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Mathematics Critical Thinking Ability Reviewing from Gender and Independent Learning Students in Stem Problem-Based Learning Assisted by Web E Learning School

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Abstract

This study aims to describe students' mathematical critical thinking skills in PBL STEM learning classes in terms of learning independence and gender. This study uses a mixed method (mixed method) sequential explanatory design. This design is combination research, characterized by data collection and quantitative data analysis in the first stage, followed by qualitative data collection and analysis in the second stage. The research subjects were students of class X SMA Negeri 1 Demak. Based on the results of the study, it was found that the mathematical critical thinking skills of male and female students with high learning independence were very good with good verbal skills, mathematical critical thinking skills of male and female students with moderate learning independence with sufficient verbal abilities, thinking skills critical mathematics of male and female students with low learning independence is sufficient with less verbal ability.

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INTRODUCTION

Presidential Regulation Number 87 of 2017 concerning Strengthening Character Education (PPK). PPK is an educational movement under the responsibility of the education unit to strengthen the character of students through harmonization of heart, taste, thought, and sports by involving and cooperation between education units, families, and communities as a national movement for mental revolution (Article 1 paragraph [1]). KDP puts forward five main character values, namely religiosity, nationalism, independence, cooperation, and integrity. Strengthening these five-character values will be able to encourage students to have 21st Century skills needed in living life, such as critical thinking and problem-solving skills (critical thinking and problem solving), collaboration skills (collaboration skills), creative skills (creativities skills), and communication skills (communication skills).

Understanding critical thinking Krulik and Rudnik (1993) is to classify, organize, remember, and analyze the necessary information, test, relate and evaluate all aspects of the problem situation (in Rochaminah, 2008: 22). The understanding of critical thinking proposed by Krulik and Rudnik is essentially in line with the notion of critical thinking according to Steven because both use the steps of the scientific method in carrying out the thinking process.

Ennis (1996: 1-2) defines critical thinking as a thinking process with the aim of making accountable decisions about what to believe and what to do. In deciding what to believe and what to do, reliable information and an understanding of the topic or field of study are needed. Based on all these things one can make reliable decisions. Decisions about beliefs are very important. A key in deciding a belief is often an argument. Mathematical critical thinking means critical thinking in mathematics. The indicators are providing simple explanations (elementary clarification), building basic skills (basic support), making inferences, making further explanations (advances clarification), evaluating and considering reliable sources or arguments, (strategies and tactics) to solve problems.

Polya (1985) put forward several suggestions to help students overcome their difficulties in solving mathematical problems, namely: asking questions to direct students to work, presenting clues to solve problems instead of providing completion procedures, helping students explore their knowledge and formulate their own questions according to the needs of the problem, and help students overcome their own difficulties.

The critical thinking ability of students of SMA N 1 Demak class X The 2019/2020 school year is still relatively low, this is evidenced by the results of the assessment of the mathematical critical thinking skills of students in class X MIPA 5 on the material value of the Three-variable Linear Equation System, the average is 65, 50.

Self Regulated Learning (independent learning) is also one of the factors that determine the success of students' studies in critical thinking and problem-solving skills. Bird (2009) states "Setting and achieving goals, time management, planning, self-monitoring, self-evaluating and taking control of one's learning are all self-regulatory processes regarded as essential for lifelong learning". Setting and achieving goals, time management, planning and monitoring, self-evaluation and taking control of learning are independent processes that are considered essential for lifelong learning. This is supported by the results of the Education Commission 2000 study (in Cheng, 2011: 1).

According to Paris and Winograd (The National Science Foundation, 2000), independent learning does not only think about thinking, but helps individuals use their thinking in designing, choosing learning strategies and interpreting their appearance so that individuals can solve problems effectively.

Based on the OECD (2016) it is explained that on average across OECD countries, there is a gender gap in reading ability which is supported by data that girls' reading ability decreased by 12 points between 2009 and 2015: boys' performance improved, especially for boys' high achievers, while girls' performance deteriorated, especially for low-achieving girls. Suryabrata (2008) explains that gender differences make each individual different from other individuals, such as men being different from women in many aspects including in terms of intelligence, interest, memory, emotion and will. Meanwhile, Zhu (2007) suggests that female and

male students have different preferences in problem solving strategies.

