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MATHEMATICAL CRITICAL THINKING SKILLS OF VOCATIONAL HIGH SCHOOL STUDENTS IN SOLVING AKM PROBLEMS BASED ON PERSONALITY TYPE

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Abstract

This research is motivated by the low critical thinking and mathematical problem-solving skills of vocational school students in Lebak-Banten Regency, especially in solving AKM problems seen from the field of expertise and personality type. Vocational High School (SMK) students are students who are required to become work-ready graduates who are not only technically skilled, but also must have good critical thinking and problem-solving skills. The purpose of this study is to find out: 1) the relationship between areas of expertise and personality types on the mathematical critical thinking ability of vocational school students in solving AKM problems; and 2) the influence between personality areas and personality types on the mathematical critical thinking ability of vocational school students in solving AKM problems. The method of this research is a quantitative descriptive type of cross sectional survey. The population in this study was 8,577 students from 69 public and private schools which were grouped based on 9 areas of expertise and 4 personality types of vocational school students in Lebak-Banten Regency. Data collection in this study was through questionnaires, students' mathematical critical thinking ability tests, and interviews. The data analysis techniques used in this study are descriptive statistics and inferential statistics. The results in this study show that; 1) there is a relationship between personality type and mathematical critical thinking ability of vocational school students in solving AKM problems; and 2) the influence between personality types on the mathematical critical thinking ability of vocational school students in solving AKM problems.

Keywords: *Fraudulent financial reporting, Financial stability, External pressure, Rationalization.*

INTRODUCTION

Vocational education is the most important education to equip prospective workers to face today's industrial challenges, especially in vocational schools. In the era of global transformation and rapid technological advancement, vocational schools are required to produce graduates who not only have the ability to think technically but also must have strong problem-solving skills and good critical thinking (Rudiatna, 2022; Rahmadani et al., 2023). These two abilities, including the ability to analyze, evaluate, and synthesize information, to ensure that vocational school graduates are able to face complex challenges in the world of work later (Rahmadani et al., 2023). Thus, the critical thinking and problem-

solving skills that vocational school students can learn are not only limited to theoretical understanding, but also include work readiness and practical abilities that can relate to their work environment. The technical aspects, skills, and ability to adapt to changes that occur in a dynamic work environment are part of practical skills (Rahmadani et al., 2023). The combination of specific practical skills with the improvement of students' critical thinking and mathematical problem-solving skills is a major challenge in the development of practical skills in vocational schools. This method encourages students to create various ways in dealing with difficulties and consider various effective solutions. This allows them to open up opportunities in various ways to overcome life's challenges, both starting from natural phenomena and human interaction. Currently, a curriculum system is being implemented that will apply as a whole, namely the independent curriculum. The independent curriculum has several characteristics, including project-based learning for the development of students' soft skills and character that encourages faith, piety, cooperation, global diversity, independence, critical thinking, and creativity. One of the goals of the independent curriculum which is part of the Pancasila student profile is critical thinking, which is different from ordinary or routine thinking. Critical thinking is an intellectual thinking process that deliberately assesses the quality of thinking in a reflective, independent, and rational manner. Critical thinking is the ability to understand a problem by selecting relevant information that can ultimately draw valid conclusions. The ability to think critically in mathematics learning needs to be developed so that students have the ability to think and solve problems in real life and the industrial world, in accordance with the goals in the independent curriculum for the vocational school level which includes the improvement of critical thinking skills. Critical thinking is the main focus in both local and international educational contexts, given the importance of learning and innovation in the face of dynamic changes in the modern world. This shows that until now, educators are still actively looking for innovations and new strategies to integrate these two skills in the learning process. (Rosmana et al., 2022; Widiono & Millati, 2021; Cahyono et al., 2024) (Anisa, 2017; Nafi'ah et al., 2019; Cahyono et al., 2024) (Kurnianto & Haryani, 2019; Cahyono et al., 2024) Claris & Riley, 2012; Cahyono et al., 2024)

