The Effect of Analytical Thinking and Critical Thinking on Mathematical Problem Solving Ability

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Abstract
Education is an effort to create a basis for developing human resources towards better ones. In the era of the independent curriculum, the educational approach emphasizes the 4C concept which includes Communication, Collaboration, critical thinking and creativity. Vocational school level learning places more emphasis on understanding how students can think critically and analytically. Critical thinking can be formed from the way they reconstruct their knowledge. The research aims to determine the simultaneous influence of analytical thinking and critical thinking skills on problem solving abilities. The research used a sample of 47 class The research uses multiple linear regression analysis for the independent variable (analytical thinking and critical thinking) and the dependent variable (problem solving ability). The results of the ANOVA significance research were 0.000, then the calculated F value was 60.617. Then the R2 value was 0.734. This shows that analytical thinking and critical thinking simultaneously influence mathematical problem solving abilities with a percentage of 73.4%.

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Abstrak
Pendidikan merupakan usaha membuat sebuah dasar dalam pengembangan sumber daya manusia menuju yang leih baik. Pada era kurikulum merdeka, pendekatan pendidikan menakankan pada konsep 4C yang mencakup *Communication*, *Collaboration, critical thinking dan creativity*. Pembelajaran tingkat SMK lebih menekankan pada pemahaman tentang bagaimana siswa dapat berpikir kritis dan analitis. Berpikir kritis dapat terbentuk dari cara mereka merekonstruksi pengetahuannya. Penelitian bertujuan untuk mengetahui pengaruh simultan kemampuan berpikir analitis dan berpikir kritis terhadap kemampuan pemecahan masalah. Penelitian menggunakan sampel 47 siswa kelas XII di SMKN 1 Bendo dengan menggunakan kuesioner skala likert dengan hasil uji validitas instrumen menggunakan product moment dan uji reliabilitas bernilai 0,609. Penelitian menggunakan analisis regresi linear berganda untuk dengan variabel indenepden (berpikir analitis dan berpikir kritis) serta variabel dependent (kemampuan pemecahan masalah). Hasil penelitian signifikansi anova bernilai 0,000, kemudian nilai F hitung berada pada nilai 60,617 Kemudian nilai R^2 berada pada 0,734. Hal ini menunjukkan berpikir analitis dan berpikir kritis berpengrauh secara simultan terhadap kemampuan pemecahan masalah matematis dengan persentase sebesar 73,4%.

I. INTRODUCTION

Education is an effort to create a basis for developing human resources towards better ones (Sari et al., 2020; Wang & Kuo, 2019). The main aim of education is to produce humans who have broad qualities and personalities about the future so that they are able to adapt to the environment (Noviyanti et al., 2023). Education is also used as a benchmark for the level of development of a country, including Indonesia. Challenges in the world of education are increasingly complex along with the development of information technology (Rizqi & Dewi, 2022). In the independent curriculum era, the educational approach emphasizes the 4C concept which includes Communication, Collaboration, critical thinking and creativity (Lestari & Hindun, 2023).

Vocational school level learning places more emphasis on understanding how students can think critically and analytically. Critical thinking can be formed from the way they reconstruct their knowledge (Seruni et al., 2020). Meanwhile, analytical thinking skills are skills for expressing thoughts in the cognitive domain contained in Bloom's taxonomy, namely the same as critical thinking, namely at the level of analysis, synthesis, evaluation and creation (Fadly, 2021). The critical thinking process is intended so that the learning carried out does not only remember and memorize concepts but is expected to be able to develop thought patterns and apply structured

thinking patterns so that students can re-express their critical thinking concepts so they can interpret data and apply structured learning concepts (History, 2019; Wahyu et al., 2020). Critical thinking involves the ability to analyze information, then continue with evaluating arguments and then making a decision (Lestari & Hindun, 2023).

