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Student teachers' mathematical questioning and courage in metaphorical thinking learning

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Abstract. This study was designed in the form of experiments with control group design and post-test only which aimed to examine the role of metaphorical thinking learning in the mathematical questioning ability of student teachers based on the level of mathematical courage. The population of this study was student teachers of mathematics education study program in West Java Province, while the sample of this study was 152 student teachers which were set purposively and then randomly to be included in the experimental class and control class. Based on the results and discussion, it was concluded that: (a) the mathematical questioning ability of student teachers who received Metaphorical Thinking learning was better than those who received conventional learning seen from mathematical courage level; (b) learning and mathematical courage level factors affected the achievement of student teachers' mathematical questioning ability. In addition, there was no interaction effect between learning and mathematical courage level (high, medium, and low) simultaneously in developing student teachers' mathematical questioning ability; (c) achievement of mastering mathematical questioning ability of student teacher was still not well achieved on indicator of problem posing in the form of non-routine question and open question.

1. Introduction

Students' achievement of learning mathematics can be seen through their way of working out and understanding of students in solving problems given. Measuring the extent to which a person's level of understanding goes can be known through the questions raised in his resolving steps [1,2,3].

In raising the question, one must have courage first. Courage is an ability that must be possessed by someone so that it can control him or her in term of when to ask, when to answer questions, and when to respond to questions or answers given. Courage in mathematics includes one's ability to answer questions, ask questions, and provide ideas in responding answers or questions of a given problem.

But a question can be good or bad. Inadequate questions can make learning less conducive and create confusion. To raise good questions posed is a good question, then, the role of educators should be better in managing the teaching and learning process in class [4].

In order for learners to create an innovative solution that makes them understand the problem and solve it, it is necessary to have meaningful learning. In addition, the need for strategies that must be done by teachers in providing structured learning support so that students can be encouraged to learn independently, at least in addressing the problems faced both in the form of questions and statements [5,6].



Development of questioning ability and courage owned by students is also supported by the factor of questioning ability and courage owned by the teacher of mathematics. In fact, there are still teachers who are not already explored in mathematical questioning ability. Therefore, to motivate math student teachers in developing questioning ability on the subjects of mathematics is to teach them metaphorical thinking. This learning is able to connect the problem to the given question into a referred statement so as to produce accurate information [7,8,9,10].

Based on that, the problems and objectives in this research are to know and examine about: (a) is the mathematical questioning ability of math student teachers who received metaphorical thinking learning is better than those who received conventional learning seen from mathematical courage level. (b) Is there any interaction effect between mathematical courage level and learning in developing the mathematical questioning ability of math student teachers? (c) How is the achievement of the mathematical questioning ability of the math student teachers?

2. Methods

This study is designed in the form of experiments with control group design and posttest only that aims to examine the role of learning metaphorical thinking on the mathematical questioning ability of student teachers seen from mathematical courage level. The Population of this study is student teachers of mathematics education study program in West Java Province, while the sample of this study are 152 student teachers set purposively and then randomly to be included in the experimental class and control class.

Indicator of mathematical questioning ability in this research is the ability of student teachers which include: (a) Posing problems related to the context of the given statement; (b) Posing problems in the form of a non-routine question of the given statement; (c) Posing problems in the form of open questions of given statements.

The degree of mathematical courage is grouped into the three categories presented in Table 1 below:

Table 1. Categorization of mathematical courage level

Aspect of Mathematical Courage	Level
Students can answer questions; ask questions, and give ideas in responding answers or questions of given problems.	High
Students can answer questions and ask questions of given problems.	Moderate
Students can answer questions of given problems	Low

The data of the research are analyzed by using Two-Way ANOVA statistic test to see the difference and interaction effect between the learning of metaphorical thinking and the level of mathematical courage (high, moderate, and low) in producing mathematical questioning ability of student teachers.

3. Results and Discussion

Findings on the mathematical questioning ability of student teachers are presented in Table 2.

Table 2. Description of mathematical questioning ability of students prospective teachers based on metaphorical thinking (MT) learning and mathematical courage level

Mathematical Courage Level	Mathematical Questioning Ability			
	Metaphorical Thinking		Conventional Learning	
	(n = 76)		(n = 76)	
	Mean	SD	Mean	SD
High	7,684	1,003	7,227	1,020
Moderate	6,857	1,352	6,414	1,053
Low	5,833	0,811	5,480	0,770
Overall	6,579	1,278	6,342	1,172

Based on the above description, the following interpretations are obtained:

Overall, there are differences in the mathematical questioning ability of student teachers who received Metaphorical Thinking learning and conventional learning. The students' mathematical questioning ability in the classroom with learning Metaphorical Thinking and ordinary learning is high ($76.84\% > 72.27\%$). This is caused by existence of association between questioning ability and metaphorical thinking, namely: (i) Students are able to connect problem from statement; (ii) Students are able to find new concepts that they do not have; (iii) students are able to create creative ideas that come from the problem; (iv) the student is able to apply the results of his thinking in the form of question [6].

