

The Contribution of Metacognitive Skills and Reasoning Skills on Problem Solving Ability Based on Problem Based Learning (PBL) Model

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The study of correlation between metacognitive skills and reasoning skills on problem solving ability simultaneously in class used PBL learning model is still less. This study aims to reveal the relationship between metacognitive skills and reasoning skills on problem solving ability of the students in STKIP Persada Khatulistiwa Sintang in learning mathematics used Problem Based Learning (PBL) model. This research involves 29 students of 3rd semester at Primary School Teacher Education Department. This research was a correlational research. Data were analyzed using multiple regression analysis. The result of analysis shows that there is a correlation between metacognitive skills and reasoning skills on problem solving ability of the student in learning mathematics based on Problem Based Learning (PBL) model. This is indicated by the significance value of $0.046 < 0.05$. This is also indicated by the number of contribution of metacognitive skills and reasoning skills toward problem solving abilities of 20.41% and 0.69%. It appears that the relationship is an metacognitive skills and reasoning skills that has the greatest contribution to problem solving abilities.

Keywords: metacognitive skills, reasoning skills, problem solving ability, problem-based learning, learning mathematics

INTRODUCTION

The pattern of learning at various levels of education in Indonesia is still largely oriented towards conceptual mastery and has not pursued the empowerment of thinking skills including students' metacognitive skills. The same thing happened to lectures in the Primary School Teacher Education Department STKIP Persada Khatulistiwa Sintang which showed that lecturers have not fully attempted to empower metacognitive skills in lecturing. Corebima (2009) states that the empowerment of thinking and metacognition needs to be done so learners become independent learners. Livingston (1997) states that metacognition plays a critical role in successful learning. The lack of empowerment of students' metacognitive skills will have an impact on the low level of higher order thinking skills.

O'neil & Brown (1997) states that metacognition as the process by which individuals think about their own thinking in order to develop strategies to solve problems. Metacognition refers to the skills of learners consciously in monitoring their learning process. Livingston (1997) states that metacognition refers to higher order thinking which involves active control over the cognitive processes engaged in learning. Furthermore, Gagne (1985) pointed out that metacognition is a high-level cognitive process

Citation: Setiawan, B., & Supiandi, M. I. (2018). The Contribution of Metacognitive Skills and Reasoning Skills on Problem Solving Ability Based on Problem Based Learning (PBL) Model. *Anatolian Journal of Education*, 3(2), 75-86. <https://doi.org/10.29333/aje.2018.327a>

and also the ultimate goal of instructions. The goals of instructions are to deliver knowledge and also develop students' abilities to plan, monitor and even reorganize learning strategies. Students with good metacognitive skills are better critical thinkers, problem-solvers, or decision makers than students who are not. (Dawson, 2008). Suraya et al (2008) states that metacognition is one of the aspects that develop students in the math problem solving abilities. In addition to metacognition, reasoning skills are considered to play an important role in various types of cognitive activity. The activation of metacognitive skills can create self-learner which can influence the improvement of high order thinking ability (reasoning skills).

Reasoning is an activity or process of thinking to draw a conclusion or to make a new statement based on several statements known to be true or verified (Wardhani, 2004; Kusmaryono, 2013; Shadiq, 2014; Rohana, 2015). Lithner (2008) reasoning is defined as the line of thought adopted to produce assertions and reach conclusions in task solving. This means that this line of thought does not have to be based on formal logic; it could even be incorrect. Reasoning generally relates to the ability to find a problem solving.

Metacognitive skills and reasoning skills can be improved by applying some appropriate strategies or learning models. Some research findings reveal that metacognitive skills and reasoning skills can be improved by applying specific learning strategies or models. Adityas & Saadi (2015) showed that the metacognitive activity based on PBL model had an effect on problem solving abilities. Sari et al (2017) reported that Problem Based Learning model combined with Numbered Heads Together (NHT) influence the metacognitive and critical thinking skills. Sungur & Tekkaya (2006), Paidi (2008), Danial (2010), and Muhidin (2012) reported that the PBL model enable students to activate their metacognitive skills in the learning process. On the other hand Aprianti (2009), Nurmaningsih (2009) and Chairani (2015) report the study on metacognitive behavior in problem solving. Magno (2010) and Ku and Ho (2010) investigate the correlation between metacognitive skills and thinking skills. Wicaksono (2014) reported that there is a correlation between metacognitive skills and critical thinking on students' cognitive learning outcomes.

The previous researches studying on the effect, the relationship of one independent variable with dependent variable shows that there is an effect and relationship between metacognitive skills and problem solving ability and critical thinking ability. Furthermore, it needs a specific study that examines the correlation between two independent variables or more against one dependent variable. Because when the two independent variables are together, those are possible to give different effects on the dependent variable.

