UJME 11 (2) 2022: 183-190
UNNES JOURNAL OF MATHEMATICS EDUCATION
https://journal.unnes.ac.id/sju/index.php/ujme/
ISSN: 2252-6927 (print); 2460-5840 (online)

Mathematical Critical Thinking Ability in Terms of Students Learning Motivation in Probing Prompting Learning

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ARTICLE INFO

Article History:
Received 7 January 2022
Received in revised form 30 July 2022
Accepted 9 August 2022

Keywords:
Mathematical Critical Thinking Ability; Probing Prompting; Learning Motivation.

Abstract

This research aimed (1) to analyze the effectiveness of Probing Prompting learning on students' mathematical critical thinking skills and (2) to describe mathematical critical thinking skills in terms of students' learning motivation in learning with the Probing Prompting model. This research method was a combination research method (mixed method) with the type of Explanatory Sequential Design. The results showed that: (1) the mathematical critical thinking ability of the Probing Prompting class achieved classical completeness; (2) the proportion of mathematical critical thinking skills in the Probing Prompting class is more than the proportion of mathematical critical thinking skills in the Problem Based Learning class; (3) the average mathematical critical thinking ability of the Probing Prompting class is more than the average mathematical critical thinking ability of the Problem Based Learning class. Subjects with high learning motivation are able to meet all indicators of mathematical critical thinking skills, namely indicators of clarification, assessment, inference, and strategies. Subjects with moderate learning motivation tend to be able to fulfill the clarification indicators; less able to meet the assessment indicators; tend to be able to meet the inference indicators; and able to meet the indicators of strategies. Subjects with low learning motivation tend to be able to fulfill the indicators of clarification, less able to meet the assessment indicators, less able to meet the inference indicators, and tend to be able to meet the indicators of strategies.

1. Introduction

The era of globalization has become a reality that the Indonesian people and nation must face. In the era of globalization, the advancement of science and technology has had its own impact on the world of education in Indonesia. Education is very important for every human being because it allows them to gain various knowledge, experience, and skills.

The success of the education process in Indonesia cannot be separated from the learning process in schools because schools are one of the main educational implementers of the entire educational organization in addition to families and communities. Schools are faced with tremendous challenges in preparing students to be successful and productive citizens in a changing world (Kuhlthau, Maniotes, & Caspari, 2007). Learning in schools is essentially a process of teaching and learning activities. That is, there is an interaction or reciprocal relationship between teachers and students in an educational setting.

Mathematics is the basis of science. Mathematics as a scientific discipline that clearly relies on the thought process is considered very good to be taught to students (Kadarsono, Suyitno, & Waluyo, 2019). The importance of studying mathematics is emphasized by the National Research Institute from the United States of America, NRC (National Research Council, 1989) by stating that "Mathematics is the key to opportunity", which means mathematics is the key to opportunities. For a student, the success of studying mathematics will give him the opportunity to open the door to a brilliant career. By studying mathematics, students will be accustomed to making decisions and conclusions based on their thinking logically, critically, carefully, efficiently, and effectively.

To cite this article:
Dewi, O. & Wijayanti, K. (2022). Mathematical Critical Thinking Ability in Terms of Students Learning Motivation in Probing Prompting Learning. *Unnes Journal of Mathematics Education*, *11*(2), 183-190. doi: 10.15294/ujme.v11i2.59937

Based on the results of the Trends in International Mathematics and Science Study (TIMSS) survey, an international study of trends or directions for the development of mathematics and science, in 2015, Indonesia's achievement in mathematics showed that grade 4 elementary school students were ranked 44 out of 49 countries with an average an average score of 397. Likewise, in the 2018 Program for International Student Assessment (PISA) survey results, the performance of Indonesian students is still relatively low. Indonesia is in the bottom 10 of the top 10. The average achievement scores of Indonesian students for science, reading, and mathematics are 396, 371, and 379, respectively. This value has decreased when compared to the PISA results in 2015. Many factors have contributed to the low results of the TIMSS survey and this PISA. One of the contributing factors is that Indonesian students are poorly trained and have difficulty solving questions with characteristics such as the questions on TIMSS and PISA which are contextual in substance, demanding reasoning, argumentation and creativity in solving them, it can be said that students' mathematical critical thinking skills in Indonesia is still low. Badriyah & Effendi (2019) in their research also revealed that mathematical critical thinking ability is a basic mathematical ability that students need to have in learning mathematics. However, in reality, junior high school students have mathematical critical thinking skills which are categorized as very low.