Moh. Nasrul (2016) conducted a study on "Mathematical Representation of High School Students in Solving Quadratic Equation Problems in View of Gender Differences". The research was conducted at SMA N 3 Kediri. The results of the study resulted in a conclusion that in terms of the use of verbal representations through written texts, female students used it more often than male students.

The PSMA Directorate (2018) states that the learning models relevant to the 2013 curriculum are discovery-based learning, project-based learning, problem-based learning, inquiry-based learning or other models that pay attention to activities that can facilitate students to strengthen character values. through literacy activities. To be able to improve students' critical thinking skills and mathematical problem solving, the learning model that can be used is problem-based learning.

Problem-based learning (PBL) is a learning model that is used to get a completion of a task or situation that is really a problem by using known rules. Thus, problem-based learning (Problem Based Learning) focuses more on meaningful real-life problems. In this PBM, the teacher plays more of a role as a facilitator, mentor, and motivator. The teacher poses authentic problems / orients students to real problems (real world), facilitates / guides (scaffolding) in the investigation process, facilitating dialogue between students, providing student teaching materials and providing support to improve the intellectual development of students.

The main principle of PBL is the use of real problems as a means for students to develop knowledge and at the same time develop critical thinking skills and problem-solving abilities. Real problems are problems that exist in everyday life and are useful immediately when completed. The selection or determination of this real problem can be done by teachers and students who are adjusted to certain basic competencies. The problem is an open-ended problem, which is a problem that has many correct answers or has many strategies/solving algorithms, which encourages the curiosity of students to identify these strategies and solutions. The problem is ill-structured which cannot be solved directly by applying certain formulas or strategies but requires further information to understand and needs to combine several strategies or even develop their own strategies to solve them. Solving such problems will make students do the critical thinking process.

According to Juniarti, et al (2016), the design of learning activities that are directly applied in the real world to solve problems in everyday life as used by engineers and scientists with an interdisciplinary approach is STEM education (Science, Technology, Engineering, Mathematics). According to Brown, et al (2016), STEM is a meta-discipline at the school level where science, technology, engineering, and mathematics teachers teach an integrated approach, and each discipline material is not divided but handled and treated as a dynamic whole.

STEM stands for an interdisciplinary learning approach between Science, Technology, Engineering and Mathematics. Torlakson (2014) states that the approach of these four aspects is a harmonious match between problems that occur in the real world and problem-based learning. This approach can create a cohesive learning system and active learning because all four aspects are needed simultaneously to solve problems. The solution given shows that students can unite abstract concepts from every aspect.

Learning that begins with a problem can be integrated with the STEM approach (Science, Technology, Engineering and Mathematics) which is a harmonious pair between problems that occur in the real world and problem-based learning. The implementation of STEM education can be supported by various learning methods. Integrative STEM allows various learning methods to be used to support its application (Becker & Park, 2011). The purpose of using STEM education in learning Mathematics is to actualize students' mathematical critical thinking skills.

This learning model utilizes technology that supports additional learning materials for students that can be accessed online and offline whenever and wherever. While learning time in class is used by students to discuss with classmates, practice skills, and receive feedback about their progress.

Russman (2012) states that the web-based learning model is a learning model by utilizing a network to communicate and convey learning information. The web-based learning model has the following characteristics: interaction, the existence of

communication channels, either directly such as chat or indirectly such as a mailing list forum, independence, flexibility in terms of providing time, place, teachers and teaching materials so that learning is more student-centered, access, learning resources are more easily accessible through distribution on the internet network with wider access than the distribution of learning resources in conventional learning, enrichment, learning activities, material presentations, and training materials as enrichment, enabling the use of information technology devices, such as video streaming, simulations and animation.

In the current era, it is normal for every school to have a School Management Learning (LMS), one of which is the e-learning web at SMA N 1 Demak. It contains many menus, one of which is the menu of learning materials, so far, the web has only been used for assessment. With the learning materials we can use for the KBM process as well.