According to , critical thinking has four main aspects, namely clarity, bases, inference, and interaction. There is also a view from Ennis that there are six fundamental elements in critical thinking, namely focus, reason, inference, situation, clarity, and overview. From this description, the indicators of critical thinking ability in the context of this research include the ability to provide clear explanations, further elaboration, problem-solving strategies and techniques, and the ability to conclude. Thus, from these indicators, we can assess the extent of critical thinking skills possessed by students. Sumartini (2016) (Dharma et al., 2022) Based on the analysis of the results of the diagnostic test conducted by students in Lebak-Banten Regency, it can be seen that students are only able to provide limited answers according to their thinking logic. Therefore, students' ability to (1) provide simple explanations, (2) provide further explanations, (3) determine strategies and tactics, and (4) conclude that they are still lacking. In the first indicator, namely the ability to think critically to provide simple explanations, students are able to understand problems well through the identification of the information provided and the questions asked. In the second indicator, which is to provide further explanations, students have used mathematical concepts and models appropriately. In the third indicator, namely determining strategies and tactics, students showed accuracy in making calculations. However, in the fourth indicator, which is to conclude, there are still students who do not understand how to make conclusions from the problems they solve. From this explanation, it can be concluded that most students still

have difficulty in critical thinking, while only a small number of students are able to think critically effectively. (Yulianto et al., 2024)

In measuring students' level of critical thinking and problem-solving, the assessment that can be used is the Minimum Competency Assessment (AKM) test. The AKM program is part of the government's efforts to assess students' understanding of mathematics. Through AKM, the main goal is to find out the basic abilities that students have mastered, then teachers use this as a guideline to design the right learning strategies to improve students' academic achievement). The AKM tool contains several assessment elements, including critical thinking skills, problem-solving, and learning effectiveness, supporting the improvement of students' critical thinking and problem-solving skills. (Umam, 2023) (Minister of Education and Culture, 2020; Hasibuan, 2023)

According to (Minister of Education and Culture, 2020; Hasibuan, 2023), AKM focuses on measuring two basic competencies, namely reading literacy and mathematical literacy. However, in Indonesia, the term mathematical literacy is better known as numeracy, which refers to the ability to use mathematical procedures, tools, facts, and concepts in various (Ministry of Education and Culture, 2020; Hasibuan, 2023) contexts. The measured mathematical literacy consists of 5 levels of learning, where each level is used to assess students' mathematical literacy in certain educational units and classes. For example, level 1 for grade 2, level 2 for grade 4, and so on to level 5 for grade 10. However, in reality, AKM exam participants are only limited to students in grades 5, 8, and 11. AKM presents different types of questions, including short entries, multiple choice, matching, complex multiple choice, and descriptions.

AKM questions are divided into three aspects, namely content, context, and cognitive level. Content refers to material related to AKM questions, including numbers, measurements, geometry, data, uncertainty, as well as algebra. The context in the AKM questions describes the student's immediate environment, including personal, socio-cultural, and scientific aspects (Ministry of Education and Culture, 2020; Siti Suminar, 2023). The personal aspect includes individual activities and the family environment. The scientific context highlights the application of mathematics in the field of science and technology. Meanwhile, the socio-cultural context refers to activities in the community. The cognitive level describes the abilities requested in the AKM questions, including comprehension, application, and reasoning. Understanding refers to the understanding of mathematical processes, procedures, concepts, and facts. Meanwhile, applications demand the ability to apply concepts, and reasoning emphasizes the ability to apply concepts in non-routine situations (Mendikbud, 2020). Therefore, action research in the field of mathematics education at the grade level is needed to explore effective approaches in improving critical thinking and problem-solving skills among Indonesian students.

Everyone's ability to read and understand mathematics is different. Identity is an important component that affects students' ability to read and understand mathematics (Pakpahan, 2016; Cahyani & Susanah, 2022). This is because everyone has unique abilities and talents (Littauere, 2011; Cahyani & Susanah, 2022). The number of people attending a seminar with the same speaker can differ in their level of understanding. This factor shows that each student can understand the teaching and learning process in a different way with the teacher, the material, and at the same time. Students' personality types also influence their motivation to learn and their academic achievement (Rashedi and Abolmaali, 2014; Cahyani & Susanah, 2022). Therefore, it can be concluded that personality types have a significant influence on students' ability to read and understand math.

Table 1. Basic Characters of Each Personality Types

Personality Types	Basic Characters
Melancholy	Introvert, Thinker, and Pessimist
Korelik	Extroverted, Realistic, and Optimistic
Plegmatic	Introvert, Observer, and Pessimist
Sanguinis	Extroverts, Speakers, and Optimists