The results of the average achievement of the Computer-Based National Examination at MTs Ismailiyyah Nalumsari show that the average Mathematics National Examination score for MTs Ismailiyyah Nalumsari students is quite low, namely 40.45 and is relatively low compared to the average National Examination scores for other subjects. Furthermore, the fact about the low mathematical critical thinking ability of MTs Ismailiyyah Nalumsari students is shown in the percentage of students who answered correctly on the flat-sided geometry material which is quite low when compared to the material for other indicators, as well as the absorption capacity of the 2019 Mathematics Computer-Based National Examination for building material. the flat side space on the indicator "Calculating the volume of the flat side space" is only 29.27%. This shows that the mastery of MTs Ismailiyyah Nalumsari students on the flat side of the indicator is low.

Based on the results of interviews with the Mathematics teacher of MTs Ismailiyyah Nalumsari, it was found that the critical thinking ability of class VIII students was still low. Students are still oriented towards the formulas used in solving mathematical problems. Students have not been able to understand problems, find ideas to solve problems, and write down the steps for solving problems in a coherent manner, which is one indicator of mathematical critical thinking skills.

Based on the analysis of the preliminary study of mathematical critical thinking skills on the circle material, some students have not been able to analyze the meaning of the problem so they have not been able to write down the information contained in the problem and are only oriented to the formula so that the answers to each step of problem solving are not correct and produce the wrong final answer. Students also have not been able to describe problem solving actions by making generalizations from the conclusions that have been obtained correctly. The following is an example of one student's answer.

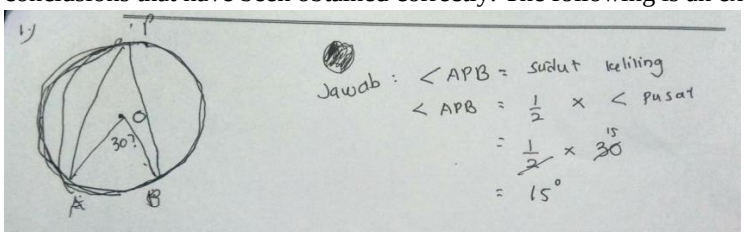

Figure 1. Student Answer

Students are able to solve mathematical problems well if they have good critical thinking skills as well. Factors that affect critical thinking skills (Prameswari, Suharno, & Sarwanto, 2018) are: (1) physical condition; (2) motivation; (3) anxiety; (4) intellectual development; and (5) interaction.

One of the factors that affect the ability to think critically is motivation. Therefore, in the process of learning mathematics, it is necessary to grow motivation to learn mathematics. With the motivation to learn can grow a strong drive and foster attention and interest in mathematics. In the learning process, learning motivation can be used as a factor that can guarantee success in achieving learning objectives. As stated by Williams & Williams (2011), "Student motivation is an essential element that is necessary for quality education", which means that student motivation is an important element needed for quality

education. In essence, motivation makes the learning process carried out later will get optimal learning outcomes.

According to one of the Mathematics teachers of class VIII MTs Ismailiyyah Nalumsari, students' motivation to compete in class learning tends to be low, which can be seen from the lack of student activity in learning in class and the number of students who seem less enthusiastic in learning. According to him, one of the reasons is because there are so many boarding students that there are many other tasks outside of class learning. This causes students' thinking tends to be divided so that students do not focus and lack of encouragement in the students themselves in participating in learning in class. As stated by Sulistianingsih (2016) in his research that the higher the motivation to learn in oneself, the higher the mathematical critical thinking ability. Therefore, learning motivation can be possible to be one of the aspects that affect students' mathematical critical thinking skills. Without learning motivation, students tend to withdraw from the environment and are lazy to think, resulting in students' mathematical critical thinking skills being low.

