors and the level of their problem-solving performance.
5. Determine the relationship between the teacher-related factors and the level of the students' problem-solving performance.
6. Propose a predictive model to help improve the problem-solving performance of the students.

Methodology

This section presents the research design used to answer the specified research questions as well as the research setting, participants, sampling, and the detailed data gathering procedures and analysis.

Research Design

This study utilized the descriptive-correlational method of research. The descriptive design is characterized by simply an attempt to determine, describe, or identify (Ethridge, 2004). Descriptive design provides a clear description of a phenomenon at a given time while the correlational research permits testing some presumed relationship between and among variables as well as making predictions (Stangor, 2011). The descriptive design was used to determine the profile and the problem-solving performance of the participants while the correlational design was used to determine the relationship between the variables under study.

Participants, Sampling, and Setting

The respondents of the study were 115 Grade 7 students and four mathematics teachers from the four selected public secondary schools in Pinamalayan. For the student respondents, the sample size was determined through the aid of G-Power Analysis while proportional stratified random sampling was used to identify the number of participants per school to ensure that each respondent school was properly represented. To specifically select the respondents, the fishbowl method was utilized. When it came to teacher respondents, total enumeration was used because of its small number and because sampling was therefore not applicable.

The study was conducted in four selected public secondary schools in Pinamalayan, Oriental Mindoro. There are 10 public secondary schools in Pinamalayan. The respondent schools were those with student population ranging from 600 to 1,000 and are all headed by a full-fledged principal. The respondent schools vary in topography. One is located along a nautical high way, the other is situated at the foot of a mountain, the third is sited near the shoreline, and the fourth school is located in a remote area of the municipality.

Data Collection

Research instrument. The main data gathering tool used for this study was a questionnaire with four major parts intended for the student respondents, and another questionnaire for the teacher respondents. For the student respondents, the first part was a survey that asked about the profile of the respondents in terms of age, gender, and grade in Mathematics (MG) and English (EG) during the second quarter. The second part was about the students' attitude towards mathematics (ATM). The third and the fourth parts were a multiple-choice type of test which aimed to determine the comprehension skills (CS) and problem-solving performance (PSP) of the students, respectively. The instrument intended for the teacher respondents gathered information about their profile in terms of age, gender, civil status, length of service, educational attainment, and teaching hours per day.

Questionnaire validation. The instrument was content-validated with the help of five experts. Further, its reliability was determined by using a test-retest method. Its *r*-coefficient was 0.83 which denoted that the instrument was highly reliable.

Permission and approval to conduct the study. The researchers asked permission to conduct the study from the Schools Division Superintendent. The approved letter was then forwarded to the principals of the selected schools. Then, the researchers distributed the instrument with the attached consent forms stating the purpose of the study, the assurance of its confidentiality, and the right of the participants to withdraw anytime they would feel uncomfortable. The directions were also explained to the student respondents and they were given one hour to answer.

Administration and retrieval of the instrument. After the respondents answered the questionnaires, they were immediately collected to ensure 100% retrieval. The test was checked and data were encoded, collated, organized, statistically treated, analyzed, and interpreted.

Data Analysis

The students' attitude towards mathematics was described using Likert's scale described as *strongly agree* (5), *agree* (4), *undecided* (3), *disagree* (2) and *strongly disagree* (1). In describing the level of comprehension and problem-solving performance of the students, the following scale was used: outstanding (90% and above), very satisfactory (85% - 89.99%), satisfactory (80% - 84.99%), fairly satisfactory (75% - 79.99%) and did not meet expectations (74% and below). For the statistical treatment of data, mean, frequency, percentage, Pearson's r, Coefficient of Determination (r^2), Stepwise Regression, and Analysis of Variance (ANOVA) were applied to answer all the specific problems of the study.

Results

This section reveals the results of the data analysis conducted by the researchers. The results were presented in a way that they answer the research questions which were previously stated.