Several studies that are relevant to this study include those related to PBL learning conducted by Rahmi Ramadhan (2016) who said that the problem-based learning-oriented mathematics learning device developed was valid, practical, and effective. The results of Suprapto's research (2016) show that the perspectives and beliefs about the attitudes of junior high school students towards STEM education can be measured by developing the AT-STEM questionnaire.

The formulation of the problem in this study is how students' critical thinking skills in mathematics in PBL STEM learning classes are viewed from learning independence and gender.

METHODS

This study uses a mixed method (mixed method) sequential explanatory design type. This design is combination research, characterized by data collection and quantitative data analysis in the first stage, and followed by qualitative data collection and analysis in the second stage, in order to strengthen the results of quantitative research conducted in the first stage. The main priority in this design emphasizes the collection and analysis of quantitative data. The mixing process occurs when the results of quantitative data inform the process of collecting qualitative data.

The research was carried out at SMA N 1 Demak with the research population being class X students for the 2020/2021 academic year. The research sample selected two classes, namely class X MIPA 5 and X MIPA 6. The two classes were given learning with the PBL STEM learning model and were categorized in terms of student learning independence (high, medium, and low learning independence). Each category on independent learning is then taken 2 students to be the subject of research.

Quantitative data collection techniques were carried out by using a mathematical literacy test. While the qualitative data collection techniques used questionnaires, interviews, and documentation techniques. Quantitative data were tested using normality test, homogeneity test, proportion completeness test, average completeness test. Meanwhile, qualitative data analysis follows the concept of Miles & Hubermen (2007) with the following steps, namely data reduction, data display, and conclusions.

RESULTS AND DISCUSSIONS

To determine the feasibility of learning tools, a feasibility test was carried out by supervisor I and supervisor II. The results of the validation of learning tools are listed in table 1 below.

Table 1. Learning Device Validation Results

Learning Media	Validator Code	Average Score	Category
Syllabus	V1, V2	4.3	Very good
Lesson Plan	V1, V2	4.2	good

From table 1, it can be concluded that the average score for learning tools is 4.32 with a very good category, so that the learning tools that have been prepared are suitable for use in research.

The results of the validation of research instruments are presented in table 2 below.

Table 2. The results of the validation of research instruments

Research instrument	Validator code	Average Score	Category
Question TBKM	V1, V2	4.11	good
Interview guidelines	V1, V2	4.6	Very good
Student Response Questionnaire	V1, V2	4.5	Very good

From table 2, it can be concluded that the average score of all instruments is 4.4 in the very good category, so the instruments that have been prepared are also suitable for use in research.

From the assessment of learning outcomes, it was found that the TBKM results were normally distributed with a value of sig = 0.08 and homogeneous with a value of sig = 0.058. In the calculation of the completeness proportion test and the average completeness test, the significant level or used is 0.05. From the data obtained the N-Gein Percent value for the experimental class is 75.12, indicating that learning with the PBL STEM method assisted by the school's web e-learning is effective in improving mathematical critical thinking skills, while for the control class with the PBL method the score of 17.06 is not effective in improving the ability mathematical critical thinking.

Because the experimental N-Gein Score is more than the Control N-Gein, it can be concluded that the PBL STEM method assisted by the school's e-learning web is better than the PBL method.

Mathematics critical thinking skills in terms of gender and students' mathematics learning independence were tested using the Two Way Anova test with the results of table 3 as follows.

Table 3. Mathematical critical thinking skills based on independent learning and gender.

Source	**Type III Sum of squares**	**df**	**Mean square**	**F**	**Sig**
Corrected Model	500.556*	5	100.111	3.874	.008
Intercept	304336.111		304336.111	1.178E4	.000
	2.778	1			.745
Kelamin			2.778	.107	.002
	389.556	1			
Kemandirian			194.778	7.537	
		2			

from the table, it can be concluded that the significant value of Gender is 0.745 > 0.05, which means that there is no difference between male and female students' critical thinking skills in mathematics. While the significant value of mathematics learning independence is 0.002 < 0.05, it shows that there is a difference in the ability to think critically in mathematics in terms of students' mathematics learning independence. The average results of mathematical critical thinking skills seen from gender and student learning independence can be shown in the following table.

