



Mathematical Critical Thinking of Students Viewed from Independent Learning in PBL with Problem Cards

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Abstract

Critical thinking skills are one of the important components that students must have in learning mathematics. In addition, student learning success is also inseparable from internal factors of students, one of which is student learning independence. To support this, an appropriate learning model is needed. Problem Based Learning assisted by problem cards can be applied to train students' mathematical critical thinking skills. This study aims to determine the description of students' critical thinking skills in terms of student independence. Sampling was carried out by cluster sampling, obtained class XI MIPA 1 as the experimental class and XI MIPA 2 as the control class. The subjects of the study were taken two each from students who had high, medium, and low learning independence, then analyzed the students' critical thinking skills in depth. The results showed that students with high independence were good in all aspects of critical thinking indicators, students with medium independence were good in the critical thinking indicators Clarification, Assessment, Inference, and still lacking in the Strategies indicator, and students with low independence were good in the critical thinking indicators Clarification, Assessment, while for the Inference and Strategies indicators they were still lacking in mastering.

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INTRODUCTION

Mathematics is a branch of science that plays an important role in human life and is the basis for other sciences. Given the importance of the role of mathematics, mathematics is one of the main subjects in schools from Elementary School to College. (Yensy, 2015).

The quality of mathematics of students in Indonesia in secondary schools is still relatively low. Based on data from the Programme for International Students Assessment (PISA), the mathematics achievement of Indonesian secondary school students was ranked 61st out of 65 countries in 2009 (OECD, 2010). Then ranked 64th out of 65 participating countries (OECD, 2012). This position improved in 2015 with a ranking of 63 out of 69 participating countries (OECD, 2016). While in 2018, Indonesia was ranked 72nd out of 78 countries for mathematics ability (OECD, 2018). Therefore, further efforts are needed to continue to improve mathematics learning in schools.

Critical thinking skills are very important skills for everyone, used to solve life's problems by thinking seriously, actively, and carefully in analyzing all the information they receive, including rational reasons so that every action they take is correct. (Liberna, 2015).

Based on the opinions of experts, the indicators of mathematical critical thinking skills that will be used in this study refer to (Perkins & Murphy, 2006), such as Clarification, Assessment, Inference, and Strategies.

Independence is a positive mental attitude of an individual who positions or conditions himself so that he can evaluate himself and his environment so that he feels comfortable carrying out activities in an effort to achieve planned goals. (Suhendri, 2012). Independence also means not depending on others, having self-confidence, behaving in a disciplined manner, having a sense of responsibility, behaving based on one's own initiative. (Hidayanti & Listiyani, 2013).

The indicators of learning independence taken refer to Haris Mudjiman in (Audhiha, Vebrianto, Habibi, Febliza, & Afdal, 2022), such as: 1) initiative in learning, 2) self-confidence, 3)

responsibility, 4) problem solving, and 5) self-control.

Problem Based Learning or problem-based learning is a learning model that challenges students to learn how to learn, and work in groups to find solutions to real-world problems. (Arends & Kilcher, 2010).

The syntax of Problem Based Learning is as follows: Phase 1, Orienting students to the problem; Phase 2, Organizing students; Phase 3, Guiding individual and group investigations; Phase 4, Developing and presenting work results; and Phase 5, Analyzing and evaluating the problem-solving process.

According to Berliana (Neliawati, 2016) stated that problem-based question card media is a means for students to learn actively involved in learning activities, think actively and critically in learning and innovatively find ways or proofs of mathematical theories. Problem cards are used as a continuation activity for students in learning and contain non-routine questions.

(Setiaji, Muktiningsi, & Farliana, 2021) stated that learning independence has a positive and significant indirect effect on critical thinking skills. Good student learning independence and good student learning motivation can improve students' critical thinking skills well.

(Nur, Syamsir, & Akmal, 2023) stated that the Problem Based Learning model and learning independence have a simultaneous effect on critical thinking. Students' critical thinking is getting better, there needs to be a problem-based learning method and combine it with independence in learning.

Critical thinking skills are one of the important components that students must have in learning mathematics. In addition, student learning success is also inseparable from internal factors of students, one of which is student learning independence. To support this, an appropriate learning model is needed. Problem Based Learning assisted by problem cards can be applied to train students' critical mathematical thinking skills. This study aims to determine the description of students' critical thinking skills in terms of student independence.

METHOD

The research design used is the Sequential Explanatory design, namely a mixed method that applies the first stage to collect and analyze quantitative data and is followed by data collection and qualitative analysis.