Student-Related Factors

The data showed the diversity of the student respondents. The majority of them were aged 12-13 years old which is the usual age of the 7th grader. However, there were some who were younger, which implied that they entered school at a young age and there were also those who were older which is common among the schools in rural areas. In terms of gender, the majority were female. They comprised more than 56.5%.

In terms of the previous grade in mathematics, most of them performed very satisfactorily with grades ranging from 85%-89.99%. Their average performance was described as satisfactory with a corresponding mean of 84.75%. When it came to their previous performance in English, 50 Grade 7 students (or 43.5%) had an outstanding performance with grades ranging from 90% and above. Their average performance was regarded as very satisfactory with a mean value of 86.75%.

Based on the comprehension test, the students had outstanding comprehension skills. Out of 115 Grade 7 students, 73 of them (or 63.5%) got 90% and above. Their average performance was 89.70%, which was described as very satisfactory.

Table 1

Student-Related Factors

Variables	f	%	Variables	f	%
Age			Previous Grade in		
11 below	2	1.7	English		
12–13	105	91.3		50	43.5
14–15	7	6.1	90% and above		
16 above	1	0.9		28	24.3
			85% - 89.99%		
				19	16.5
			80% - 84.99%		
				17	14.8
			75% - 79.99%		
				1	0.9
			74% and below		
			Mean: 86.75		
Gender			Comprehension Skills		
Male	50	43.5			

Female	65	56.5	90% and above	73	63.5
			85% - 89.99%	22	19.1
			80% - 84.99%	12	10.4
			75% - 79.99%	5	4.3
			74% and below	3	2.6
			Mean: 89.70		
Previous Grade in Mathematics					
90% and above	25	21.7			
85% - 89.99%	37	32.2			
80% - 84.99%	32	27.8			
75% - 79.99%	21	18.3			
74% and below	0	0			
Mean: 84.75					

Legend: 90% and above - outstanding, 85% to 89.99%—very satisfactory, 80% to 84.99%—satisfactory, 75% to 79.99%—fairly satisfactory and 74% and below did not meet expectations.

Among the listed items for the attitude towards mathematics, the students strongly agreed that their favorite subject was mathematics and it made them feel at ease with mean values of 4.87 and 4.60, respectively. They agreed that they felt happy attending math class (4.45), proud doing word problems in math (4.28), and studying mathematics (3.76). However, they were undecided when asked if they were excited to solve problems in math (3.28), whether math is important in their daily living (3.00), and whether math is enjoyable and stimulating (2.83). In general, the respondents had a positive attitude towards mathematics. This is in accordance with the result of the study of Villanueva (2009), which stated that most of their respondents possessed a positive attitude towards math.

Table 2

Attitude towards Mathematics

Items	Mean	Description
1. I like studying Mathematics	3.76	Agree
2. Mathematics is my favorite subject	4.87	Strongly Agree
3. I feel happy attending Mathematics class	4.45	Agree
4. I feel excited when I was ask to solve problems in math	3.28	Undecided
5. Mathematics makes me feel at ease	4.60	Strongly Agree
6. I am proud doing word problems in math	4.28	Agree
7. I find math important in our daily living	3.00	Undecided
8. Mathematics is enjoyable and stimulating to me	2.83	Undecided
Overall Mean	3.86	Agree

Legend: 5—strongly agree, 4—agree, 3—undecided, 2—disagree and 1—strongly disagree.

Teacher-Related Factors

The demographic profile of the teacher respondents is presented in Table 3. When they were grouped according to age, each age group was represented. This implies that there was no particular age required in teaching 7th grade mathematics. Further, there was only one male teacher and three females. This is because teaching is one of the professions dominated by females in the Philippines. This finding is similar to the result of the study of Gabriel (2012) that female teachers outnumbered male teachers. As to marital status, there was only one respondent who was single and the rest were married. In terms of highest educational attainment, only one was not pursuing a master's degree. This denotes that the mathematics teachers valued continuing professional development. In terms of length of service, two of them had been teaching for 5 years or less. There was one participant for each bracket 6-10 years and 11 above. In terms of teaching loads, two of them had four while the other two had five teaching loads.