Toeti Soekamto and Winataputra, as quoted by Shadiq (2009), state that the learning model as a conceptual framework describes a systematic procedure in organizing learning experiences for students to achieve learning objectives and serves as a guide for learning designers and teachers in planning and implementing teaching and learning activities. Based on this statement, to improve mathematical critical thinking skills as well as student learning motivation, an appropriate learning model is needed.

Theriana (2020), states that the Probing Prompting learning model is a learning model that is very closely related to questions, the teacher presents a series of questions that are guiding and exploring so that it becomes a thinking process that links students' knowledge and experiences with new knowledge. Furthermore, students are required to think in the question and answer process. Probing Prompting learning is an effort that can be done in order to create effective learning activities and help students think optimally to get the best results. Sudarti (Huda, 2013), suggests that the probing prompting learning process is able to activate students in challenging learning, because it demands concentration and activity. Furthermore, students' attention to the learning being studied tends to be more awake because students must always be ready to respond when a teacher points suddenly (Gumelar, 2016).

The phase or stages of the Probing Prompting learning model used refers to the stages of the Probing Prompting learning model according to Huda (2013), as quoted by Utami (2016), described through seven probing techniques which were then developed with prompting. The first stage, class presentation, students are faced with new situations, for example by presenting pictures, formulas, or other situations that contain problems. The second stage, understanding the problem, students are given the opportunity to understand the problem or have a small discussion in understanding the problem. The third stage, asking questions, students are given problems by the teacher in accordance with the learning objectives or learning indicators at the meeting. The fourth stage, formulating the problem, students are given the opportunity to formulate answers or conduct small discussions. The fifth stage, answering the problem, students are randomly assigned by the teacher to answer questions. The sixth stage, reformulating, if the answer is correct, then other students will also be appointed to provide responses related to the answer to ensure that all students are involved in ongoing activities. However, if the student experiences a traffic jam or the answers given are inaccurate, inaccurate, or silent, then the teacher asks other questions whose answers are directions for solving answers. The last stage, students were given different final questions to emphasize that the indicators of achievement of learning competencies had really been understood by all students.

The purpose of this research was to analyze the effectiveness of learning with the Probing Prompting model on students' mathematical critical thinking skills and to describe critical thinking skills in terms of students' motivation to learn with the Probing Prompting model. The Probing Prompting learning model is effective on students' mathematical critical thinking skills if it fulfills the three hypotheses in this study. The hypotheses used in this study were: (1) students' mathematical critical thinking skills with the Probing Prompting learning model achieve classical mastery; (2) the proportion of students' mathematical critical thinking skills with the Probing Prompting learning model is more than the proportion of students' mathematical critical thinking skills with the Problem Based Learning learning model.

2. Methods

This research used a combination research method (mixed method) type of explanatory sequential design. The design for quantitative research used was Quasi-Experiments in the form of Posttest-Only Design. Quasi-Experiments is a type of experimental design where the researcher uses groups that have formed naturally and each participant is not assigned randomly (Creswell, 2016).

The population in this study was class VIII MTs Ismailiyyah Nalumsari even semester of the academic year 2020/2021, namely class VIII A, VIII B, VIII C, and VIII D as many as 91 students. The samples taken were two classes, where one class was the experimental class and the other was the control class. The experimental class is a class that in its learning uses the Probing Prompting learning model, namely class VIII D with many students, namely 23 students, while the control class is a class that uses the Problem Based Learning learning model, namely class VIII C with many students, namely 30 students.

