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The Role of Self-Efficacy and Mathematics ability in the Problem Solving Mathematics

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***Abstract*—The problem solving skills are part of learning mathematics and an important component of 21st century education. But students often experience success doing it. The purpose of this study was to determine the relationship between mathematical abilities, self-efficacy and problem solving abilities. This is a result of low mathematical abilities and self-efficacy. The research was a survey. Samples were randomly selected as many as 135 students from whole high school students in the Kota Bengkulu. The research instruments were a self-efficacy questionnaire, a mathematical ability test and a mathematical problem solving test. Data was analyzed using structural equation modeling. We used LISREL 8.8 to test the structural model. The results, there is a positive direct effect of mathematics ability on problem solving abilities; there is a positive direct effect of self-efficacy on problem solving abilities, and there is a positive direct effect of mathematics ability on self-efficacy.**

Keywords—self-efficacy; mathematics ability; problem solving ablility

I. INTRODUCTION

Problem solving ability is one part of learning mathematics. Problem solving is a critical component of a comprehensive 21st century education [1]. Students need to understand the problem, translate in the language of mathematics, and solve it mathematically, finally he is able to find a solution to the problem [2]. They tend to have difficulty making mathematical models, and often forget not to translate mathematical solutions to actual problems [3,4]. Also, students are often unsure of the answer. He has a low self-efficacy [5,6]. As a result, mathematical abilities are also low [3]. Even though mathematics is an important and compulsory subject in high school. Therefore, mathematics teachers must be able to properly manage the mathematics class [7].

The diversity of mathematical abilities, and self-efficacy of students become variables that must be considered in preparing learning plans. The mathematical thinking uses one of the most powerful and natural constructions of the human mind—the ability to use symbols to switch between concepts and processes [8]. According to Bandura, perceived self-efficacy is defined as people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives [5]. Self-efficacy beliefs determine how people feel, think, motivate themselves and behave. Such beliefs produce these diverse effects through four major processes. They include cognitive, motivational, affective and selection processes.

The concept of schemata, knowledge structures was guide cognitive processing. Self-schemata, particularly important in the maintenance of maladaptive behavior patterns, are described and related to the construct of self-efficacy [9]. The positive effects of mathematics self-efficacy on mathematics achievement and of reading achievement on self-efficacy [10]. There are positive the direct and indirect effects of mathematics ability on mathematics performance, specially, with regarding to powerful predictor and mediator of mathematics self-efficacy [11]. The metacognition and self-efficacy significantly predicted problem-solving ability. Also, self-efficacy moderated the relationship between metacognition and problem-solving ability [12]. According to Latterell, there are situations similar to problem solving. The problem solving of non-routine problems is an important skill [13]. The problem solving of routine problems is also a skill that is needed and appreciated by mathematicians. Routine problem solving is not just the application of procedural skills, because again there is a step in which students must decide which procedure will be applied.

The results of study of Abosede and Adesanya, that the self-efficacy and the problem solving skills accounted for 61.1% of the variance in the job performance [14]. There is a significant combined contribution of self-efficacy and problem solving skills in the prediction of job performance. Also, there are significant and positive relationship among self-efficacy, problem solving skills and job performance. Therefore, good self-efficacy is needed so students are able to develop their thinking processes. In mathematics learning process, students often have the misconception. Therefore, one of the ways to reduce the misconception is by requiring students to explain the way and the results of their thinking [7]. Thus, mathematical thinking ability is closely related to problem solving ability.

The problem solving process involves mental activity and/or physical activity. The physical and mental activities of metacognition involve an explicit description of how concepts/principles of mathematics are developed in students' minds [7]. Therefore, necessary increased awareness of the importance of problem-solving skills, and significantly

increased confidence in problem-solving abilities [1]. The mathematics education in schools and gave the five inter-related components namely: concepts, skills, processes, attitudes and metacognition needed to be considered and emphasized by teachers in developing mathematical problem solving ability in students for an effective mathematics [15]. Students can increase their problem-solving skills in a relatively short period of time. At the same time, they can improve their approach to the solution of a given mathematical problem, performing significant signs of autonomy [16]. Therefore, educating students so that they make effective decisions, solve problems, have self-confidence, are open to collaborative cooperation, can communicate effectively emphasized. Thus, students are expected to have a very high success rate [17].

Result of research of Zarch and Kadivar, that is all of the path coefficients of latent variables in the structural model revealed that mathematics ability is a powerful indicator of mathematics self-efficacy and performance [11]. The model explained 50% in mathematics performance and 38% in mathematics self-efficacy. Mathematics ability had a direct effect (β=0.34) and indirect effect (β=0.27) on mathematics performance. The total effect of exogenous variable on dependent variable was 0.61. In addition, mathematics self-efficacy had a direct effect (B=0.43) on mathematics Performance. These coefficients revealed that the important part of relation between math ability and performance was explained by math self-efficacy.