Four personality categories are known in Hippocrates' personality theory, namely Melancholic, Choleric, Plegmatic, and Sanguinis (Littauere, 2011; Cahyani & Susanah, 2022). Each personality type has strengths and weaknesses that must be improved. Table 1 outlines some of the basic characteristics of each of these personality types. According to Littauere (2011) (Cahyani & Susanah, 2022), people with Melancholic personality tend to have strict habits. They pay attention to detail and thoroughness, prioritize order, and usually complete tasks quickly. In addition, they have the ability to quickly find problems and create effective solutions. Perfectionism and having high standards are the characteristics of people of this personality type. In addition, they tend to like the way data is presented in the form of graphs and diagrams. In contrast, Choleric people tend to concentrate on achieving targets. They have a tendency to solve problems quickly and sensibly. Because of their tendency to emphasize on the end result, they often set measurable targets for each task they complete. Plegmatists are usually calm and love serenity. They often avoid conflict and prefer to come to an agreement with solutions that have been put forward by others. They have good management skills and can solve problems with simpler techniques. Those with a Sanguinist personality tend to act proactively and creatively when completing tasks. They often have a high level of enthusiasm and are able to generate fresh ideas to start a project (Littauere, 2011; Cahyani & Susanah, 2022). Based on previous research, students' personality characteristics have a relationship with the level of mathematical literacy. found that student characteristics play a role in determining mathematical literacy scores. Research by shows that differences in personality types, based on Keirse's Personality Theory, have an influence on the level of mathematical literacy. In addition, the study found that the Koleris and Sanguinis personalities had a correlation with students' mathematical literacy. Rusmining et al., (2014) (Hasibuan, 2023) Masriyah and Firmansyah (2018) Murtinasari, n.d, 2022

Based on this context, this study was conducted to answer questions about the analysis of mathematical critical thinking skills in solving problems of vocational school students in solving AKM questions based on personality type. Although previous research has investigated the relationship between students' personality characteristics and the mathematical skills of vocational school students, there have not been many studies that specifically explore the impact of certain personality types on the ability to think critically in the problem-solving of vocational school students based on the context of the AKM exam as an evaluation tool. So this study aims to: 1) analyze the relationship between areas of expertise and personality types on the mathematical critical thinking ability of vocational school students in solving AKM problems; and 2) explore the influence of areas of expertise and personality types on the critical thinking ability of vocational school students in solving AKM problems.

METHOD

This research is a quantitative descriptive research with a *Cross Sectional Survey method*. This research was conducted in grade 11 of SMK Lebak-Banten Regency, both public and private. The population is 8,577 students. The probability sampling technique (random sampling) with the slovin formula was used to determine the number of samples, which was 382 students. The research subjects were selected based on the results of the questionnaire which was categorized into 4 categories, namely melancholy, choleric, plegmatic, and sanguinist. The sample size of each category is also seen based on the field of expertise of vocational schools in Lebak Regency, Banten, which can be seen in Table 2.

Table 2. Data on the Number of Vocational School Subject Samples in Lebak Regency, Banten.

Vocational School Students' Areas of Expertise	Personality Types According to Hippocrates' Personality Theory				Total
	Melancholy	Choleric	Plegmatic	Sanguinis	
Construction and Building Technology	10	9	9	12	40
Manufacturing and Engineering Technology	20	15	20	15	70
Energy and Mining	5	5	1	1	12
Information Technology	15	17	16	17	65
Health and Social Work	10	10	10	10	40
Agribusiness and Agritechnology	9	15	11	17	52
Maritime	-	-	-	-	-
Business and Management	20	15	10	12	57
Tourism	5	6	5	6	22
Arts and Creative Economy	5	5	6	8	24
Total	99	97	88	98	382

Data was collected through personality type questionnaires, tests of students' mathematical critical thinking skills using AKM questions and interviews. Students were given a questionnaire of 40 questions which were divided into 20 strength questions and 20 weakness questions. From the results of filling out the questionnaire, 4 students with different personality types were obtained as research subjects. The research subjects were then given a critical thinking ability test that used AKM level 4 questions as many as 5 description type questions that had been learned by the students. Furthermore, the researcher conducted an interview to dig deeper into the ability to think critically in solving problems in AKM. To make this easier, a student code is made which is presented in Table 3.

Table 3. Description of Interview Result Code

Code	Description
Px-y	The questions asked by the researcher to the research subject are related to the number x in the order y. For example: P1-1 is the question asked by the researcher to the research subject for question number 1 in the first order.
SAX-y	The information provided by the study subjects with personality type A is related to the number x in the order y. For example: SM1-1 is the information provided by a study subject with a melancholic personality type (SM) related to question number 1 in the first order.

Then the selection of the interview subjects to be used is as many as 4 people from different personality types. The list of subjects that have been rejected can be seen in Table 4.