Table 3
Teacher-Related Factors

Demographic Variables	f	%	Demographic Variables	f	%
Age			Length of Service		
24 below	1	25	5 years below	2	50
25–29	1	25	6–10 years	1	25
30–34	1	25	11 above	1	25
35 above	1	25			
Gender			Highest Education Attainment		
Male	1	25	BSEd	1	25
Female	3	75	With Units in Master's Degree	3	75
Marital Status			Number of Teaching Loads		
Single	1	25	5	2	50
Married	3	75	4	2	50

Level of Problem-Solving Performance of the Students

Based on the result of the worded problems, 41 students (or 35.7%) performed satisfactorily. They got an equivalent rating of 80% to 84.99%. There were 26 (or 22.6%) who performed fairly satisfactory, while 22 (or 19%) did not meet expectations and 19 (or 16.6%) showed very satisfactory problem-solving performance. It is also notable that there were 7 students (or 6.1%) who performed outstandingly in the given worded problems. The mean value of 84.75 showed that generally, the respondents performed satisfactorily in the given problem-solving test.

Table 4
Level of Problem-Solving Performance

Problem-Solving Performance	f	%	Description
90% and above	7	6.1	Outstanding
85% - 89.99%	19	16.6	Very Satisfactory
80% - 84.99%	41	35.7	Satisfactory
75% - 79.99%	26	22.6	Fairly Satisfactory
74% and below	22	19.0	Did not meet expectations
Mean: 84.75			Satisfactory

Legend: 90% and above—outstanding, 85% to 89.99%—very satisfactory, 80% to 84.99%—satisfactory, 75% to 79.99%—fairly satisfactory and 74% and below did not meet expectations

Relationship between Factors and Problem-Solving Performance

Based on the correlation result, the previous grade in mathematics is related to the students' problem-solving performance. This is evidenced by the *r* value of 0.248 with the *p* value of 0.004 which is significant at $\alpha = 1\%$. This signifies that though there is only a weak relationship between the students' previous grade in mathematics and their problem-solving performance, such relationship is significant. More so, previous math grades contributed 6.1% to the problem-solving performance per result of coefficient of determination. This affirms the results of some studies that previous math knowledge (Kiwanuka & Damme, 2015), computational and mathematical skills (Suydam & Weaver, 1977), knowledge about principles, rules and processes in mathematics (Suydam & Weaver, 1977) are related to students' problem-solving performance.

Moreover, the previous grade in English significantly affected the students' problem-solving performance. This was supported by the *r* value of 0.297 ($p < 0.01$) which is considered a weak correlation but still attributed an 8.3% of problem-solving performance. This implies that knowledge in the language is important in problem-solving. This supports the finding of Bernardo (2002) that word problems stated in the second language become more challenging for the learners. If the students find difficulty in decoding the language in the problem, they may find it hard to visualize the problem (Angateeah, 2017). If they are unable to translate worded problems into mathematical symbols (Dela Cruz & Lapinid, 2014), the students may also find it difficult to solve the given worded problems.

Another student factor that contributed to the problem-solving performance is the comprehension skills. The computed *r* value of 0.349 is significant at $\alpha = 1\%$. The result of the coefficient of determination indicated that comprehension skills contributed 12.2% to students' problem-solving performance. The problem-solving performance was attributed to reading skills (Fuschs & Fuschs, 2000; Helwig et al., 1999; Jiban & Deno, 2007; Lamb, 2010), word recognition (Jordan & Hanich, 2000), reading comprehension (Salma & Rodrigues, 2012; Yeo, 2009), decoding the problem (Tsai et al., 2001), and linguistic knowledge (Bernardo, 1999).

