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Exploring Proficiency of Solving Mathematical Problem Among Mathematics Major

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Abstract

Learning problem-solving in mathematics was a challenge for both learners and teachers because of its complexity. Development of the skill necessitates understanding towards common observable predictors to depict the viable actions of typical students. This study created a model that determines the predictors' direct and indirect effects on mathematics problem-solving efficiency. It utilized predictive correlation design using multiple regression analysis to examine the hypothesized predictors. Results showed that self-efficacy and English proficiency did not directly influence the ability to perform in problem-solving; analytical-logical does otherwise. Notable findings displayed an inverse relationship of study habits among students. With that, improving analytical-logical skills promotes greater learning along with the development of English proficiency and self-efficacy. Furthermore, the study habits of mathematics majors were not meaningful because of the potential exposure to problem-solving.

Keywords: path analysis, mathematics performance, critical thinking skills, problem-solving skill

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INTRODUCTION

Solving mathematical problems is one of the concerns of students anywhere in the country. Not many students can understand and solve mathematical problems correctly. Some are having difficulty in analyzing and even understanding the problem itself. Others may understand but are too lazy to study and solve it. Problem-solving skill is a difficult objective to achieve for students and for teachers to teach. It is generally regarded as the most significant cognitive activity every day and in professional contexts. Students faced difficulties solving mathematical problems due to the lack of cognitive abilities and incompetency in acquiring many mathematics skills (Tambychik & Meerah, 2010). Cognitive skills include the ability to recall, perceive, and memorize, which help solve mathematical problems. This study was formulated to determine the predictors that affect the students' efficiency in solving mathematical problems.

Many students were having trouble solving mathematical problems because of difficulty understanding the problem structure embedded in the problem context. Solving mathematical problems needed a greater understanding of the problem. Hence, its relationship to English proficiency has been addressed. Mestre (2013) explored the role of language comprehension in solving mathematical problems. He appealed that language proficiency greatly influenced understanding the problem. With the different languages around the world, language proficiency interacts with mathematical problems in different ways. It is possible that in solving mathematical problems, there will be a lot of interpretations. English as the universal language will serve as the tool to have a common understanding of the problem. Henry et al. (2014) stated that

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mathematics scores showed a linear relationship between English proficiency. Saquing-Guingab (2015) also added that any good student in English might be suitable in Science and Mathematics. However, Beal et al. (2010) claimed that ELLs (English Language Learners) and non-ELLs do not differ in their performance in mathematics. In addition, low English students get low mathematics performance due to their difficulty understanding the problem, which is the essential skill to comprehend the situation of the given problem. Bernardo (2005) also stated that the linguistic factor does not affect abstract mathematical components of the word problem-solving. However, they may affect the other components, such as those related to reading comprehension and understanding. Solving mathematical problems will help utilize the critical thinking skills of the students. Students need to think critically to solve mathematical problems effectively (Peter, 2012). Thus, critical thinking skills will play an essential role in understanding mathematical problems.

The ability to think critically involves evaluating the problem contexts. Solving mathematical problems does not only include evaluating but also examining and collecting the facts about the problem contexts. Thus, critical thinking skills should go hand-in-hand with analytical-logical skills to acquire efficiency in solving mathematical problems. Analytical-logical skill is also considered an essential skill for solving mathematical problems that include the ability to visualize, articulate, conceptualize or solve both complex and complicated problems by making sensible decisions given the available information is embedded (Rahman, 2019). Students' thinking is on different levels of development. Rahman & Ahmar (2016) determined the different levels of thinking and their relationship to the efficiency of solving mathematical problems. It includes formal thinking level, transitional thinking level, and concrete thinking level. At each level, it is concluded that students can plan, visualize, and analyze problems logically, thus resulting in efficiency in solving mathematical problems.