The correlational studies are used to study the relationship of two or more variables, in which variations in one variable relate to variations in other variables (Sudjana and Ibrahim, 2007). According to Emzir (2009), correlational research is applied for determining the relationship between independent variables with dependent variables, or for using these relationships to make certain predictions. Predicting a complex phenomenon using only one factor (independent variable) often only produces less accurate results. In many cases, the more accurate information we have the more accurate predictions can be made, for example, by combining two or more independent variables, the prediction of the dependent variable will be more accurate than just using each independent variable partly. Thus, the addition of the number of independent variables will increase the prediction accuracy of the dependent variable. Relationship studies usually investigate a number of variables that are believed to be related to major variables, for example if the problem-solving variable has no high relationship, it can be eliminated for further concern.

The description of the relationship or correlation between two independent variables or more against one dependent variable in this study can be seen using a learning model. The appropriate learning model to illustrate the relationship between metacognitive skills and reasoning skills on problem

solving abilities is a learning model that facilitates students to develop their own knowledge and apply their concepts by solving problems in learning. The learning model that is considered appropriate to apply is the Problem Based Learning model. Problem Based Learning Model (PBL) is based on learning not only the process of memorizing concepts or facts but also the process of interaction between individuals and their surroundings. Problem Based Learning models (PBL) can also develop the skills needed in the knowledge era (Tan, 2003) because they can develop higher order thinking skills such as critical thinking skills, problem-solving strategies, self-regulated learning, collaborative learning, and lifelong learning (Steck at al, 2012). Problem Based Learning (PBL) model can be applied in higher education level because PBL is based on problem, involving thinking activity to solve problem and correlating with cognitive function of learners (Izzaty, 2006). PBL potentially empower metacognitive skills (Ackay, 2009).

Mathematics courses are considered potentially used as a research material to improve problem-solving skills and conceptual skills. Mathematics is one of the most important subjects of science. Because of its importance, math is taught from elementary school level to college level. Math needs to be given to all learners to equip learners to be able to think logically, analytically, systematically, critically, creatively and to work together so that learners are capable to acquire, manage, and apply information to survive in an ever-changing, uncertain, and competitive condition (Permendiknas No. 22, 2006). Furthermore, Depdiknas (2006) pointed out that math needs to be taught to learners to be able to understand the concepts of mathematics and able to apply it in problem-solving activities.

Based on several correlation studies, the contribution of each factor can be revealed in problem-solving ability, metacognitive skills and reasoning skills, the simultaneous contribution of metacognitive skills and reasoning skills against problem-solving skills.

METHOD

General Background of Research

This study belongs to a descriptive correlational study. This correlational research attempts to explain whether there is a relationship between variables or not based on the value of the correlation coefficient. This research uses metacognitive skills and reasoning skills as independent variable, problem solving ability as dependent variable and Problem Based Learning (PBL) model as control variable. This research was conducted to reveal the contribution of metacognitive skills and reasoning skills toward problem solving ability based on Problem Based Learning (PBL) model in Primary School Teacher Education Department STKIP Persada Khatulistiwa Sintang.

Sample of Research

The sample used in this research is the students of 3rd semester of D6 class with the number of students as many as 29 students. Sampling technique uses purposive sampling. Before establishing the sample, the writer does the equivalence test based on daily test scores. Equivalence testing samples was done by using a different test criteria that there is no difference between the classes used ($p > 0.05$).

Instrument and Procedures of Research

The instrument used in this study consists of two things, namely instruments for learning devices and instruments for measuring research variables. Instruments for learning tools consist of: 1) Semester Lesson Plan (RPS), 2) Student Worksheet (LKM). Instruments for measuring the research variables consists of an essay test used to obtain data about metacognitive skills, reasoning skills and problem-solving abilities. The process of collecting data in this research begins doing pretest to know the

metacognitive skills, reasoning skills, and problem solving abilities and running the learning process with Problem Based Learning (PBL) model and followed by giving posttest.

Data Analysis

This research data is data about metacognitive skills, reasoning skills and problem solving abilities collected through pretest and posttest. The difference value between pretest and posttest was analyzed using multiple regression analysis with SPSS 23.0 for Windows program. The analysis results are used to determine the multiple correlation between two criteria and one predictor. Before analyzing the multiple regressions, the data were firstly tested with the normality test data using Kolmogorov-Smirnov test.

FINDINGS

Problem Based Learning Model

The data in this research includes data of metacognitive skill, reasoning skill and problem-solving ability. These three data were obtained through pretest and posttest. The summary data from those three research results can be seen in Table 1.