Last, the *r* value of 0.173 showed that the attitude of the students towards mathematics significantly correlated with their problem-solving performance as its *p* value is less than 0.05. Even though it only indicated a weak relationship, it is still worth noting that it significantly affected and contributed to 3.0% of the problem-solving performance of the students. The result is similar to the finding of Guven and Buket (2012) that students' attitude has a moderate significant and positive relationship with their problem-solving performance. As the students are aware of the importance of mathematical concepts in real life situation, they are more eager to answer worded mathematical problems.

In terms of teacher-related factors, gender ($\underline{r} = 0.245$, $p < 0.05$) is significantly related to problem-solving performance of the respondents. The result showed that the weak correlation still led to 6% influence in the problem-solving performance of the students. The result conforms with the proposition of Gabriel (2012) that sex is significantly related to mathematics performance.

On the contrary, the number of teaching loads had an inverse relationship with the problem-solving performance of the students ($r = -0.243$, p< 0.005). After computing the coefficient of determination, the result indicated that the teaching loads influenced the students' problem-solving performance at 5.9%. This implies that teachers should be given as much as possible less teaching loads to have ample time in preparing the lesson and devising worthwhile activities such as real-life problem-solving strategies in teaching mathematical concepts.

Predictive Model for Problem-Solving Performance

Among the presented variables involving student profile, teacher-related factors, and comprehension skills, there were only two variables that turned out to be predictors of problem-solving performance. Based on the stepwise regression, comprehension skills and grade in English predicted problem-solving performance. This implies that the grade in English and comprehension skills should be reinforced and strengthened to improve students' level of problem-solving performance.

Table 5
Relationship between Factors and Problem-Solving Performance

Variables	R	R^2	P-value	Variables	R	R^2	P-value
Age	0.045	0.002	0.315	Age	-0.096	0.009	0.154
Gender	-0.33	0.001	0.363	Gender	0.245**	0.060	0.004
Grade in Mathematics	0.248**	0.061	0.004	Marital Status	-0.061	0.003	0.260
Grade in English	0.297**	0.083	0.001	Length of Service	-0.090	0.008	0.170
Comprehension Skills	0.349**	0.122	0.000	Educational Attainment	0.127	0.016	0.089
Attitude towards Mathematics	0.173*	0.030	0.033	Number of Teaching Load	-0.243**	0.059	0.004

Legend: * - significant at 5%, ** - significant at 1%

By using the predictive model below, the teachers may be able to predict the problem-solving performance of the students. After the students were given a comprehension test and their English grade was determined, problem-solving performance could also be ascertained. Through this model, the students can be encouraged to improve their reading comprehension for they know its relevance not only in the English subject but also in mathematics.

Table 7 presents the ANOVA result which shows that comprehension skills (f = 15. 712, $p < 0.01$) and grade in English (f = 11.818, $p < 0.01$) were significant at 1% level of significance. This implies that students' level of comprehension skills and grade in English vary. Based from their profile, the students' average performance in reading comprehension was higher than their previous grade in English.

Table 6
Stepwise Regression Result

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	56.275	6.108		9.214	.000
Comprehension Skills	.269	.068	.349	3.964	.000
2 (Constant)	38.553	8.932		4.316	.000
Comprehension Skills	.231	.068	.300	3.420	.001
Grade in English	.243	.091	.234	2.661	.009

a) Dependent Variable: Problem-Solving Performance
b) Predictors: (Constant), Comprehension Skills (CS)
c) Predictors: (Constant), Comprehension Skills, Grade in English (EG)

Predictive Model for problem-solving performance

$$\hat{y} = 56.275 + 0.269\ (CS)$$

$$\hat{y} = 38.553 + 0.231\ (CS) + 0.243\ (EG)$$

After the stepwise regression and the other variables were removed, the model summary was presented in Table 8. Based on the new model, comprehension contributed 12.2% while comprehension skills and grade in English provided 17.4% to the problem-solving performance of the student respondents.