Furthermore, the researcher gave treatment to the experimental class with a learning process in the form of using the Problem Based Learning model assisted by problem cards, and the control class used learning with the Discovery Learning method. The learning process lasted for 3 meetings and when it was finished, the researcher would obtain quantitative data from the results of the final mathematical critical thinking ability test (posttest).

Quantitative data obtained from the test results are used as a reference to conduct interviews on mathematical critical thinking skills based on the level of student independence. Qualitative data are also obtained from the results of interviews and student documentation. The interview results are used to interpret students' mathematical critical thinking skills in terms of the level of learning independence.

(Sugiyono, 2010) states that population is a generalization area consisting of objects/subjects that have certain quantities and characteristics determined by researchers to be studied and then conclusions drawn. The population in the study were all students of class XI MIPA MAN 2 Brebes in the odd semester of the 2023/2024 academic year distributed in seven classes.

(Sugiyono, 2010) states that the sample is part of the number and characteristics possessed by the population. The sample in this study was taken by simple random sampling (class random technique) so that the sample obtained in this study was students of class XI MIPA 1 as the experimental class and XI MIPA 2 as the control class. Simple random sampling was taken because each member of the population has the same opportunity to be used as a sample.

The selection of research subjects in the experimental class was obtained through

purposive sampling technique, namely a determination technique with certain considerations. (Sukestiyarno, 2020). The determination of the research subjects is based on the results of the critical thinking ability test and the student independence questionnaire. The research subjects will be taken as many as 6 students, two students from a low level of independence, two students from a medium level of independence and two students from a high level of independence.

RESULTS AND DISCUSSIONS

This research was conducted in class XI MIPA 1 MAN 2 Brebes as an experimental class and XI MIPA 2 as a control class. The number of students in class XI MIPA 1 MAN 2 Brebes was 32 students and the number of students in class XI MIPA 2 MAN 2 Brebes was 32 students. Learning in the research class was carried out 3 times with the material of sequences and number series using the application of the Problem Based Learning learning model assisted by problem card media, while learning in the control class used the Discovery Learning model.

All students of class XI MIPA 1 as the experimental class were given a critical thinking ability test after all learning on the sequence and series material with the Problem Based Learning model assisted by problem cards was finished being taught. A summary of the results of the mathematical critical thinking ability test for the experimental class and the control class can be seen in table 1 below.

Table 1. Critical Thinking Ability Test Results Score Recap

	Experimental Class	Control Class
Max Value	88,75	84,00
Min Value	56,25	50,00
Average	73,24	65,41
Percentage of Completion	90,62%	28,12%

The implementation of the Learning Independence questionnaire aims to group students into three groups, namely: a group of students with high independence, a group of students with moderate independence, and a group of students with low independence. The research subjects were selected 6 students from the high, moderate and low independence groups with criteria determined by the researcher. The following is a list of research subjects that can be seen in table 2.

Table 2. List of Research Subjects

Student Group	Research Subject
High	E-25
	E-28
Medium	E-15
	E-26
Low	E-20
	E-13

Six research subjects were interviewed to obtain in-depth information about what they had learned from the written critical thinking skills test.

The results of the study showed that subjects E-25 and E-28 were able to work on questions for the indicator of critical thinking ability clarification well. This was reinforced by the results of interviews with both subjects who were able to explain their work results well. The results of triangulation showed that the data obtained were valid, so it can be said that both student subjects with high learning independence were able to answer questions with the clarification indicator well, or were able to identify the relationship between assumptions or statements very well.

The results of the study showed that subjects E-25 and E-28 were able to work on questions for the critical thinking ability assessment indicator well, although there were errors in calculating the final results of subject E-25's work. Both subjects were able to work well,

reinforced by the results of interviews with both subjects who were able to explain their work results well. The results of triangulation showed that the data obtained were valid, so it can be said that both student subjects with high learning independence were able to answer questions with assessment indicators well, or were able to consider the value of the criteria or situations given well.

The results of the study showed that subjects E-25 and E-28 were able to work on questions for the indicator of critical thinking skills inference well, although there were steps that were missed but did not change the conclusion answer. This is reinforced by the results of interviews with both subjects who were able to explain the results of their work well. The results of triangulation show that the data obtained are valid, so it can be said that both student subjects with high learning independence are able to answer questions with inference indicators well, or are able to generalize and conclude well.