Self efficacy is the belief of a person in mobilizing his ability to get success in carrying out tasks with indicators: (1) confidence in self motivation, (2) confidence in cognitive potentials, and (3) confidence in one's ability to perform tasks [6]. Self-efficacy of gifted students made an independent contribution to the prediction of problem-solving in a model that controlled for the effects of math anxiety, cognitive ability, mathematics achievement, self-efficacy for self-regulated learning, and sex. Gifted girls surpassed gifted boys in performance but did not differ in self-efficacy [18]. Thus, we were to discussing about the role of self-efficacy and mathematics ability in the problem solving mathematics.

II. METHOD

This research is a survey. We examined the effect of self-efficacy and mathematical abilities on problem solving ability. The population is whole high school students in the Kota Bengkulu. Samples were randomly selected as many as 135 students. There are three latent variables, that is self-efficacy, mathematical abilities and problem solving abilities. The research instruments were a self-efficacy questionnaire, a mathematical ability test and a mathematical problem solving test. Data was analyzed using structural equation modeling. We used LISREL 8.8 to test the structural model for the direct and indirect influence of latent variables.

III. RESULTS AND DISCUSSIONS

The data from the study are the ability to understand mathematics (= MA), self-efficacy (= SE), and problem solving ability (= PS) as latent variables. The indicator variables of the latent variable self efficacy are self-confidence in self-motivation (X1), self-confidence in cognitive potential (X2), and (3) trust in one's ability to perform tasks (X3). The mathematical ability variables as latent variables consisting of seven indicator variables. These variables are restate a concept (X4); classify objects according to certain properties in accordance with the concept (X5); provide examples and non-examples of the concept (X6); presents the concept in different forms of mathematical representation (X7); develop a condition that is sufficient or sufficient condition of a concept (X8); use, utilize and choose specific procedures (X9); and apply the concept to algorithm to problem solving (X10). Also, understanding problems (X11), making mathematical models (X12), solving problems based on mathematical models (X13), finally, testing solutions to problems (X14), the last four manifest variables are for latent variable problem solving abilities. Data were analyzed using Lisrel 8.8. The results of data analysis are presented in Figure 1 (Basic Model Standardized Solution).

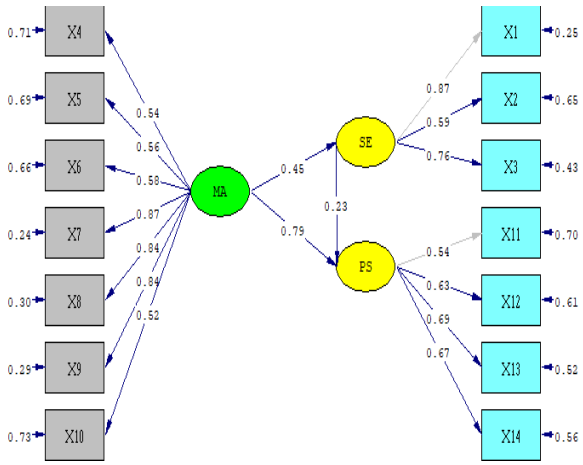

Fig. 1. Basic model standardized solution.

Furthermore, the path diagram of the Lisrel test results is presented in Figure 2, namely the Basic Model T-Values. This diagram determines the significance of the direct effect between latent variables. This is a statistical hypothesis test to determine whether the research hypothesis is accepted or not.

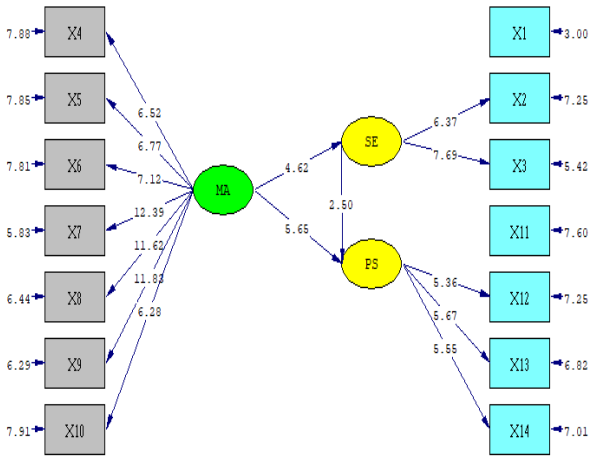

Fig. 2. Basic model T-values.

Based on the path diagram (Figures 1 and 2), we summarize in a table to determine the validity of each indicator variable and the reliability of each latent variable. Also, to determine the significance of each indicator variable (manifest). The tables are Table 1, Table 2 and Table 3.