Table 7

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	478.481	1	478. 481	15. 712	.000[b]
	Residual	3441.119	113	30.452		
	Total	3919.600	114			
2	Regression	683.029	2	341.515	11.818	.000[c]
	Residual	3236.571	112	28.898		
	Total	3919.600	114			

a. Dependent Variable: Problem-Solving Performance (PSP)

b. Predictors: (Constant), Comprehension Skills (CS)

c. Predictors: (Constant), Comprehension Skills, Grade in English (EG)

Table 8

Model Summary[a]

Model	R	R^2	Adjusted R Square	Std. Error of the Estimate	Change Statistics		
					R Square Change	F Change	df1
1	.349[b]	.122	.114	5.518	.122	15.712	1
2	.417[c]	.174	.160	5.376	.052	7.078	1

a. Dependent Variable: Problem-Solving Performance

b. Predictors: (Constant), Comprehension Skills

c. Predictors: (Constant), Comprehension Skills, Grade in English

Conclusions and Recommendations

The respondents represented a variety of attributes as shown in their profile. The majority of the student respondents were 12 years old, female, with an average grade in Mathematics of 84.75 and 86.75 in English and with comprehension skills of 88.91, all described as very satisfactory. For the teacher respondents, most of them were female, married, and currently taking their master's degree.

The students' mean performance in problem-solving only was at the satisfactory level. It was evident that there was need to improve the students' problem-solving performance. Their performance, however, was affected by various factors such as previous grade in math (Kiwanuka & Damme, 2015) and English, comprehension skills (Salma & Rodrigues, 2012), and attitude towards Mathematics (Balbalosa, 2010; Effandi & Normah, 2009; Guven & Buket, 2012; Mohamed & Waheed, 2010; Villanueva, 2009). For teacher-related factors, gender (Zacariah et al., 2012) and teaching loads (Gwambombo, 2013; Ramos et al., 2015) contributed to the level of problem-solving performance of the students. After analyzing the possible determinants of problem-solving performance, it turned out that comprehension and grade in English were the major contributing factors. As Problem-solving does not only requires computation but also understanding and analysis of the problem, it is imperative that students comprehend (Salma & Rodrigues, 2012) and decode the problem first (Tsai et al., 2012) to devise and carry out a plan needed to solve the problem (Polya, 1957).

It is then recommended by the researchers that reading comprehension should be developed in early grades for the students to have better problem-solving performance. Supplemental materials may be developed which contain English terms used in problem-solving and its corresponding mathematical expression to aid in the problem comprehension of the students. The teachers should also present different problem-solving heuristics such as working backward, using tables, diagrams, and illustrations to make the problem less abstract and less complex for the students. Teachers should be given fewer teaching loads so that they have ample time for the preparation of their lessons, make instructional aids, and devise worthwhile learning activities. This study is limited to performance in problem-solving and does not cover problem-solving strategies. Therefore, it is also recommended that further study be conducted which would include problem-solving strategies that students utilize. Moreover, only the positive attitude towards mathematics was covered in this study so it is also recommended that the negative attitude towards mathematics like anxiety, misconception, and others may also be included in future studies.

References

Andaya, O. J. (2014). Factors that affect Mathematics achievement of students of Philippine Normal University–Isabela Campus. *Researchers World, 5*(4). doi:10.13140/RG.2.2.28300.00643

Angateeah, K. S. (2017). An investigation of students' difficulties in solving non-routine word problems at lower secondary. *International Journal of Learning and Teaching, 3*(1), 46–50.

Aplaon, Z. (2015). The teaching practices in Mathematics IV, students' competence and mastery level in Bongabong Districts. Paper presented at the 2nd International Research Presentation and Seminar, October 5–6, 2015 at

Puerto Galera, Oriental Mindoro, Philippines. *MinSCAT, TUCST and EDS Business School International Research Journal, 2*(2), 18- 24.