The results of the study showed that subjects E-25 and E-28 were able to work on questions for the critical thinking skills indicator strategies well even though they had not answered question number 8 perfectly. This was reinforced by the results of interviews with both subjects who were able to explain well the results of their work and the strategies for solving question number 8. The results of triangulation showed that the data obtained were valid, so it can be said that both student subjects with high learning independence were able to answer questions with the strategies indicator well, or were able to predict the results of proposed actions and evaluate possible actions well.

The results of the study showed that subjects E-15 and E-26 were able to work on questions for the indicator of critical thinking ability clarification well. This was reinforced by the results of interviews with both subjects who were able to explain their work results well. The results of triangulation showed that the data obtained were valid, so it can be said that both student subjects with moderate learning independence were able to answer questions with

the clarification indicator well, or were able to identify the relationship between assumptions or statements well.

The results of the study showed that subjects E-15 and E-26 were able to work on questions for the critical thinking ability assessment indicator well. Both subjects were able to work well, reinforced by the results of interviews with both subjects who were able to explain their work results well. The results of triangulation showed that the data obtained were valid, so it can be said that both student subjects with moderate learning independence were able to answer questions with assessment indicators well, or were able to consider the value of the criteria or situations given well.

The results of the study showed that subjects E-15 and E-26 were able to work on questions for the indicator of critical thinking skills inference well, although there were steps that were missed but did not change the conclusion answer. This is reinforced by the results of interviews with both subjects who were able to explain the results of their work well. The results of triangulation show that the data obtained are valid, so it can be said that both student subjects with moderate learning independence are able to answer questions with inference indicators well, or are able to generalize and conclude well.

The results of the study showed that subject E-15 and subject E-26 were able to work on questions for the critical thinking skills indicator strategies well for question number 4, while they were not able to work on question number 8. This was reinforced by the results of interviews with both subjects who were able to explain their work results for question number 4 well but were unable to explain question number 8. The results of triangulation showed that the data obtained were valid, so it can be said that both student subjects with moderate learning independence were able to answer questions with the strategies indicator quite well, or were able to predict the results of proposed actions and evaluate possible actions quite well, but had not yet mastered it.

The results of the study showed that subject E-20 and subject E-13 were able to work on questions for the indicator of critical thinking ability clarification number 1 well, although there was a calculation error in subject E-13, while number 5 both did not work on it. This is reinforced by the results of interviews with both subjects who were able to explain the results of their work quite well. The results of triangulation show that the data obtained are valid, so it can be said that both student subjects with low learning independence were able to answer questions with the clarification indicator well, or were able to identify the relationship between assumptions or statements quite well.

The results of the study showed that subject E-20 and subject E-13 were able to work on questions for the critical thinking ability assessment indicator well for question number 2 while not working on question number 6. Both subjects were able to work well, reinforced by the results of interviews with both subjects who were able to explain the results of their work well. The results of triangulation showed that the data obtained were valid, so it can be said that both student subjects with low learning independence were able to answer questions with assessment indicators well, or were able to consider the value of the criteria or situations given well.

The results of the study showed that subjects E-20 and E-13 were able to work on questions for the critical thinking ability indicator inference quite well, although there were steps that were missed but did not change the conclusion answer, while in number 7 both of them did not work on it. This is reinforced by the results of interviews from both subjects who were able to explain the results of their work well for number 3 and could not explain number 7. The results of triangulation showed that the data obtained were valid, so it can be said that both student subjects with low learning independence were able to answer questions with the inference indicator quite well, or were able to generalize and conclude quite well, although they had not yet mastered it.

The results of the study showed that subject E-20 and subject E-13 were not yet able to

work on questions for the critical thinking skills indicator strategies well for questions number 4 and number 8. This was reinforced by the results of interviews with both subjects who were not yet able to explain their work results for questions number 4 and number 8 well. The results of triangulation showed that the data obtained were valid, so it can be said that the two student subjects with low learning independence were not yet able to answer questions with the strategies indicator well, or were not yet able to predict the results of proposed actions and evaluate possible actions well.

CONCLUSION

Description of mathematical critical thinking ability reviewed from student independence towards the Problem Based Learning model assisted by problem cards is as follows: Students with high independence are good in all aspects of critical thinking indicators, namely Clarification, Assessment, Inference, and Strategies. Students with moderate independence are good in the critical thinking indicators of Clarification, Assessment, Inference, and are still lacking in the Strategies indicator, and students with low independence are good in the critical thinking indicators of Clarification, Assessment, while for the Inference indicator they are still lacking in mastery, and have not been able to master the Strategies indicator.

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