Table 1

Summary of data on metacognitive skill, reasoning skill and problem-solving ability and their differences

	N	Mean	Std. Deviation	Minimum	Maximum
Metacognitive Skill	29	45,4023	20,33093	15,45	85,64
Reasoning Skill	29	73,4483	9,74938	58,69	93,63
Problem Solving Ability	29	74,1379	18,67007	36,71	109,96

Data obtained through the test were analyzed using multiple regression analysis. This type of analysis was chosen to determine the relationship between two independent variables (predictor) against one dependent variable (criteria). Analysis of data using multiple regressions should be preceded by normality test data using Kolmogorov-Smirnov test. The results of the normality test summary can be seen in Table 2.

Table 2

Summary results of normality test data on skill, reasoning skill and problem-solving ability

		Metacognitive Skill	Reasoning Skill	Problem Solving Ability
	N	29	29	29
Normal Parameters ^{a,b}	Mean	45,4023	73,4483	74,1379
	Std. Deviation	20,33093	9,74938	18,67007
Most Extreme Differences	Absolute	,142	,140	,210
	Positive	,142	,135	,100
	Negative	-,100	-,140	-,210
Test Statistic		,142	,140	,210
Asymp. Sig. (2-tailed)		,138 ^c	,156 ^c	,002 ^c

Normality test is to determine whether the distributed research data results are normal or not. The data is set to be normally distributed if the probability is $p_{counted} > 0.05$ and not normally distributed if the probability $p_{count} < 0.05$. Based on the results of normality test by using Kolmogorov-Smirnov test, it is known that normality test on metacognitive skill of 0.138, reasoning ability of 0.156 and data problem solving ability of 0.002. It can be concluded that the data in the study is normally distributed.

The summary of correlation of regression analysis between metacognitive skill and reasoning skill on problem solving ability by applying PBL learning model is presented in Table 3 to Table 6.

Table 3

Summary of variance analysis of correlation between metacognitive skill and reasoning skill on problem solving ability by applying PBL model

ANOVA ^a						
	Model	Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2058,357	2	1029,178	3,474	,046 ^b
	Residual	7701,645	26	296,217		
	Total	9760,002	28			

Based on the result of data analysis in Table 3 using multiple regression of correlation between metacognitive skill and reasoning skills on problem solving ability by applying of PBL learning, the results had an F-test value of 3.474 with significance value of $0,046 < 0,05$. It can be concluded that research hypothesis (H_1) is accepted and null hypothesis (H_0) is rejected. This suggests that there is a correlation between metacognitive skills and reasoning skills on problem-solving abilities. The B values of the two variables (metacognitive skill and reasoning skill) are presented in Table 4, and the constants are 73,908. It can be seen that the multiple regression equation is $y = 0.426X_1 + -0.260X_2$.

Table 4

Regression coefficient of correlation between metacognitive skill and reasoning skill on problem solving ability with PBL model

Coefficients ^a						
	Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	73,908	24,869		2,972	,006
	PBL Metacognitive Skill	,426	,163	,464	2,620	,014
	PBL Reasoning Skill	-,260	,339	-,136	-,767	,450

Table 5 shows the correlation coefficient (R) is 0459 with a value of reliability (R^2) of 0211. The correlation value of 0.459 shows a weak correlation between metacognitive skill and reasoning skill on problem solving ability. It also shows that metacognitive skill and reasoning skill contribute 21.10% in explaining problem-solving abilities, while the rest of 78.9% is explained by other factors beyond metacognitive skill and reasoning skill.

Table 5

Summary of multiple regression results correlation between metacognitive ability and reasoning ability to problem-solving ability with PBL model

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,459 ^a	,211	,150	17,21096

Table 6

Contribution of metacognitive skill and reasoning skill on problem solving skills with PBL model

Variable	RC(%)	EC(%)
X1 (Metacognitive Skill)	96,7	20,41
X2 (Reasoning Skill)	3,3	0,69
Total	100	21,1

Table 6 shows that metacognitive skill parameters provide an effective contribution of 20.41%, while reasoning skill parameters provide an effective contribution of 0.69% on problem-solving abilities.

DISCUSSION

Based on the results of hypothesis test, the results had an F-test value of 3.474 with significance value of $0,046 < 0.05$ which means there is a correlation between metacognitive skill and reasoning skill on problem solving ability by applying Problem Based Learning (PBL) model. The results of this study are in line with the results of the study of Hacker & Dunlosky (2003), Yunus at al, (2008) and Ihsan (2016) which pointed out that one's ability to solve problems is influenced by metacognition skills. The correlation between metacognitive skill and reasoning skill on problem solving ability in this research is because metacognitive skill is an important matter in solving problems which include self-monitoring and planning. Self-monitoring refers to an individual's ability to perform a direct examination of the problem-solving process. Planning involves certain complexity of problem-solving into sub-goals so they can be solved separately and sequentially to enrich the final completion. Mohammad (2003) stated that metacognitive experiences are more important to determine the achievement of problem-solving ability. Panaoura & Philippou (2004) reported that consciousness and skill in metacognitive self-checking play a role in solving problems. O'neil & Brown (1997) defined that metacognition as the process by which individuals think about their own thinking in order to develop strategies to solve problems.