Balbalosa, J. (2010). Factors affecting the mathematics performance of laboratory high school of Laguna State Polytechnic University academic year 2009–2010. (Unpublished master's thesis). Laguna State Polytechnic University, Siniloan, Laguna, Philippines. Retrieved from https://www.bartleby.com/essay/Factors-Affecting-Mathematics-Performance-of-Laboratory-High-PK68TZ4K6YZA

Bernardo, A. B. (1999). Overcoming obstacles to understanding and solving word problems in mathematics. *Educational Psychology*, *19*(2), 149–163.

Bernardo, A. B. (2002). Language and mathematical Problem-solving among bilinguals. *The Journal of Psychology, 136*, 283–297.

Bruner, J. (1961). *The Act of Discovery. Cambridge,* MA: Harvard University Press.

Candelario-Aplaon, Z. (2017). Needs assessment of senior high school mathematics teachers in teaching statistics and probability. *International Forum, 20*(2), 143–159. Retrieved from https://journals.aiias.edu/iforum/article/view/315

Crulikshank, D.E., & Sheffield L. J. (1992). *Teaching and learning elementary school*. NY: Macmillan.

Dela Cruz, J. K., & Lapinid, M. R. (2014). *Students' difficulties in translating worded problems into mathematical symbols*. Paper presented at the De La Salle University Research Congress, 2014, Manila. Retrieved from http://www.dlsu.edu.ph/conferences/dlsu_research_congress/2014/_pdf/proceedings/LLI-I-009-FT.pdf

Department of Education (2013). K to 12 Mathematics Curriculum Guide. Retrieved from http://www.deped.gov.ph

Effandi, Z., & Normah, Y. (2009). Attitudes and problem-solving skills in Algebra among Malaysian matriculation college students. *European Journal of Social Sciences, 8*(2), 232–245.

Ethridge, D. E. (2004). *Research Methodology in Applied Economics*. Hoboken, NJ: John Wiley and Sons.

Fuchs, L., Fuchs, D., Eaton S.B., Hamlett, C.L., & Karns, K.M. (2000). Supplementing teacher judgments of mathematics test accommodations with objective data sources. *School of Psychology Review, 29*, 65–85.

Gabriel, E. (2012). *Determinants of the mathematics performance of the fourth year high school students of Sta. Lucia District* (Master's thesis). Ilocos Sur Polytechnic State College, Ilocos Sur, Philippines. Retrieved from https://www.slideshare.net/eugenedbest/determinants-of-the-mathematics-performance-of-the-iv-year-high-students-by-eugene-d-gabriel

Guven, B., & Buket, O. (2012). Factors influencing mathematical problem-solving achievement of seventh grade Turkish students. *Learning and Individual Differences, 23*(1), 131–137. Retrieved from https://www.researchgate.net/publication/271607678_Factors_influencing_mathematical_problemsolving_achievement_of_seventh_grade_Turkish_students

Gwambombo, I. (2013). *The effect of teachers' workload on students' performance in community secondary school: A study of Mbeya City* (Doctoral dissertation). The Open University of Tanzania, Dar es Salaam, Tanzania. Retrieved from http://repository.out.ac.tz/913/1/IDDE%2C_GMhuruma_-_EXERNAL_-_OUT.doc_gabriel.pdf

Heller, J., & Hungate, H. (1985). Implications for Mathematics instruction of research in mathematical thinking. In E.A. Silver (Ed.), *Teaching and learning mathematical Problem-solving, multiple research perspectives*, (n.p.). Hillsdale, NJ: Erlbaum.

Helwig, R., Rozek-Tedesco, M. A., Tindal, G., Heath, B., & Almond, P. J. (2010). Reading as an access to mathematics Problem-solving on multiple choice tests for sixth-grade students. *Journal of Educational Research*, *93*(2), 113-125. doi:10.1080/00220679909597635

Ignacio, N., Nieto, L., & E. Barona, E. (2006). The affective domain in mathematics learning. *Journal of Mathematics Education*, *1*(1), 16-32. Retrieved from https://www.researchgate.net/publication/316249720_The_Affective_Domain_in_Mathematics_Learning

Intranos, P., Inprashita, M., & Srisawadi, N. (2014). Students' Problem-solving strategies in problem solving mathematics classroom. *Procedia–Social and Behavioral Sciences*, *116*, 4119-4123. doi:10.1016/j.sbspro. 2014.01.901.