Critical and analytical thinking is closely related to Mathematics learning at the secondary school level. Critical thinking in mathematics is a fundamental basis in the process of generating new ideas, developing thought patterns and analyzing opinions (Dhayanti et al., 2018; Wechsler et al., 2018). In the 2013 curriculum era, critical thinking skills in mathematics were also implemented with the aim that students had critical thinking skills from an early age (Wulandari, 2020). The concept of critical thinking in mathematics with the stages of the identification process, results of identification analysis, evaluation, then the inference process was developed by Paul and Elder in 2019 through their book entitled the miniature guide to critical thinking concepts and tools (Paul & Elder, 2019). Critical thinking is able to build the quality of students' thinking so that it can produce better learning (Syafitri et al., 2021).

Based on the results of initial research conducted by conducting interviews with several mathematics teachers (November 7th 2024), there are students' weaknesses in solving mathematics problems in vocational school learning. Students seem to easily experience stressors when faced with a problem in learning mathematics. They consider learning mathematics too difficult to solve and give up easily. Researchers assume that these students' shortcomings and weaknesses are caused by students' lack of critical and analytical thinking skills, therefore this research aims to find out how much influence critical and analytical thinking skills have on students' problem solving abilities in mathematics learning, especially in vocational school learning. . Previous research conducted (Yuwono et al., 2020) revealed that there was no significant influence between students' high and low analytical thinking abilities on learning outcomes. Another research conducted by (Saputri et al., 2020) who examined the influence of critical thinking on mathematics learning outcomes stated that critical thinking had a positive and significant effect on mathematics learning outcomes. In this research, the researcher aims to determine the simultaneous influence of analytical thinking and critical thinking skills on problem solving abilities.

II. METHOD

This research uses a quantitative descriptive research method with a causal research design to find out how much influence analytical and critical thinking has on the mathematical problem solving abilities of students majoring in Building Information Modeling Design at SMK Negeri 1 Bendo Magetan Odd Semester 2024/2025 Academic Year. The research was carried out in October 2024.

The population in this study was 90 students spread across classes XI and XII majoring in Modeling Design and Building Information at SMK Negeri 1 Bendo Magetan. The data collection technique used simple random sampling with a sampling formula using the Slovin formula with an error rate of 0.01 so that the sample obtained was 47 samples.

Data collection techniques use documentation techniques from student learning outcomes and questionnaires to determine critical and analytical thinking abilities. The questionnaire was created using a Likert scale. The validity test of the instrument involved 30 respondents using a significance level of 0.05 (5%) using product moment. According to the rules of instrument validity, if r count > r table, then the instrument is declared valid. The Cronbach alpha reliability test is 0.609. An instrument is said to be reliable if the r value > 0.6. The data analysis technique uses multiple linear regression analysis which aims to test the influence of the independent variables (X1 and X2) on the dependent variable (Y).

III. RESULT AND DISCUSSION

A. Result

The results of the research used the F Test and T Test to determine the simultaneous influence of analytical thinking variables on problem solving abilities, critical thinking variables on problem solving abilities, analytical thinking variables and critical thinking simultaneously on mathematical problem solving abilities.

1. The Effect of Analytical Thinking on Mathematical Problem Solving Ability

Below are shown the results of multiple linear regression analysis between analytical thinking ability and problem solving ability.

Table 1. T Test for Analytical Thinking

Model	B	Std Errors	Beta	t	Sig
Constant	41.877	5.462		7.667	.000
Analytical Tinking	.392	.153	.236	2.572	.014

Based on the calculation results of multiple simple linear regression analysis, the calculated t value is 2.572, where the t table value with a sample size of 47 is 2.015. If the calculated t value is > than t table, then there is an influence of the independent variable on the dependent variable. Then the results of the significance calculation show the significance value is 0.014. If the significance value is <0.05 then there is a significant influence between the independent variable and the dependent variable. Based on the calculated t value and significance, this shows that there is a significant influence between analytical thinking on mathematical problem solving abilities.