The instrument used in this study consisted of a mathematical critical thinking ability test instrument, a learning motivation questionnaire, and an interview kit. The test instrument was used to measure the mathematical critical thinking ability of the experimental and control classes which had previously been tested in class VIII A as the test class. A learning motivation questionnaire was given to the experimental class to classify the experimental class students into high learning motivation, medium learning motivation, and low learning motivation. The interview kit consisted of interview guidelines that were used to reveal students' mathematical critical thinking skills in more depth and to facilitate the interview process.

The indicators used to measure the ability to think critically mathematically on the flat-sided geometry material in this study are presented in Table 1.

Table 1. Mathematical Critical Thinking Ability Indicator

Indicator	Description	Subindicator
Clarification	Analyze the meaning of the problem.	1. Understand the questions given. 2. Write down the information contained in the questions. 3. Write down what is asked in the question.
Assessment	Gather relevant information.	1. Write down relevant concepts/ideas to solve problems. 2. State the formula that will be used to solve the problem.
Inference	Infer relationships between ideas.	1. Reach a conclusion in each step of problem solving.
Strategies	Describe problem solving actions.	1. Make generalizations from the conclusions that have been obtained on the problem correctly.

The data obtained in this study were in the form of mathematical critical thinking ability test results, learning motivation questionnaire results, and interview results. The results of the mathematical critical thinking ability test as quantitative data to be tested for hypotheses with quantitative data analysis including classical completeness test, proportion difference test, and average difference test. Based on the results of the learning motivation questionnaire, 2 research subjects were selected at each level of learning motivation, namely 2 subjects with high learning motivation, 2 subjects with moderate learning motivation, and 2 subjects with low learning motivation. Determination of the subject is done by using purposive sampling technique to conduct interviews. The results of tests and interviews of research subjects were used to describe mathematical critical thinking skills in terms of students' learning motivation in Probing Prompting learning. Activities in qualitative data analysis in the form of data reduction, data display, and conclusion drawing/verification. Checking the validity of the data in this study used technical triangulation.

3. Results & Discussions

3.1. Mathematical Critical Thinking Ability Data Analysis

Mathematical critical thinking ability data is in the form of quantitative data which is the result of written tests in the experimental class and control class. Based on SPSS calculations related to the homogeneity test for the experimental class and control class using the Levene test, it was found that the mathematical thinking ability data for the two classes had the same variance (homogeneous). Based on SPSS calculations related to the normality test using the Saphiro-Wilk test, it was found that the data on the mathematical critical thinking ability test results for the Probing Prompting class were normally distributed and the results of the combined Probing Prompting and PBL class combined mathematical critical thinking skills test using the Kolmogrov-Smirnov test were also normally distributed.

Hypothesis 1 test related to classical completeness test for Probing Prompting class. The following is the classical completeness test hypothesis for the Probing Prompting class.

$H_0: \pi \leq 0.745$ (students' mathematical critical thinking skills in solving problems with the Probing Prompting learning model do not achieve classical completeness)

$H_1: \pi > 0.745$ (students' mathematical critical thinking skills in solving problems with the Probing Prompting learning model achieve classical completeness)

The classical completeness test was carried out using the one-sided (right-handed) proportion test. Based on the calculations, obtained $z_{count} = 1.85$. The value z_{table} with $\propto = 5\%$ is 1.64, so that $z_{count} = 1.85 > z_{table} = 1.64$. As a result, H_0 it was rejected. That is, students' mathematical critical thinking skills in solving problems with the Probing Prompting learning model achieve classical completeness.

Hypothesis 2 test is related to the difference in the proportion of mathematical critical thinking abilities of Probing Prompting class students and PBL class students. The following is the hypothesis of the difference in proportion test.

