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Analysis of Mathematic Creative Thinking Ability and Metacognition of Students on *Probing-Prompting* Learning Models with *Scaffolding* Srategy

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Abstrak

This study aimed to: (1) examine the effectiveness of the learning probing prompting model with scaffolding strategy on mathematical creative and metacognitive thinking skills, (2) examine the effect of metacognition on mathematical creative thinking skills with probing prompting model learning with scaffolding strategy, (3) describing ability on mathematical creative thinking in terms of students' metacognition with probing prompting model learning with scaffolding strategy. This research was a mixed method type with concurrent embedded design. Population in this study were students of class VII SMP Negeri 7 Semarang in the academic year of 2017/2018. The results showed that probing prompting model learning with scaffolding strategies was effective for mathematical creative and metacognitive thinking skills. Metacognition had a positive effect on mathematical creative thinking ability by probing prompting models learning with scaffolding strategies. A student with high metacognition was able to meet four indicators maximally and perfectly, while another one met one indicator well, but for the other three indicators he is able to master well, there were only a few errors. Students with middle-metacognition ability were able to meet two indicators maximally, but cannot fulfill the other two indicators. Students with low metacognition were able to fulfill one indicator maximally and could not fulfill the other three indicators.

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INTRODUCTION

Mathematics in the world of education is very important to learn because problems in everyday life can be described in mathematical models so that the solution is faster and simpler. Noviana (2013) said that mathematics learning needs to be designed in some way that it has potential to develop students' creative thinking skills. Therefore, the ability to think creatively is one important factor of learning objectives because giving knowledge merely to students will not help him a lot in everyday life, so learning should develop students' attitudes and abilities that can help them deal with problems in the future creatively.

Creative thinking contains aspects of cognitive, affective, and metacognitive skills. Hong in Saparwadi (2014) said that creative thinking can be taught and developed, starting from the awareness of creative thinking and leading to the application of creative thinking habits. Therefore, metacognition is one of the important factors in developing students' thinking ability in learning because metacognition is a tool that can predict academic success and problem-solving abilities, students who have the ability to be able to distinguish information they have learned and who have not learned effectively are they whom are more likely to be able to review and learn new information.

Learning to be creative is almost similar to learning sport, which requires potential, a conducive environment, and continuous training (Mawadah, Kartono and Hardi: 2015). Hossain & Tarmizia in Rochani (2016) in their research results said that group learning has a significant influence on attitudes and cognitive outcomes of mathematics learning achievement. Sumarmo (2010) reveals cognitive skills in creative thinking ability, namely: identifying problems and opportunities, developing good and different problems, identifying relevant and irrelevant data, productive problems and opportunities; generate lots of ideas (fluency), different ideas (flexybility) and new products or ideas (originality), examine and assess the relationship among choices and alternatives, change old mindsets and habits, develop new relationship, expand and renew plans or ideas. Affective skills contained in creative thinking include: feeling problems and opportunities, tolerance of uncertainty, understanding environment and creativity on others, extrovert, brave to take risks, building confidence, self-control, curiosity, expressing and responding to feelings and emotions and anticipating something unknown. While metacognitive skills in creative thinking include: designing strategies, setting goals and decisions, predicting from incomplete data, understanding creativity and something that is not understood by others, diagnosing incomplete information, making multiple judgments, managing emotions and advancing elaboration of solutions for problems and plans.

According to O'Neil and Brown (Purwanti: 2017) Stating that metacognition is a process of someone thinking about thinking in order to develop strategies to solve problems. Lack of awareness and control of cognitive process can cause delays in cognitive functions which in this case vary for each individual.

Findings from research conducted by Wilson and Clarke (2004); Ozsoy and Ataman (2009); Sengul and Katranci (2012), show that metacognition is important in solving mathematical problems. Shen and Liu (2011) suggest that metacognition is the ability to associate important roles with prior knowledge, draw conclusions and monitor or assess personal performance shown during learning process.

According to Karina, Sugiarto and Emi (2013), to improve students' mathematical creative thinking skills, there is a need for learning approaches and learning models which allow students to make observations and explorations in order to build their own knowledge. In line with this, Prompting Probing learning model is included in thinking and problem-based approach. E. C. Wragg and G. Brown (2012) are the inventors of the probing prompting learning model which is closely related to the question. The questions raised during this learning are called probing questions. Probing question is a question that is digging to get further answers from students who intend to develop the quality of answers, so that the next answers are clearer, more accurate and reasonable (Suharsono, 2015).