In addition, if reviewed based on the level of mathematical courage, the ability to ask mathematically of students who received Metaphorical Thinking learning also looks different and shows mathematical questioning ability with Metaphorical Thinking learning is better than those who learn with conventional learning. Mathematical questioning ability at the mathematical courage of high level for both learning is high ($76.84\% > 72.27\%$). Meanwhile mathematical ability at mathematical courage of moderate and low level for both learning is moderate ($68.57\% > 64.14\%$ and $58.33\% > 54.80\%$).

When seen from which factors affecting the development of mathematical questioning ability, it seems that the two factors (learning and mathematical courage level) affect each other on the development of mathematical questioning ability. In addition, there is no interaction effect between learning and mathematical courage level in developing the student teachers mathematical questioning ability.

To support the description of the mathematical questioning ability of the student teachers, then data analysis about the mathematical questioning ability of the teacher candidate students through the statistical test of average difference. After testing the normality of data distribution of students' mathematical questioning ability obtained that the data is normally distributed. Based on these findings, the test of means difference test is performed by Two-Way ANOVA test (Table 3).

Table 3. Summary of two-way ANOVA test of students' mathematical questioning ability based on the learning factor and level of mathematical courage

SOURCES	Sum of Squares	DF	Mean Square	F _{Count}	Sig
Learning Approach (A)	6,338	1	6,338	6,390	0,013
Mathematical Courage Level (B)	79,999	2	40,000	40,327	0,000
A x B	0,083	2	0,042	0,042	0,959
Inter	144,815	146	0,992		

Based on Table 3 we get sig = 0,013; So it can be concluded that there is a significant difference between student teachers' mathematical questioning ability whose learning using Metaphorical Thinking learning with the use of conventional learning.

If viewed on the basis of the level of mathematical courage (high, moderate, and low) seen from Table 3, it can be concluded that there is at least one group of certain levels of mathematical courage level whose mathematical inquiring abilities differ significantly with another mathematical courage level. To know which degree of math is different is a significantly Scheffe test. The results are presented in Table 4.

Table 4. Scheffe test of mathematical questioning ability development based on mathematical courage (MC) level

MC Type (I)	MC Type (J)	Mean Difference (I – J)	Sig	Interpretation
High	Moderate	0,8390*	0,001	Different
Moderate	Low	0,9115*	0,000	Different
High	Low	1,7505*	0,000	Different

Based on Table 4, it is concluded that mathematical questioning ability has developed at all mathematical courage level. In addition, it is also concluded that there is no interaction effect between learning and mathematical courage level (high, medium, and low) simultaneously in developing student teachers' mathematical questioning ability.

Other findings related to the achievement of student teachers' mathematical questioning ability it is also found that mathematical questioning ability is not achieved well as expected. The achievement result is attached to Table 5.

Table 5. Achievement of mathematical asking ability

Indicators of mathematical questioning ability	Mathematical Courage Level	Learning Class MT	Learning Class
Posing problems is connected to contexts of given statements	High	100%	100%
	Moderate	96%	89%
	Low	82%	79%
	Overall	92%	90%
Posing problems is in the form of non-routine of given statements	High	84%	82%
	Moderate	70%	67%
	Low	66%	65%
	Overall	78%	77%
Posing problems is in the form of open questions of given statements	High	73%	71%
	Moderate	70%	68%
	Low	69%	66%
	Overall	72%	69%

Based on the findings in Table 5, it can be concluded that the achievement of the mathematical questioning ability of the prospective teacher students is still not well achieved on the indicator of problem submission in the form of non-routine questions and open questions. Based on the observation, the obstacle faced by the students is still difficult to construct non-routine questions by expecting open an answer from other students such as:

- Students' are not trained to think openly in their previous learning.
- Student's thinking is more concerned with the results than the process that has become the learning culture.
- The constraint can also be interpreted that learners often have difficulty solving problems caused by the lesson taught is still monotonous (not centered on the students) [8]. In addition, the learning culture experienced by learners in the class has not been accustomed to thinking abstract in solving the problem [6,11].

4. Conclusion

Based on the results and discussion, it can be concluded that: (a) Mathematical questioning ability of student teachers who received metaphorical thinking learning is better than those who received

conventional learning seen from mathematical courage level (high, moderate, and low); (b) Learning and mathematical courage level factors influence students' achievement in mathematical questioning ability. In addition, there is no interaction effect between learning and mathematical courage level (high, medium, and low) simultaneously in developing student teachers' mathematical questioning ability; (c) Achievement of mastering mathematical questioning ability of student teacher is still not well achieved on indicator of problem posing in the form of non-routine question and open question.

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