Table 4. The ability to think critically in mathematics in STEM PBM classes based on students' mathematics learning independence.

Independent Learning	**Mean**	**Std. Error**	**95% Confidence Interval**	
			Lower Bound	Upper Bound
Low	87.67	1.47	84.67	90.66
Medium	92.50	1.47	89.50	95.50
High	95.67	1.47	92.67	98.66

From the table above, it can be concluded that students' mathematical critical thinking skills using the PBL STEM method in terms of students' mathematics learning independence are as follows: the average mathematical critical thinking ability of students who have low learning independence is 87.67, while students' mathematical critical thinking skills with low learning independence moderate learning independence is 92.5 while the critical thinking ability of students with high mathematics learning independence is 95.67. From this, it can be concluded that the students' mathematical critical thinking skills are the highest students who have high mathematics learning independence.

For students' mathematical critical thinking skills in terms of gender, it can be seen in table 5 below.

Gender	Independent Learning	Mean	Std. error	95% Confidence Interval	
				Lower Bound	Upper Bound
man	Low	85.50	2.08	81.26	89.74
	Medium	94.17	2.08	89.93	98.41
	High	97.00	2.08	92.76	97.00
woman	Low	89.83	2.08	81.26	94.07
	Medium	90.83	2.08	86.60	95.07
	High	94.33	2.08	90.10	98.57

From the table it can be concluded that the average mathematical critical thinking ability of male students with low mathematics learning independence is 85.5 while female students with low mathematics learning independence is 89.83, the average mathematical critical thinking ability of male students with moderate mathematics learning independence is 94.17 while female students with moderate mathematics learning independence are 90.83, the average mathematical critical thinking ability of male students with high mathematics learning independence is 97.00 while female students with high mathematics learning independence is 94.33. From this it can be seen that the average of the highest mathematical critical thinking skills are female students with high learning independence.

From the results of the research, the description of students' critical thinking skills in mathematics in terms of independence in learning mathematics and gender starts from indicators of answering questions with relevant reasons, checking the truth of a statement or question process, checking the truth of the results or solutions accompanied by explanations, analyzing and clarifying questions, answers and arguments, evaluating and considering reliable sources or arguments for male students with high mathematics learning independence on average have very good abilities, as well as female students with high learning independence, while for male students with independent learning mathematics is having good critical thinking skills, it's just that in writing the problem solving has not used a lot of verbal language, for female students with moderate independence have good critical thinking skills, with verb language I'm good too. In contrast to male students with low independence in learning mathematics, tend to solve problems on the main points, looks good on some indicators only, does not use verbal language as well, for female students with low learning independence, also has less critical thinking skills. good, but some questions still seem to use verbal language, it's just not quite right.

CONCLUSION

Based on the results and discussion as described in the previous chapter, it can be concluded that the mathematical critical thinking skills of male students with high learning independence have a very good average with good verbal skills, female students' mathematical critical thinking skills with high learning independence. have a very good average with good verbal abilities, male students' critical thinking skills in mathematics with moderate learning

independence with moderate verbal abilities, female students' mathematical critical thinking skills with moderate learning independence with sufficient verbal abilities, thinking skills male students' critical mathematics skills with low learning independence are sufficient with poor verbal abilities, female students' mathematical critical thinking skills with low learning independence are sufficient, with less verbal abilities.

Based on the conclusions of the study, the researcher wants to convey the following suggestions. This research is limited to the mathematical critical thinking skills of students in SMA N 1 Demak class X MIPA 5 in solving problems. Therefore, the researcher suggests that if you want to carry out similar research, you should use other classes or other schools, this research is limited to the mathematical critical thinking skills of students at SMA N 1 Demak class X MIPA 5 in solving problems of compositional and inverse functions. Therefore, the researcher suggests that if you want to carry out similar research, you should use other materials. When measuring mathematical critical thinking skills, teachers need to pay attention to the independence of students' mathematics learning so that it is easier to understand a subject matter that allows learning achievement to increase. teaching related to students' mathematical critical thinking skills by involving the independence of learning mathematics simultaneously, teachers need to cultivate a culture of teaching students by considering the gender differences of students.

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