Table 4. List of Interviewed Subjects

It	Student Code	Score	Personality Type
1	BC	1	Introvert
2	SK	1	Extrovert
3	SP	1	Introvert
4	SS	1	Extrovert

The data analysis techniques used in this study are descriptive statistics and inferential statistics. Descriptive statistics are used to find out a general picture of the mathematical critical thinking ability of vocational school students in solving AKM problems based on their areas of expertise and personality types. Meanwhile, inferential statistics used the Pearson correlation test and the t-test. In testing this data, the researcher used SPSS 25.

RESULTS AND DISCUSSIONS

The results of the descriptive statistical test in this study showed:

Table 5. Descriptive statistical test results

Description of KBKM for Vocational Students						
By	Personality	n	Mean	Std. deviation	Xtall	Xlow
Construction and Building Technology	Melancholy	10	37,00	14,181	60	10
	Chorelis	9	35,56	11,844	50	15
	Plegmatic	9	33,33	12,748	50	15
	Sanguinis	12	39,17	13,953	60	15
Sum		40	36,50	12,969	60	10
Manufacturing and Engineering Technology	Melancholy	20	30,75	14,168	50	5
	Chorelis	15	31,67	16,868	55	5
	Plegmatic	20	34,00	15,526	60	5
	Sanguinis	15	32,00	12,071	45	5
Sum		70	32,14	14,511	60	5
Energy and Mining	Melancholy	5	34,00	15,685	60	20
	Chorelis	5	34,00	16,639	60	5
	Plegmatic	1	35,00	.	35	35
	Sanguinis	1	55,00	.	55	55

By		Description of KBKM for Vocational Students				
Areas of Expertise	Personality	n	Mean	Std. deviation	Xtall	Xlow
Sum		12	35,83	17,430	60	5
Information Technology	Melancholy	15	30,00	16,036	5	55
	Chorelis	17	33,53	13,201	10	60
	Plegmatic	16	31,88	15,586	5	60
	Sanguinis	17	29,12	12,529	5	45
Sum		65	31,15	14,108	5	60
Health and Social Work	Melancholy	10	31,50	9,443	15	45
	Chorelis	10	39,50	13,632	25	60
	Plegmatic	10	30,50	11,414	10	50
	Sanguinis	10	32,50	12,748	15	55
Sum		40	33,50	11,994	10	60
Agribusiness and Agritechnology	Melancholy	9	35,00	13,693	15	55
	Chorelis	15	35,33	13,819	10	55
	Plegmatic	11	33,64	17,761	10	60
	Sanguinis	17	33,53	14,005	10	55
Sum		52	34,33	14,350	10	60
Business and Management	Melancholy	20	33,75	15,033	5	60
	Chorelis	15	31,00	10,724	15	55
	Plegmatic	10	32,50	8,580	20	45
	Sanguinis	12	35,42	15,733	15	60
Sum		57	33,16	12,978	5	60
Tourism	Melancholy	5	35,00	13,693	15	50
	Chorelis	6	33,33	12,517	20	55
	Plegmatic	5	30,00	10,000	15	40
	Sanguinis	6	32,50	11,292	15	45
Sum		22	32,73	11,205	15	55
Arts and Creative Economy	Melancholy	5	38,00	14,405	20	55
	Chorelis	5	35,00	14,577	15	55
	Plegmatic	6	33,33	18,886	10	60
	Sanguinis	8	39,38	12,660	15	55
Sum		24	36,67	14,346	10	60

From Table 5 above, it can be known the distribution of variables in general regarding the mathematical critical thinking ability of vocational school students in solving AKM problems based on their areas of expertise and personality types.

Furthermore, a Pearson correlation test was carried out to determine the relationship between the type of discrimination and the mathematical critical thinking ability of vocational school students in solving AKM problems

Table 6. Pearson Correlation Test Correlations

		Students' Mathematical Critical Thinking Skills	Student Personality Type
Students' Mathematical Critical Thinking Skills	Pearson Correlation Sig. (2-tailed) N	1 382	.106* 382
Student Personality Type	Pearson Correlation Sig. (2-tailed) N	.106* 382	1 382

*. Correlation is significant at the 0.05 level (2-tailed)

Judging from Table 6, it can be concluded that there is a significant relationship between personality type and students' mathematical critical thinking ability in solving AKM problems, which is 0.039%, which is less than 0.05%.

Furthermore, the t-test is to determine the influence of personality type on students' mathematical critical thinking ability in solving AKM problems.

Table 7. Multiple linear regression t test

		Coefficients ^a				
		Unstandardized		Standardized		
Type		B	Std. Error	Beta	t	Sig.
1	(Constant)	29.663	.597		49.649	.000
	Students' Mathematical Critical Thinking Skills	.037	.018	.106	2.069	.039

a. Dependent Variable: Student Personality Type

From Table 7, it can be concluded that the significance value of students' mathematical critical thinking ability is less than 0.05, so there is an influence on personality type.