Less varied learning strategies also inhibit students' creative thinking skills. One strategy that can be applied in learning mathematics is the Scaffolding strategy. According to Mamin (2008) scaffolding is a practice based on Vygotsky's concept of zone of proximal development (the closest development zone). The implementation of the Scaffolding strategy means giving individuals a large amount of assistance during initial stages of learning and then reducing assistance gradually.

Results from research conducted by Molenaar, Sleeger's and Boxted (2014) showed that scaffolding facilitated learning because it supported students in activities they could not achieve successfully and developed the knowledge and skills needed to carry out the next task. According to Alfian, Dwijanto and Sunarmi (2017) scaffolding means giving individuals a large amount of assistance during initial stages of learning and then reducing the assistance. Such assistance can be in the form of instructions, encouragement, warnings, outlining the problem into steps of solving, providing examples, and other actions which allow students to learn independently.

Based on description of the background above, researchers apply *probing prompting learning model* with *scaffolding* strategy and integrate the abilities of mathematical and metacognitive creative thinking into their learning tools.

The formulations of the problems in this study are (1) whether the probing prompting learning model with scaffolding strategy on students' creative thinking skills is effective or not, (2) whether there is metacognitive influence on students' creative thinking skills, and (3) how students' mathematical creative thinking skills are viewed from student metacognition and probing prompting models with scaffolding strategy.

In line with the problems raised, the objective to be achieved is to examine the effectiveness of the probing prompting learning model with the scaffolding strategy on students' creative thinking abilities, test whether there is a student's metacognition influence on students' mathematical creative thinking skills or not, describe mathematical creative thinking abilities in terms of students' metacognition on probing prompting models with scaffolding strategy. While the benefits of this study are to provide additional insight for teachers about the creative thinking process, increase students 'creative thinking skills and metacognition through *probing prompting learning* models with scaffolding strategy.

METHODS

This research is a *mixed method* type with *concurrent embedded* design. This study was started with observation, then quantitative and qualitative data collection, followed by data analysis and interpretation.

The study was carried out in SMP Negeri 7 Semarang with study population was students of class VII 2017/2018 academic year. The research subjects were 32 students for a class with probing prompting learning with scaffolding strategies, as well as 32 students for a class with conventional learning.

Data sources in this study were students' results obtained from mathematical creative thinking skills (KBKM), results of metacognition questionnaire, and results sheet of metacognition interviews. KBKM test results as a quantitative research data source, while data sources for qualitative research are answer sheets of students' KBKM tests, results of metacognition questionnaire, and results of metacognition interviews. The mathematical creative thinking ability test used in this study is a test of creativity. Dwijanto argued (2007: 24), "Creativity tests are used to measure divergent thinking skills, there are no right or wrong answers. The quality of a person's response is measured from the extent to which it is unique and different from most people. The more unique and original, the higher the score. " Therefore the type of test used in this study is a subjective type of description form (essay). The mathematical creative thinking ability test used consists of pretest and posttest which is adjusted to the indicator of mathematical creative thinking ability. Quantitative data were tested using normality test, homogeneity test, average similarity test, average completeness test, proportion test, KBKM improvement test, and influence test. While the qualitative data analysis is done with validation data, making verbal data transcripts, data reduction, data presentation, and data verification.

The analysis of the metacognition questionnaire was obtained from filling out a questionnaire with 1-5 likert scale. The criteria for metacognition scores is generally illustrated in Table 1.

Table 1. Criteria for Metacognition Score

Value Limits	Group
$x < \mu - \sigma$	Low
$\mu - \sigma \leq x < \mu + \sigma$	Medium
$\mu + \sigma \leq x$	High

RESULTS AND DISCUSSION

Validator assessment on learning devices which includes syllabus, lesson plans, worksheets, questionnaires, and interview guidelines have an average value that is included in the excellent category. The learning device is used in the learning process in the experimental class. Learning in the experimental class was carried out using *probing prompting learning* model with *scaffolding* strategy.

After doing research data collection at SMP Negeri 7 Semarang, the data of pretest and posttest results were obtained on mathematical creative thinking ability in the experimental class and control class with quadrilateral material. The following is the result of descriptive analysis of students' mathematical creative thinking abilities in the experimental class and control class in Table 2.