Metacognition ability is identified as an important factor in the problem-solving process (Brown, 1978; Flavel, 1979; Carr, 2010). This is in line with the results of Keiichi's research (2000) which stated that metacognitive plays an important role in problem solving and students were more skillful in problem solving if they possessed metacognitive knowledge. Foong (2002) stated that success in problem solving relates to students' disposition and monitoring of their own thinking processes and their metacognitive level. Metacognitive ability as a part of the self-regulated process, the ability to control their self-thinking process is at every stage of problem solving. Lee & Fensham (1996) stated that metacognition ability consisting of planning, controlling and monitoring the implementation processes and evaluating processes play a very important role in the learning process. Metacognitive skill can help students to solve problems through effective planning which involves the process of knowing the problems that need to be solved and understanding the effective strategies to solve them. Desmita (2012) stated that metacognitive skills in learning process can be demonstrated by performing metacognitive activities such as planning on how to complete the task.

Metacognition is the awareness of one's thinking about his self-thinking process both about what to know and what to do. In terms of thinking about what to think related to students' awareness of their ability to solve problems. Metacognitive has two components, metacognitive knowledge and metacognitive skills. Metacognitive knowledge is concerned with declarative knowledge, procedural knowledge, and conditional knowledge in solving a problem (Veenman, 2006). While metacognitive skills are related to prediction skills, planning skills, monitoring skills, and evaluation skills (Mulbar, 2008). Such skills are metacognitive in nature (Livingston, 1997). By using metacognitive skills, students will be aware of their thinking processes and can evaluate the outcomes of their thinking processes so that students can devise appropriate strategies to solve problems (Pratiwi & Budiarto, 2014). The results of this study confirmed that metacognitive skills contribute to problem solving skills so that teachers in the learning process should facilitate students with certain lessons that can develop students' metacognitive skills. Such learning process will lead the students into people who have the skill to solve problems, able to make informed decisions and become independent thinkers who are ready to live in real life.

Further, related to the relationship between reasoning skills and problem-solving ability with the application of PBL model, the reasoning skills and problem solving has a very important role to achieve the goals of education and the success of students in school. The results of this study are in line with the results of research conducted by Bjulan & Kristiansand (2007) who reported that

mathematical reasoning relating to making conjecture and proving can be supported with a problem-solving learning strategy. English (1994) stated that reasoning plays a significant role in problem solving. Kaur et al (2009) stated that the thinking process that can optimize problem-solving abilities is reasoning. Bjuland & Kristiansand (2007) stated that reasoning has five interrelated processes in thinking activities which include: 1) sense making is closely related to the ability to construct problem schemes and present knowledge, 2) conjecturing is the activity of predicting a conclusion and factual theory, 3) convincing means performing a solution strategy based on the previous two processes, 4) reflecting is reevaluating activities of the three processes that have been done by looking back the relevance to the relevant theories, 5) generalizing is the final conclusion of the whole process which are then identified and generalized in a process. The results of this study show that reasoning ability has correlation to problem solving ability by applying PBL model.

One of the learning models that potentially empower problem solving abilities is Problem Based Learning (PBL). PBLs focus on challenges to make students think. Learning using the PBL model is similar to teaching metacognitive and critical thinking skills to students so it can indirectly develop students learning with PBL models of metacognitive skills and thinking ability (Arends, 2008; Book et al, 2016). According to Arends (2009), the goals of PBL include: 1) building broad and flexible knowledge base, 2) developing effective problem-solving skills, 3) developing self-directed, lifelong learning skills, 5) becoming effective collaborators, 6) becomes an internal motivation for learning. Further Tan (2004) mentioned the purpose of PBL is to make learners proficient in process skills, problem-solving skills and lifelong learning. Yuan et al (2008) stated that PBL allow learners to participate and deal with problem-solving situations in small group work during the learning process. PBL use the problem as a first step in collecting and integrating new knowledge (Muhson, 2009). PBL facilitates learners through real-world and authentic problem solving and integrating interdisciplinary knowledge (Keziah, 2010).

CONCLUSION

Based on the findings and discussions, it can be concluded that there is a correlation between metacognitive skill and reasoning skill on problem-solving ability with Problem-based Learning (PBL) model. In addition, it is known that the contribution of metacognitive skills on problem solving abilities is higher than the contribution of reasoning skills. Based on these facts, further research should reveal more about the correlation between metacognitive skills and reasoning skills on problem-solving abilities in different populations and instruments. Because of that, lecturers should consider empowering metacognitive skills and reasoning skills by applying appropriate learning models. This is because metacognitive skills and reasoning skills are important predictors for making successful learning.

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