Discussion

The descriptive statistical analysis in table 2 above shows that students who are included in 9 areas of expertise with personality types who dominate in the ability to think critically mathematical problem solving AKM problems as seen from std. deviation or data distribution in general including: 1) the field of construction and building technology students who dominate in this field are melancholic personality students who are 14.181%, 2) the field of manufacturing technology and engineering students who dominate in this field are students with a correlational personality which is 16.868%, 3) the field of energy and mining students with a dominating personality is corelic with a percentage of 16.639%, 4) the field of information technology students who dominate in this field are students with

melancholic personality which is 16.036%, 5) the field of health and social work of students with a correlational personality who dominates with a percentage of 13.632%, 6) the field of agribusiness and agritechology of students in this field who dominate, namely plegmatic students with std.deviation of 17.761%, 7) the field of business and management of students with sanguinist personality who dominate in this field which is 15.733%, 8) the field of tourism melancholy students who dominate in this field with std.deviation of 13.693%, and 9) the arts and creative economy sector that dominates in this field are plegmatic students with a std.deviation of 18.886%. From this, it can be concluded that the number of samples or students who have personality types in this study are students who are included in the personality: 1) melancholy, which is found in the fields of construction and building technology, information technology, and tourism, 2) coralistic, namely in the fields of manufacturing and engineering technology, energy and mining, and the fields of health and social work, 3) plegmatic, namely in the fields of agribusiness and agritechology, and the field of arts and creative economy, 4) sanguinis, namely the field of business and management.

The results of the inferential statistical analysis contained in Table 6 explain whether personality type has a significant relationship with students' mathematical critical thinking ability or not. The basis for making the decision is that if the cynical value < 0.05 , then there is a relationship and vice versa. In Table 6, the significance value of personality type is 0.039, meaning less than 0.05, so in conclusion, personality type has a relationship with students' mathematical critical thinking ability. And has a positive relationship direction or correlation with the strength of the relationship, which is 0.106, meaning that there is a very significant relationship between personality type and students' mathematical critical thinking ability because there is an integration between students' mathematical critical thinking indicators and students' personality type questionnaires. Which of the 9 areas of expertise, the melancholic type of expertise is the one that dominates this because the melancholic type is a personality type that tends to have an orientation to a tight schedule. They pay more attention to details carefully, prioritize order, and have a tendency to complete work according to plan (Littauere, 2011). Based on the results of hypothesis testing in Table 7, the regression coefficient value is 0.037 and the significance value is $0.039 < 0.05$. This means that there is a significant influence between the type of student discipline on mathematical critical thinking skills. This is reinforced by the results of the researcher's answers and interviews with students with melancholy, choretic, plegmatic, and sanguinistic personalities in 9 areas of expertise related to work in AKM questions:

Table.8 Respondents' Answers

BC	Mentioning that in working on the questions, SM is more thorough and able to state information that is in accordance with the answer key. Students with SM personalities are also able to provide answers according to the polya stages. However, it is still lacking in answering questions on the indicator of building basic skills.
SK	Explaining that SK is able to answer questions according to the answer key and polya stages. However, the Decree has not been able to provide an answer regarding the indicator of providing a simple explanation.
SP	SP said that he was able to answer all the questions but still felt that there was something lacking about how to answer the questions with the answer key that had been available. And SS students prefer to work in a calm atmosphere.

SS SS tends to pay less attention to the questions carefully, but SS is able to answer questions with creative and varied abilities. One of the indicators that SS is able to work on is in setting strategies and tactics.

From the results of the analysis of descriptive statistical data and inferential statistics as well as the analysis of student answers and interviews, the researcher obtained data that there is indeed a strong relationship and influence between students' personality types and their critical thinking skills. Which for the relationship is 0.039% and the influence is 0.039% which means that this study has the same relationship and influence.

CONCLUSION

Based on the analysis of the data that has been presented in the discussion above, that there is a balanced relationship and rafting between the two means that the personality type of students on critical thinking skills in vocational school students in Lebak-Banten Regency is grouped in 9 areas of expertise with a significance of $0.039 < 0.05$. And it was the melancholic students who dominated in this study.

Through the results of the conclusion above, it can be understood that the true existence of every individual is someone who is able to solve his problems which can be seen by his personality type. Not only that, but the areas of expertise they take are also chosen based on their respective personality types.

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