$H_0: \pi_1 = \pi_2$ (the proportion of students who achieve learning mastery using the Probing Prompting learning model is not more than the proportion of students who achieve learning mastery using the Problem Based Learning learning model)

$H_1: \pi_1 > \pi_2$ (the proportion of students who achieve mastery learning with the Probing Prompting learning model is more than the proportion of students who achieve learning mastery using the Problem Based Learning learning model)

The difference in proportion test was carried out using the z-test. Degrees of freedom $= n - 1 = 53 - 1 = 52$. Based on the calculations, obtained $z_{count} = 2.1$. The value z_{table} with $\propto = 5\%$ is 1.64, so that $z_{count} = 2.1 > z_{table} = 1.64$. As a result, H_0 it was rejected. That is, the proportion of students who achieve mastery learning with the Probing Prompting learning model is more than the proportion of students who achieve learning mastery using the Problem Based Learning learning model.

Hypothesis 3 test is related to the difference in the average mathematical critical thinking ability of Probing Prompting class students and PBL class students. The following is the hypothesis of the average difference test.

$H_0: \mu_1 \leq \mu_2$ (the average result of students' mathematical critical thinking skills with the Probing Prompting learning model is not more than the average results of students' mathematical critical thinking skills with the Problem Based Learning learning model)

$H_1: \mu_1 > \mu_2$ (the average result of students' mathematical critical thinking skills with the Probing Prompting learning model is more than the average result of students' mathematical critical thinking skills with the Problem Based Learning learning model)

The average difference test was carried out using the t-test.

Degrees of freedom $= n_1 + n_2 - 2 = 23 + 30 - 2 = 51$, $t_{table} = t_{1-\alpha} = t_{0.95} = 1.675$. Based on the calculation, obtained $t_{count} = 3.388$, so that $t_{count} = 3.388 > t_{table} = 1.675$. As a result, H_0 it was rejected. That is, the average result of students' mathematical critical thinking skills with the Probing Prompting learning model is more than the average result of students' mathematical critical thinking skills with the Problem Based Learning learning model.

3.2. Description of Mathematical Critical Thinking Ability Viewed from Student Learning Motivation

Learning motivation questionnaires were distributed to students in the Probing Prompting class at the end of the meeting. Based on the analysis of the results of filling out the learning motivation questionnaire, 26.1% of students with high learning motivation were obtained, as many as 6 of 23 students; 56.5% of students with moderate learning motivation, as many as 13 of 23 students; and 17.4% of students with low learning motivation, as many as 4 of 23 students.

The results of the analysis of the tendency of mathematical critical thinking skills in terms of students' learning motivation in Probing Prompting learning are presented in Table 2.

Table 2. The tendency of Mathematical Critical Thinking Ability in terms of Student Learning Motivation

Indicator	Levels of Learning Motivation		
	High	**Moderate**	**Low**
I. Clarification	capable	tend to be able	tend to be able
II. Assessment	capable	less fortunate	less fortunate
III. Inference	capable	less fortunate	less fortunate
IV. Strategies	capable	capable	tend to be able

3.3.1 Mathematical Critical Thinking Ability Subjects with High Learning Motivation

Subjects with high learning motivation are able to meet all indicators of mathematical critical thinking skills, namely indicators of clarification, assessment, inference, and strategies. Based on observations during the learning process, subjects with high learning motivation tend to take the initiative to do practice questions on the worksheet after finishing discussions with their time without being asked. Subjects who have high learning motivation also take the initiative to present the results of their discussions in front of the class and or without being ordered by the teacher. Subjects with high learning motivation tend to immediately do the tasks given by the teacher and do not like to procrastinate in completing their work, and do not prioritize doing things other than assignments.

Research conducted by Steinmayr & Spinath (2008) shows that most of the motivational variables contribute to the prediction of school achievement. Furthermore, research by Kriegbaum, Becker, & Spinath (2018), that "even though intelligence was a stronger predictor of school achievement, motivation incrementally predicted school achievement over intelligence." Therefore, both intelligence and motivation are student characteristics that must be considered when predicting student achievement. Saptono (2016) argues that students who have high learning motivation are more likely to get good learning outcomes because they will do their best to learn these subjects. This supports the results of this study that subjects with high learning motivation gave high mathematical critical thinking ability test results, namely with an average of 85.625 and were able to fulfill all indicators of mathematical critical thinking skills.