Israel, G. D., Beaulieu, L. J., & Hartless, G. (2001). The influence of family and community social capital on educational achievement. *Rural Sociology, 66*(1), 43-68.

Jansen, B. R. J., Schitz, E. A., & van der Maas, H. L. J. (2016). Affective and motivational factors mediate the relation between math skills and use of math in everyday life. *Frontiers in Psychology, 5(*13), 1-11. doi:10.3389/fpsyg.2016.00513

Jensen, B., & Seltzer, A. (2000). Neighborhood and family effects in educational progress. *The Australian Economic Review, 33* (1), 17-31.

Jiban, C.L., & Deno, S.L. (2007). Using math and reading curriculum-based measurements to predict state mathematics test performance: Are simple one-minute measures technically adequate? *Assessment of Effective Intervention, 32*(2), 78–89.

Jordan, N. C., & Hanich, L. B. (2000). Mathematical thinking in second-grade children with different forms of learning disabilities. *British Journal of Psychology, 82*, 375–386.

K to 12 Toolkit. (2012). *Reference guide for teacher educators, school administrators and teachers*. Retrieved from http://www.seameo-innotech.org/eNews/Kto12Toolkit_ao17july2012.pdf

Kaahwa, J. (2012). The experience of Ugandan females in Mathematics. *Science Journal of Psychology*. doi:10.7237/sjpsch103

Kiwanuka, H., & Damme, J. V. (2015). Factors affecting Mathematics achievement of first year secondary school students in Central Uganda, *South African Journal of Education, 35*(3), 1-17. doi:10.15700/saje.v35n3a1106

Kupari, P. (2006). Student and school factors affecting Finnish mathematics achievement: Results from TIMSS 1999 data. In S. J. Howie, & T. Plomp, (Eds.), *Contexts of learning mathematics and science. Lessons learned from TIMSS* (pp. 127-140). London, UK: Routledge.

Lamb, J. H. (2010). Reading grade levels and mathematics assessment: An analysis of Texas mathematics assessment items and their reading difficulty. *The Mathematics Educator, 20*(1), 22–34.

Littlefield, J., & Rieser, J. (1993). Semantic features of similarity and children's strategies for identification of relevant information in mathematical story problems. *Cognition and Instruction*, *23*(2), 145–159.

Mayer, R. E. (1985). *Mathematical ability in human abilities: An information processing approach*. In R. J. Sternberg (Ed.), *Human abilities: An information-processing approach* (pp. 127-150). New York, NY: Freeman.

Mohamed, L. & Waheed, H. (2011). Secondary students' attitude towards mathematics in a selected school of Maldives. *International Journal of Humanities and Social Science, 1*(15), 277–281.

Montague, M. (2003). *Solve it! A practical approach to teaching mathematical problem-solving skills*. Reston, VA: Exceptional Innovations.

Muir, T., Beswick, K., & Williamson, J. (2008). "I'm not very good at solving problems": An exploration of students' problem-solving behaviors. *Journal of Mathematical Behavior*, *27*(3), 228–241. Retrieved from https://www.sciencedirect.com/science/article/pii/S1877042814009185

Ochwo, P. (2013). *Pupil, teacher, and school factors that influence student achievement on the primary leaving examination in Uganda: Measure development and multilevel modeling* (Unpublished doctoral dissertation). Ohio, USA: 12 Kiwanuka, Van Damme, Van Den Noortgate, Anumendem, Namusisi Kent State University. Available at http://media.proquest

.com/media/pq/classic/doc/3321868521/fmt/ai/rep/NPDF?_s=0BNTogwOtR%2 BDuWBm4kqJduTPgvk%3D.