Table 2. Results of Pretest and Posttest Mathematical Creative Thinking Ability

		Eksperimen	Control
Pretes	Lots of data	32	32
	Average	41.06	39.81
	Standard Deviation	9.7	9.57
	Min	18	24
	Maxs	56	58
Postes	Lots of data	32	32
	Average	72.62	52.875
	Standard Deviation	10.95	14.403
	Min	50	36
	Maxs	100	92

From the results of the study obtained the average posttest of mathematical creative thinking ability of students in the experimental class and control class were 72.62 and 52.875 respectively. Minimum completeness criteria (KKM) in SMP Negeri 7 Semarang is 60. Classical completeness is used to find out whether many students who complete mathematical creative thinking have already reached a minimum of 75% or not. Based on the results of classical completeness on students' mathematical creative thinking ability in the experimental class, it was revealed that the number of students gained 60 as many as 29 students from the total number was 32 students. Based on propotion examination to experimental class, it was gained that Zcalculation > Ztabel. This means that H0 is rejected. This means that the proportion of students completing learning classically reaches 75%. Thus it can be concluded that the classical mastery of student learning in mathematics learning probing prompting models with scaffolding strategies is achieved, i.e. more than 75% of students pass minimum score.

Table 3. Gains Test Result

	Pretes	Postes	G	Conclusion	Criteria
Control	39.81	52.88	0.231	Increase	Low
Eksperimen	41.06	72.62	0.545	Increase	Medium

The average students 'mathematical creative thinking skills in *probing prompting learning* with *scaffolding strategy* is more than the average students' mathematical creative thinking skills in conventional learning. Based on the results of the calculation of the two similarity tests on average obtained t count = 6.173. Because t-hitung = 6.173> 1.67 = t table means H0 is rejected. This means that the average posttest score of students 'mathematical creative thinking skills on learning probing prompting models with scaffolding strategies is more than the average posttest value of students' creative thinking skills with conventional models.

Increased students' mathematical creative thinking skills in the experimental class are better than control class students. The results of the normalized gain calculation using the average test of mathematical creative thinking skills are in Table 2. This gives the assumption that the increase in mathematical creative thinking abilities of experimental class students is higher than the control class.

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The influence of students 'metacognition on students' mathematical creative thinking skills was tested using simple linear regression analysis. The results of students 'metacognition influence on students' mathematical creative thinking skills obtained sig = 0.001, so that sig = 0.001 <0.05, then H0 is rejected. So it can be concluded that there is a significant influence between metacognition and students' mathematical creative thinking skills. Furthermore, the magnitude of the influence of metacognition on mathematical creative thinking ability was obtained R square = 0.309, which means that the metacognition variables influence the students' mathematical creative thinking ability variables by 30.9% and the remaining 69.1% is influenced by other factors.

Student classification based on acquired metacognition is used as a consideration in choosing subjects to be interviewed more deeply about mathematical creative thinking abilities. Following is the result of the metacognition questionnaire analysis, student groupings were obtained in Table 4.

Table 4. Grouping of Students Based on Metacognition

Interval	Criteria	f	%
x < 70	Low	5	15.625
70 ≤ x < 110	Medium	23	71.875
110 ≤ x	High	4	12.5
Sum		32	100

The average results of posttest scores on mathematical creative thinking ability in terms of students' metacognition based on the grouping of students mentioned above, are students with high metacognition gained an average of 83.71 then students with moderate metacognition gained 71.91 and students with low metacognition obtained an average of 59.5.

While seen from the average percentage of metacognition scores from each of these indicators can be seen in Table 5 below.

Table 5. Average Experimental Metacognition of Student Groups Judging from the Indicators.

No	Indicator	No Item	Average	Criteria
1	Metacognition Knowledge			
	Declarative Knowledge	2, 4, 5, 10,20,	97.83	Medium
	Procedural Knowledge	28 6, 14,	97.5	Medium
	Conditional Knowledge	18, 22, 23, 27	101.6	Medium
		1, 7, 11,17, 19 Average	98.98	Medium
2	Metacognition Regulation			
	Planning	33, 9, 21, 24,	105.4	Medium
	Monitoring	26 8, 15,	101.25	Medium
	Evaluating	25, 29 12, 13,	102.75	Medium
		16, 30 Average	103.13	Medium

Based on the results of the study, the information obtained is as follows: (1) the average ability of mathematical creative thinking in the class that uses *probing prompting learning* model is more than 29% of scaffolding strategies (60), (2) mathematical creative thinking skills in classes using probing prompting learning models with scaffolding strategy is above the minimum score classically, (3) mathematical creative thinking skills in classes using *probing prompting learning* models with scaffolding strategies is better than those using conventional learning models, (4) Increasing students' creative thinking skills in classes using model learning probing prompting with a scaffolding strategy occurs. So, it can be concluded that *probing prompting model* learning with scaffolding strategies is effective towards mathematical creative thinking abilities.

The effect of metacognition on mathematical creative thinking ability was tested using a simple regression test. Based on the results of the study showed that there was a significant influence between metacognition on students' mathematical creative thinking skills. The magnitude of the effect of metacognition variables affect the variables of mathematical creative thinking ability by 30.9% and the remaining 69.1% is influenced by other factors.