3.3.2 Mathematical Critical Thinking Ability Subjects with Moderate Learning Motivation

Subjects with moderate learning motivation are able to meet the indicators of mathematical critical thinking skills in strategies, tend to be able to meet the indicators of clarification and inference, but are less able to meet the indicators of assessment. Based on observations during the learning process, the subject of motivation was quite active in discussion activities even though he lacked confidence when expressing his opinion. Even so, subjects with learning motivation were not afraid and embarrassed to ask when they felt difficult. As revealed by Amalia (2017), students with moderate learning motivation meet the motivational indicators in the medium category, including tenacity, likes to work independently, likes to find and solve problems, are active in learning, and have a passion for learning.

Hazarida, Deswita, & Richardo (2015) revealed that students who have learning motivation are trying their best to solve questions that are considered difficult to answer and are enthusiastic in following or paying attention to the teacher when teaching. This supports the results of this study that subjects with moderate learning motivation gave moderate mathematical critical thinking ability test results, namely with an average of 73.75 and were able to meet three indicators of mathematical critical thinking skills, namely indicators clarification, inference, strategies, but less able to meet the assessment indicators.

3.3.3 Mathematical Critical Thinking Ability Subjects with Low Learning Motivation

Subjects with low learning motivation tend to be able to meet the indicators of mathematical critical thinking skills clarification and strategies, but are less able to meet the indicators of assessment and inference. Based on observations during the learning process, students with low learning motivation tend

to underestimate the ongoing learning. They are cool to chat and play alone. Moslem, Komaro, & Yayat (2019) revealed that students with low motivation will look indifferent, get bored quickly, easily give up and try to avoid activities. The factor that causes a decrease in student learning motivation is the right time to study (Cahyani, Listiana, & Larasati, 2020). Students with low learning motivation turned out to be students who also studied at the cottage, so the possibility of their time to study was slightly less compared to other students who did not study at the cottage. Students who study at the cottage must be good at managing time for cottage activities and school-related activities.

Research conducted by Ng, Liu, & Wang (2016) shows that a low average value of learning outcomes indicates that students have a lower tendency of self-motivation. Muhammad (2016) revealed that students who have low motivation, then their learning outcomes are not in accordance with what is expected. This is in line with the results of this study that subjects with low learning motivation gave low mathematical critical thinking ability test results, namely with an average of 50 and only able to meet two indicators of mathematical critical thinking skills, namely indicators clarification and strategies, but are not able to meet the indicators of assessment and inference.

4. Conclusion

Based on the results of research conducted by researchers, the following conclusions were obtained. The Probing Prompting learning model on students' mathematical critical thinking skills meets the following indicators of research effectiveness. (1) The mathematical critical thinking ability of class VIII MTs Ismailiyyah Nalumsari with the Probing Prompting learning model achieved classical completeness. (2) The proportion of students' mathematical critical thinking skills completeness grade VIII MTs Ismailiyyah Nalumsari with the Probing Prompting learning model is more than the proportion of students' mathematical critical thinking skills using the Problem Based Learning model. (3) The average mathematical critical thinking ability of class VIII MTs Ismailiyyah Nalumsari with the Probing Prompting learning model is more than the average mathematical critical thinking ability of students with the Problem Based Learning model.

Description of mathematical thinking ability in terms of student learning motivation obtained the following results. (1) Subjects with high learning motivation are able to fulfill all indicators of mathematical critical thinking skills, namely clarification, namely analyzing, negotiating or discussing the meaning of the problem; assessment, namely collecting and assessing relevant information; inference, namely concluding the relationship between ideas, namely by reaching conclusions in each step of problem solving; and strategies, which describes the action to solve the problem. (2) Subjects with moderate learning motivation were able to fulfill the indicators of strategies, namely describing problem solving actions; tend to be able to meet the indicators of clarification and inference; and less able to meet the assessment indicators. (3) Subjects with low learning motivation tend to be able to fulfill the indicators of clarification and strategies; and less able to meet the indicators of assessment and inference.

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