TABLE I. VALIDITY & RELIABILITY OF SELF-EFFICACY

Indicator	Standardized Loading Factors (SLF) ≥ 0.50	Standard Errors	t-value	Declaration	Reliability	
					CR≥0.7	*VE≥0.5*
X1	0.87	0.25	**	Good validity	0.79	0.56
X2	0.59	0.65	6.37	Good validity		
X3	0.76	0.43	7.69	Good validity		

Based on Table 1, it shows that there are three observed variables (X1, X2, and X3) over the latent self-efficacy variable that has passed the validity test, because it has met the requirements, namely the value of loading factors ≥ 0.50 and t-value ≥ 1.96. Also, construct reliability (CR) is 0.79 ≥ 0.70, indicating that the reliability test of the self-efficacy variable produces good values. So, self-efficacy has good consistency.

TABLE II. VALIDITY & RELIABILITY OF MATHEMATICS ABILITY

Indicator	Standardized Loading Factors (SLF) ≥ 0.50	Standard Errors	t-value	Declaration	Reliability	
					CR≥0.70	*VE≥0.50*
X4	0.54	0.71	6.52	Good validity	0.86	0.50
X5	0.56	0.69	6.77	Good validity		
X6	0.58	0.66	7.12	Good validity		
X7	0.87	0.24	12.39	Good validity		
X8	0.84	0.3	11.62	Good validity		
X9	0.84	0.29	11.81	Good validity		
X10	0.52	0.73	6.28	Good validity		

To explain the indicator variables for mathematical abilities, see Table 2. The table confirms the validity of the seven observed variables (X4 - X10) on the variable mathematical ability. The seven observed variables are valid. This is in accordance with the provisions that the loading factor value is ≥ 0.50 and t-value ≥ 1.96. For reliability, the value of construct reliability (CR) is 0.86 ≥ 0.70, indicating that the reliability test of the variable mathematical ability produces good values. Thus, mathematical abilities have good consistency.

TABLE III. VALIDITY & RELIABILITY OF PROBLEM SOLVING ABILITY

Indicator	Standardized Loading Factors (SLF) ≥ 0.50	Standard Errors	t-value	Declaration	Reliability	
					CR≥0.7	*VE≥0.5*
X11	0.54	0.70	**	Good validity	0.79	0.56
X12	0.63	0.61	5.36	Good validity		
X13	0.69	0.52	5.67	Good validity		
X14	0.67	0.56	5.66	Good validity		

The last latent variable is problem solving ability. Referring to Table 3, there were all valid indicator variables. This was fulfilling the value of loading factor ≥ 0.50 and t-value ≥ 1.96. For construct reliability value (CR) is 0.73 ≥ 0.70, indicating that the reliability test of the problem solving ability variable was good values. This also means that problem solving abilities have good consistency. Although variance extracted (VE) 0.40 <0.50 (this is an optional test).

Furthermore, we test the existence of a direct influence between the variables MA, SE and PS. The path diagram shows that the t-value is tested by Ho's statistical hypothesis, with the alternative hypothesis as follows.

- H1: There is a positive direct effect of mathematics ability on problem solving abilities.
- H2: There is a positive direct effect of self-efficacy on problem solving abilities.
- H3: There is a positive direct effect of mathematics ability on self-efficacy.

Based on Figure 2, the t-value for the direct influence of the MA on PS is 5.65. This shows that t-value = 5.65> 1.96, with a 95% confidence level rejecting Ho. Thus H1 is accepted, which means that there is a positive direct effect ability on problem solving abilities. This supports the results of Özsoy's research that the main skill to be imparted to students, both in mathematics and the academic disciplines, is that of thinking; this can be realized by the means used by the student [19]. People try to understand and make sense of life and academic skills through language and transfer this information together with other skills into different contexts and situations. Both language skills and mathematical problem solving skills drive in tandem with thinking skills that capitalize on language. In short, mathematical thinking skills have become more important for modern people than mathematical operation skills.

Still from Figure 2, the t-value for the direct effect of SE on PS is 2.50, which means that t-value > 1.96. Therefore, reject Ho (for a 95% confidence level). H2 is thus accepted, which means that there is a positive direct effect of self efficacy on problem solving abilities. Parto's research that there is a positive correlation between self-efficacy and positive attitude and problem solving [20]. The more individual has wrestled with the problem, the higher his self-efficacy is, the more positive his attitude. On the other hand, the lower the self-efficacy of the individual, the higher the sense of threat and the more negative attitude.

Finally, consider the t-value for the direct effect of the MA on SE in Figure 2. The result is that t-value = 4.62> 1.96, means that Ho is rejected for a significance level of 95%. So, there is a positive direct effect of mathematics ability on self-efficacy. This is supported by Ayotola and Adedeji that there is a strong positive relationship between mathematics self-efficacy and achievement in mathematics [21]. It was also observed that there is no significant difference in the mathematics self-efficacy scores of male and female students.

IV. CONCLUSION

We concluded that there is a positive direct effect of mathematics ability on problem solving abilities. Second, there is a positive direct effect of self-efficacy on problem solving abilities. Finally, there is a positive direct effect of mathematics ability on self-efficacy.

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