2. The Effect of Critical Thinking on Mathematical Problem Solving Ability

Below are shown the results of multiple linear regression analysis between critical thinking ability and problem solving ability.

Table 2. T Test for Critical Thinking

Model	B	Std Errors	Beta	t	Sig
Constant	41.877	5.462		7.667	.000
Critical Thinking	1.322	.127	.959	10.431	.000

Based on the calculation results of multiple simple linear regression analysis, the calculated t value is 10,431 where the t table value with a sample size of 47 is 2.015. If the calculated t value is > than t table, then there is an influence of the independent variable on the dependent variable. Then the results of the significance calculation show the significance value is 0.000. If the significance value is <0.05 then there is a significant influence between the independent variable and the dependent variable. Based on the calculated t value and significance, this shows that there is a significant influence between critical thinking and mathematical problem solving abilities.

3. The Effect of Analytical Thinking & Critical Thinking on Mathematical Problem Solving Ability

In analyzing the influence of two independent variables (analytical & critical thinking) on the dependent variable (problem solving ability), the F test is used. Below are the results of the F test to determine whether there is a significant influence of analytical thinking & critical thinking on mathematical problem solving abilities.

Table 3. ANOVA

Model	Sum Of Squares	df	Mean Square	F	Sig
Regression	1106.405	2	553.202	60.617	.000 [b]
Residual	401.553	44	9.126		
Total	1507.957	46			

Tabel 4. Ringkasan

Model	R	R^2	Adjustment R^2	Std Error
1	.857	.734	.722	3.020

Based on the results of simple multiple linear regression analysis calculations, it is known that the significance value of X1 (analytical thinking) and X2 (critical thinking) towards Y (Mathematical Problem Solving Ability) is 0.000. If the significance value is <0.005 then variables X1 and If the calculated F value > F Table then there is an influence of X1 and X2 on Y simultaneously. The percentage of positive and significant influence is also shown in the R squared value of 0.734. This shows that analytical and critical thinking has an influence of 73.4% on students' problem solving abilities, while the remaining 26.6% is influenced by other factors.

B. Pembahasan

Problem solving ability is a student's ability to solve mathematical problems by observing the process of finding answers based on problem solving steps, namely understanding the problem, planning problem solving, solving the problem, and double checking (Havill J, 2020). Problem solving abilities are closely related to the problem based learning model. Problem-based learning relates to problems that students must solve by integrating new knowledge independently (Aslan, 2021; Seibert, 2021).

In mathematical learning, problem solving skills using the concepts of analytical thinking and critical thinking are very necessary for students to be able to formulate and interpret various complex mathematical problems. Mathematical problem solving abilities are useful for formulating, solving and interpreting various contexts (Safithri & Huda, 2021). The context contained in mathematics learning is varied, starting from number theory, analysis, algebra, sets and others. To understand these various contexts, students' analytical and critical thinking skills are very necessary.

Critical thinking skills are very important because they can unite important ideas and develop them to solve a problem. Critical thinking can help us carry out mathematical studies to solve existing problems. By doing critical thinking, we will avoid making bad decisions, so that the decisions we make tend to be more targeted.

IV. CONCLUSION AND SUGGESTION

A. Conclusion

Based on the results of multiple liner regression analysis using independent variable data (Analytical thinking & critical thinking) on the dependent variable (Problem Solving Ability), it can be concluded that analytical thinking ability has a significant effect on mathematical problem solving ability. Critical thinking skills have a significant effect on mathematical problem solving abilities. The ability to think analytically and think critically has a simultaneous influence on the mathematical problem solving abilities of the DPIB skills competency at SMKN 1 Bendo. This result is supported by an R squared value of 0.734, which means that analytical thinking and critical thinking abilities have an effect of 73.4% on problem solving abilities.

B. Suggestion

After completing this research, the researcher hopes that this research can be used as reference material in compiling and developing students' critical and analytical thinking abilities because they have a very large role in problem solving abilities.

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