Students who acquired analytical-logical skills tend to rely mainly on their ability to solve mathematical problems. Some failed to take into consideration that the key to learning includes study habits. Study habit is also one important factor that affects student's mathematical performance. Ashish (2013) mentioned that students must ditch unproductive study habits and replace them with a good one no matter what academic level. He further added that establishing good study habits will ensure efficiency in solving mathematical problems. Marc (2011) claimed that good study habits would contribute to better problem-solving skills in mathematics. Added to that opinion, Elliott et al. (1990) mentioned that study habits stimulate better mathematics performance due to constant practice solving problems. Even Sangcap (2010) claimed that studying produces an increase in one's mathematical ability. Agreed by Fernández et al. (2019) and recommended tutorials and other student accessibility services to help students improve their study habits in mathematics. Higher effort and a more substantial commitment to studying mathematics are needed to increase understanding of mathematical problems.

In addition, the mathematical performance showed a significant relationship with student's study habits. It is concluded that the main reason for students' low performance in mathematics is due to their lack of interest in studying mathematics subjects (Suan, 2014). Students find mathematics subjects boring and difficult to understand without a teacher's aide. Singh, P. (2016) agreed that students have low scores on mathematics examinations not because they lack the ability to solve the problem but because they do not give ample time to study and understand mathematical problems on their exams.

In most cases, students are not studying mathematics because they are not confident. They feel anxious if they are doing the correct way of solving mathematical problems, which will take most of their study time. Teachers should help boost students' self-efficacy in the classroom, as Akomolafe (2013) suggested. Teachers must encourage a student to solve a particular problem caused by the study of Hoffman (2010). Self-efficacy plays a vital role in solving mathematical problems. He even added that enhancing self-efficacy also enhances efficiency in solving a mathematical problem. It is identified as a significant predictor that aids in reducing students' problem-solving time with greater accuracy. Individuals developed confidence resulting in higher accuracy in solving mathematical problems. An example of mathematical problems is word problems which can be solved step by step procedure. However, some word problems are considered maladaptive, which discourages the solver due to its complicated solution. When you can solve maladaptive mathematical problems, you will be able to boost your self-esteem. According to Kitsantas et al. (2011), to enhance students' self-efficacy concerning mathematics, they should successfully handle and solve mathematical problems.

The hypothesized predictors showed great relevance in assessing students' mathematical performance. English proficiency, analytical-logical skills, study habits, and self-efficacy were all significant factors compared to recognize their relationship with each other to the efficiency of solving mathematical problems. As shown in Figure 1, these predictors, directly and indirectly, affect the efficiency of solving mathematical problems. Thus, this study is anchored on the General Linear Model to identify and understand the effect of predictors on the efficiency of solving mathematical problems.

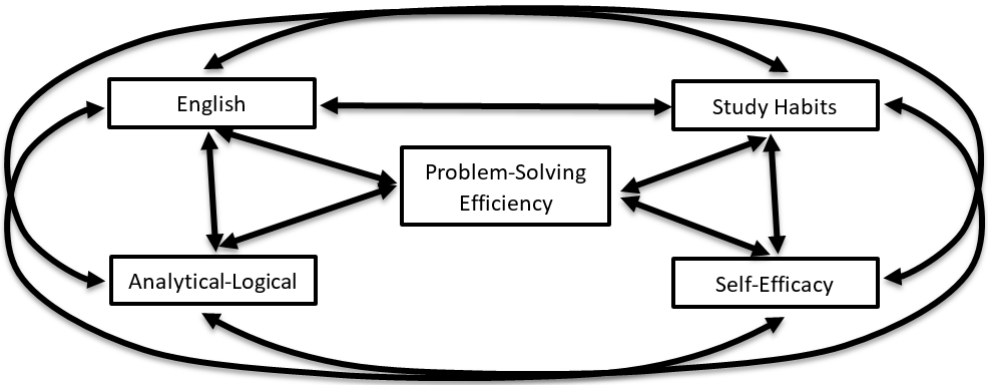

Figure 1. Schematic diagram of the study

With all the hypothesized variables of the study that may have directly affected the efficiency of problem-solving among students, few studies considered to explore the interrelationships among the associated variable to the dependent variable. In this study, it showed the path of relationships among to showcase the direct and indirect effects among variables of the study.