Polya, G. (1957). *How to solve it: A new aspect of mathematical method* (2nd ed.). Princeton, NJ: Princeton.

Phonapichat, P., Wongwanich, S., & Sujiva, S. (2014). An analysis of elementary school students' difficulties in mathematical problem-solving. *Procedia – Social and Behavioral Sciences, 116*, 3169-3174.

Ramos, R., Baking, E., Quiambao, D., Nicdao, R.V., Nuqui, A. C., & Cruz, R. (2015). The reading comprehension and mathematics proficiency level of high school students and their correlates. *Journal of Business & Management Studies, 1*(2), 1-7.

Salma, J., & Rodrigues, S. (2013). Students' difficulties in comprehending mathematical word problems in English language learning context. *International Research*, *1*(3).

Sanchez, H. S. (2012). The impact of self-perceived subject matter knowledge on pedagogical decisions in EFL grammar teaching practices. *Language Awareness, 23*(3), 220-233. Doi: 10.1080/09658416.2012.74908

Silver, E. A. (1985). Research on teaching mathematical Problem-solving: Some underrepresented themes in needed directions. In E.A. Silver (Ed.), *Teaching and learning mathematical Problem-solving, multiple research perspectives*, Hillsdale, NJ: Erlbaum.

Singh, K., Granville, M., & Dika, S. (2002). Mathematics and Science achievement: Effects of motivation, interest and academic engagement. *The Journal of Educational Research*, *95*, 323–332.

Soancatl, V., Lèon, A., Martinez, C, & Torres, L. (2010). *Leading students to solve math's problems using question-led learning*. Paper presented at the Proceedings of the 4th European Conference on Games-Based Learning. Retrieved from https://www.researchgate.net/publication/290751373_Leading_students_to_solve_maths_problems_using_question-led_learning

Suydam, M. N., & Weaver, J. F. (1977). Research of problem-solving: Implication for elementary school classroom. *Arithmetic Teacher, 25*, 42.

Strangor, C. (2011). *Research methods for the behavioral sciences* (4th ed.). Belmont, CA: Cengage.

Tella, A. (2008). Teacher variables as predictors of academic achievement of primary school pupils mathematics. *International Electronic Journal of Elementary Education, 1*(1), 16–33.

Tingley, J. C. (2012). *Talking aloud partner Problem-solving (TAPPS)*. Retrieved from https://shodhganga.inflibnet.ac.in/bitstream/10603/45119/12/12 _chapterpdf

Tsai, M. J., Hou, H. T., Lai, M. L., Liu, W. Y., & Yang, F. Y. (2012). Analyzed visual attention for solving multiple choice mathematics problems. *Computers & Education, 58*(1), 375 - 385.

Verschaffel, L., Greer, B., & Corte, E. D. (2000). *Making sense of word problems*. Lisse, The Netherlands: Sweets and Zeitlinger.

Villanueva, E. (2009). *Predictors of mathematics achievement in Algebra of second year high school students in the City Division of Candon, Ilocos Sur* (Unpublished master's thesis). Ilocos Sur Polytechnic State College, Tagudin, Ilocos Sur, Philippines.

Xin, Z., Lin, C., Zhang, L., & Yan, R. (2007). The performance of Chinese primary school students in realistic arithmetic word problems. *Educational Psychology in Practice*, *23*(2), 145-159.

Yeo, K. J. (2009). Secondary 2 students' difficulties in solving non-routine problems. *International Journal of Mathematics Teaching and Learning, October 2009,* 1-30.

Zacariah, K. M., Kibet, K., Muthaa, G. M., & Nkonke, G. R. (2012). Factors contributing to students' poor performance in Mathematics at Kenya Certificate of Secondary Education in Kenya: A case of Baringo County, Kenya. *American International Journal of Contemporary Research*, *2*(6), 87-91.

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