Analysis of mathematical creative thinking abilities focused on six research subjects, i.e.: two subjects of students who had high metacognition, two subjects of students who had moderate metacognition and two subjects who had low metacognition. The 6 students were selected by looking at each student's posttest answers and certain considerations such as answers and unique ways of solving.

After analyzing the data on the level of creative thinking ability from the results of creative thinking ability tests, questionnaires and interviews of each subject in terms of the metacognition, the researchers obtained can be seen in Table 6 below.

Table 6. List of Research Subjects

No	Metacognition Ability Level	Subject Code	TKBK
1	High	E-18	TKBK 4
2	High	E-28	TKBK 2
3	Medium	E-31	TKBK 3
4	Medium	E-2	TKBK 3
5	Low	E-30	TKBK 2
6	Low	E-4	TKBK 1

It is known generally that the ability to think creatively between subjects who have high, moderate and low levels of metacognition ability is different. In mathematical creative thinking skills, a student with high metacognition is able to meet four indicators with the best and very good, while another one fulfills one indicator well, but for the other three indicators are also able to master well, there are only a few mistakes. Therefore, it can be concluded that students who have high metacognition also have good mathematical creative thinking skills. This is consistent with the opinion of Siswono (2008) which states that students who are very creative are able to solve problems with more than one alternative answer and ways of solving or making different problems smoothly and flexibly.

Students with metacognition are able to meet two indicators maximally, but cannot fulfill the other two indicators properly. Students with metacognition are able to solve math problems appropriately (fluency), able to use various strategies in solving mathematical problems (flexibility / flexibility). This is consistent with the opinion of Siswono (2008) which states that creative students are able to show different ways of solving smoothly.

Students with low metacognition are able to fulfill one indicator maximally and cannot fulfill the other three indicators. Students with low metacognition are able to solve mathematical problems correctly (fluency) or able to use various strategies in solving mathematical problems (flexibility / flexibility). This is in accordance with the opinion of Siswono (2008) which states that students who are creative enough are able to show different ways of solving problems smoothly and are able to make one answer or solution that is different from general habits. While students who are less creative, are unable to solve problems using their own language and are different from others, but they can solve mathematical problems smoothly and use variety of strategies.

CONCLUSIONS

The conclusions of this study is probing prompting models learning with scaffolding strategies is effective. This is shown through probing prompting model learning with scaffolding strategies; completing them classically; the average mathematical creative thinking skills over minimum passing score; students' creative thinking skills in learning with probing prompting models with scaffolding strategy is better than average students’ creative mathematic thinking skills in conventional learning; and students' mathematical creative thinking skills in probing prompting model learning with scaffolding strategies has increased.

In terms of the relationship between metacognition and students 'mathematical creative thinking skills, it was concluded that there was a significant positive influence between metacognition on students' mathematical creative thinking skills. Therefore, assessment and development of metacognition are quite helpful when teachers want to know and to foster students' mathematical creative thinking skills in the classroom.

In terms of analyzing mathematical creative thinking skills in terms of metacognition, it can be concluded that students who have high metacognition both meet the indicators of flexibility. For the other three indicators, i.e: fluency, originality and elaboration (elaboration), they are fulfilled maximally and very well only by a student, while other students master well, but there are still few errors. Students who have moderate metacognition are able to master two indicators of mathematical creative thinking abilities. They are able to solve problems appropriately and fluently, able to use various strategies or ways to solve problems (flexibility). Students who have low metacognition are only able to carry out one indicator of mathematical creative thinking ability, namely fluency or flexibility.

Based on the results of this study, researchers suggested that teachers always pay attention to students' creative thinking abilities and metacognition skills in learning mathematics because there are differences in the way of students' solving problems. Students with low metacognition consist of students who are creative enough, only flexible in providing answers, and less creative students who are only fluent in giving answers. The risen idea came from classroom learning. To understand problems, this student reads questions over and over until he understands. The method used to solve problems is general and does not have variety of methods. The teacher needs to provide motivation to the student that the student is able to solve the problem, so that he will feel confident with the ideas raised by himself.

Students with moderate metacognition consist of creative students. Students are still used to using procedures that are commonly used, do not have a method that is rarely used by others. Besides, students have not been able to develop an idea nor to add or specify the details of an object so that it becomes interesting and even more interesting. In this case the teacher should always provide motivation, questions and practice questions that can foster creativity so that students are accustomed and have better creative thinking skills. In addition, further research is needed on the level of students' metacognition skills which are not only classified as high, medium and low.

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