As such, to identify the different patterns within the specified variables, path analysis is used. It is performed to evaluate the relationship between the dependent variables (English proficiency, Analytical-Logical, Study habits, and Self-efficacy) and the independent variable (Problem-solving Efficiency). Hence, researchers will create a comprehensive model showing what variable contributes to students' proficiency in solving mathematical problems.

RESEARCH METHOD

This study utilized Correlation Predictive Design. All math major students enrolled in the Academic year 2018-2019 on different campuses of State University in Southern Leyte were the respondents of this study. Standardized assessment tools with minor modifications to quantify the respondents' responses on the research instrument are as follows; Study Habits Inventory was adapted from C. Gilbert Wrenn, Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ). Analytical-Logical Skills adapted from Whimbey, A., Lochhead, J., & Narode, R. (2013), and English Proficiency and Problem Solving were researcher-made questionnaires. Validation of the questionnaires was through pilot testing and used Cronbach Alpha to test the reliability with a result of 0.792.

The student-respondents were given questionnaires which fit to the objectives of the study. After gathering all the needed information, data were organized and presented in the form of tables. Analysis of data was done with the aid of appropriate statistical tests.

RESULTS AND DISCUSSION

Relationship of the variables of the study

Table 1. Correlation matrix of the identified variables

	n	Mean	SD	Math Efficiency	English Proficiency	Self-Efficacy	Analytical-Logical
Math Efficiency	80	11.33	4.124	-			
English proficiency	80	25.9	4.83	.309**	-		
Self-efficacy	80	3.1569	.47399	.225*	-.095	-	
Analytical-logical	80	15.17	4.289	.526**	.535**	0.146	-
Study habits	80	2.6965	.28817	-.303**	-.049	-.113	-.022

** significant at 0.01; * significant at 0.05

As presented in table 1, all predictors are significant at 0.01 except the self-efficacy. On the other hand, only study habits negatively correlated to the efficacy and the other predictors. The result implies that all the indicators increased the efficiency of solving mathematical problems but not study habit.

Structural Model of the Efficiency of Students in Problem Solving

Table 2. Direct, Indirect, and Total Effects of the Predictors to the Response Variable

Effect	Paths	Coefficient	Total
Direct	Analytical-Logical → Efficiency	.471	
	Study Habits → Efficiency	-.275	.196
Indirect	English Proficiency →Analytical-Logical → Efficiency	.556*.471 = .262	.357
	Self-Efficacy → Analytical-Logical → Efficiency	.202*.471 = .095	
Total			.553

Based on table 2, the predictors that directly affect the efficiency of solving mathematical problems are analytical-logical skills and study habits. The analytical-logical skills increased the efficiency by .471, but study habits decreased it by .275. Students who have good analytical-logical skills solved both easy and complex mathematical problems. In contrast, students who have good study habits in mathematics tend to complicate things in solving the problem. The predictors that showed a direct relationship to efficiency implied that students were already exposed to various mathematical problems; thus, they could easily comprehend and analyze the problem. However, students should keep their phase by not being too reluctant at the same time not to over-study the problem because it will result in inefficiency in solving mathematical problems.

On the other hand, English proficiency and self-efficacy showed an indirect effect on efficiency. However, these indicators showed a direct effect on the analytical-logical ability of the students. Students who are not confident and less proficient in English found it hard to analyze and solve mathematical problems correctly. Furthermore, students who are willing and confident that they can solve mathematical problems contribute to a better analysis that leads to better efficiency in solving mathematical problems.

This study created a model shown in Figure 2. The model is based on the relationship of predictors to the efficiency in solving mathematical problems. It reveals the path analysis of the independent variables of the study. Moreover, it showed the direct and indirect effects on the efficiency of solving mathematical problems.

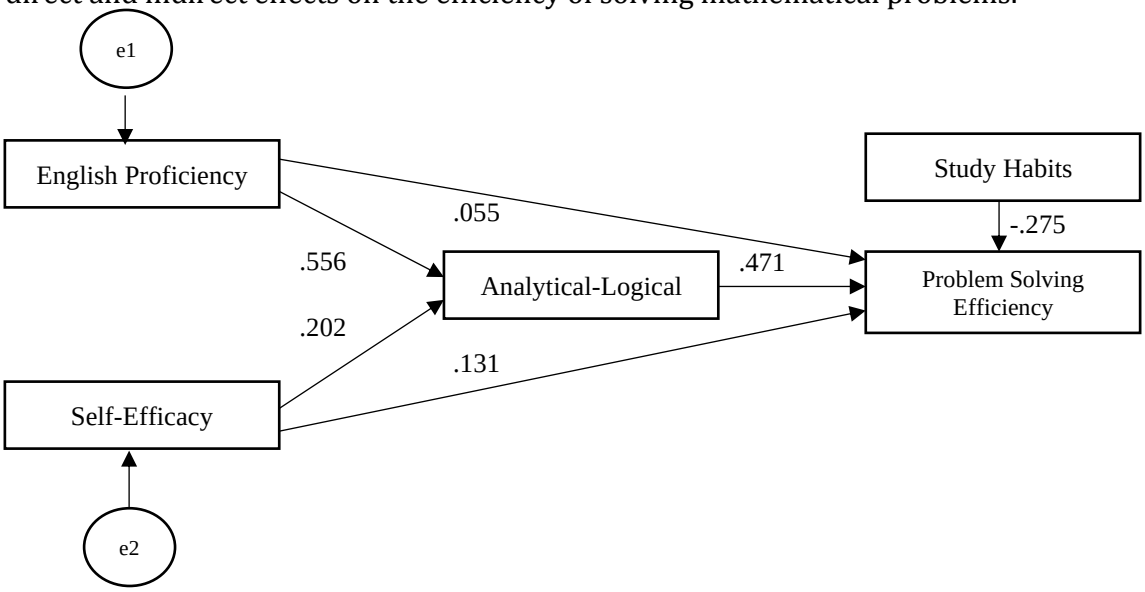

Figure 2. The diagram shows the efficiency of students in problem solving

CONCLUSION

Mathematical problem-solving is one of the challenging parts of being math major student. This study used the typically identified predictors that affect students' efficiency in solving mathematical problems: English Proficiency, Analytical-Logical, Study Habits, and Self-efficacy. These predictors were used to understand their relationship and effects on the efficiency of solving mathematical problems. After running the multiple regression analysis, the data revealed that analytical-logical

(positively affect) and study habits (negatively) directly affect efficiency among the mentioned predictors. In contrast, English proficiency and self-efficacy indirectly affect mathematics' efficiency through analytical-logical skills.

This study suggests that students should have strong analytical-logical skills to achieve greater understanding in solving mathematical problems, resulting in better efficiency in solving mathematical problems. Also, analytical-logical skills can be enhanced with the help of English proficiency and self-efficacy. English proficiency aids in improving the understanding of the mathematical problem, while self-efficacy aids in encouraging that one can solve the mathematical problem. However, study habits contrariwise affect students' efficiency in solving mathematical problems..

DECLARATION

Author Contribution

All authors contribute in the research process, such as collecting the data, analyzing the data, and writing the manuscript. All authors approved the final manuscript.

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Conflict of Interest

The author declares that they have no competing interests.

Ethics Declaration

I as author acknowledge that this work has been written based on ethical research that conforms with the regulations of our institutions and that I have obtained permission from the relevant institutes when collecting data. We support the International Journal on Emerging Mathematics Education (IJEME) in maintaining high standards of personal conduct, practicing honesty in all our professional practices and endeavors.

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