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The Relation between Mathematical Connection Abilities and Mathematical Problems Solving Skill of Cadet

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Abstract

This study aims to identify the relationship between mathematical connection ability (MCA) and mathematical problem-solving skills (MPSS) in cadets of the Ship Operation Engineering Technology Study Program at the Surabaya Maritime Polytechnic. Using a quantitative descriptive approach, 21 cadets were given two questions designed to measure MCA and MPSS, which were then analyzed using descriptive statistics and the Spearman rank correlation test. The results showed a significant positive correlation between MCA and MPSS, with a coefficient value of 0.901. This finding indicates that cadets with higher MCA tend to have better problem-solving skills. Additionally, cadets experienced difficulties with questions involving trigonometric concepts in a nautical context, such as the use of compass points and distance calculations. This study highlights the importance of strengthening MCA and MPSS in maritime vocational education to enhance cadets' technical and cognitive skills, particularly in solving complex operational problems in the maritime sector.

Keywords: *mathematical connection ability; mathematical problem solving skill*

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INTRODUCTION

Mathematical problem solving skill (MPSS) is a key competency in higher education, especially in the field of engineering, including for cadets in ship operation engineering technology programs. In the context of higher education, KPMP not only functions as a cognitive skill but also as a basis for solving complex technical problems in the field (Polya, 2004). This skill includes students' ability to identify, analyze, and formulate solutions to complex and real problems in ship operations, such as route management, fuel efficiency, and operational safety (Akakpo, 2016; Astriawati & Setiyantara, 2019; Jonassen, 2011). Recent studies have shown that someone who has good problem-solving skills can solve problems more effectively in real contexts, especially in environments that require speed and accuracy of decisions (Leland et al., 2005; Yildirim & Sidekli, 2018).

In addition to mathematical problem solving, there is mathematical connection ability (MCA), which refers to the ability to connect mathematical concepts in various contexts and situations (Sugianto & Qohar, 2020), so it is expected that with good mathematical connection ability, problem solving skill will be good. Several studies have found that mathematical connection ability plays an important role in strengthening students' understanding of deep and applicable mathematical concepts (Suharto & Widada, 2019). With good MCA, students are better prepared to apply various mathematical principles in challenging technical situations, such as those often encountered in the field of ship operations engineering technology.

In higher education, mastery of mathematical connections has long been associated with academic and professional performance. Students who are able to understand and connect mathematical concepts will find it easier to solve complex technical problems, for example in the field of navigation or ship operational engineering technology, such as fuel efficiency calculations, operational risk analysis, ship navigation route optimization, mapping, navigation, and marine resource management (Astriawati & Setiyantara, 2019; Fragassa et al., 2020; Jatmiko & Hobri, 2021; Malalina et al., 2024). This was also expressed by Tarida & Fitri (2022) that in the nautical study program, students must learn how to sail safely, which is related to mathematics which is one of the basic materials for learning how to sail safely. With the conditions related to navigation problems, it is expected to have a good impact when cadets implement MCA combined with MPSS.

Furthermore, several studies have examined the relationship between MCA and MPSS, but most have focused on high school students. There is a lack of research on MCA and MPSS among applied undergraduate students (vocational) or cadets, particularly in the field of Ship Operations Engineering Technology. For example, a study by Hartati et al. (2017) found that MCA has a strong influence on MPSS, with a t-count of 0.201, which is greater than the t-table value. This study was conducted on 120 seventh-grade junior high school students. Similarly, Berlinda et al. (2023) found that MCA has a 16.67% effect on MPSS in a study involving 63 tenth-grade high school students. Additionally, research by Mirawati et al. (2021) on 23 eighth-grade students showed that MCA had a 57.83% effect on MPSS. Most other studies have primarily been conducted on mathematics education students, such as those by Hodiyanto (2017), Irmayanti (2016), Khaidir & Ramdhani (2023), and Suhardri et al. (2017).

Based on these conditions, this study examines MCA and MPSS in cadets, who are known not only to participate in lecture activities but also in physically demanding cadet training. Additionally, the primary focus of applied undergraduate cadets is not solely on learning mathematics, as it is considered a general foundational subject rather than a core competency (IMO, 2014a, 2014b). This aligns with observations describing the learning conditions of cadets at Politeknik Pelayaran Surabaya (Astuti et al., 2020). Therefore, the researcher aims to investigate the relationship between MCA and MPSS among cadets at Politeknik Pelayaran Surabaya, considering their unique academic and training conditions, which differ from typical student activities.

RESEARCH METHODOLOGY

This study is a quantitative descriptive study that examines the correlation between mathematical connection ability and problem-solving ability among cadets in the Ship Operation Engineering Technology Study Program. The research population consisted of two classes of second-semester cadets who had completed mathematics courses. One class was randomly selected, and TROK A, consisting of 21 cadets, was chosen as the research sample. Each cadet was given two questions designed to assess their mathematical connection ability and problem-solving ability in writing. Tables 1 and 2 provide the scoring guidelines for evaluating these abilities.

Table 1. Scoring Guidelines for Mathematical Connection Ability (MCA)

Score	Description
0	No answer
1	There is an answer but has not been able to identify the mathematical concept/procedure/process contained in the information presented and has done many calculations that are not focused.
2	Can identify some of the mathematical concepts/procedures/processes contained in the question but the final answer is not quite right
3	Can identify the mathematical concepts/procedures/processes contained in the question, using terms and notations that are almost right and there are calculation processes that are not quite right so that the final answer is not quite right
4	Can identify the mathematical concepts/procedures/processes contained in the question, using the right terms and notations and doing calculations completely and correctly

Table 2. Scoring Guidelines for Mathematical Problem Solving Skill (MPSS)

Stage	Score	Description
Understanding the Problem	3	Understand the problem completely and correctly, able to express known information and questions asked from the given problem
	2	Misinterpreting part of the problem or understanding part of the problem
	1	Misinterpreting the problem completely or not understanding the problem completely
	0	No answer
Planning a Resolution Strategy	3	Making a correct plan and leading to the correct solution
	2	Making a problem-solving plan that can be implemented but may not get the right results/get the wrong results
	1	Not having or making a plan that is relevant to the problem
	0	No answer
Solving the Problem According to Plan	3	Solving the entire problem and getting the correct answer
	2	Solving part of the problem and getting the correct answer
	1	Not solving the problem or solving part or all of the problem but getting the wrong results
	0	No answer
Evaluating	3	Solving the entire problem and getting the correct answer
	2	Solving part of the problem and getting the correct answer
	1	Not solving the problem or solving part or all of the problem but getting the wrong results
	0	No answer

After obtaining the scores, the data for each ability is grouped into high, medium, and low categories based on standard deviation rules, as shown in Table 3.

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Table 3. High, Medium, and Low Categories Based on Standard Deviation Rules

Interval	Description
$x \leq \bar{x}$ - SD	Low
$\bar{x}$ - $SD < x \leq \bar{x} + SD$	Medium
$\bar{x} + SD < x$	High

Next, it is tested with descriptive statistics starting from the Kolmogorov Smirnov normality test and the Pearson correlation test with a significance level of 0.05. However, when the data obtained is not normally distributed, the data will be tested for correlation with the Spearman Rank correlation test with a significance level of 0.05.

RESULTS AND DISCUSSION

This research was conducted in July 2024 in Class TROK A semester II who had taken applied mathematics courses. From the research results, conditions regarding the completeness of solving research questions were obtained.

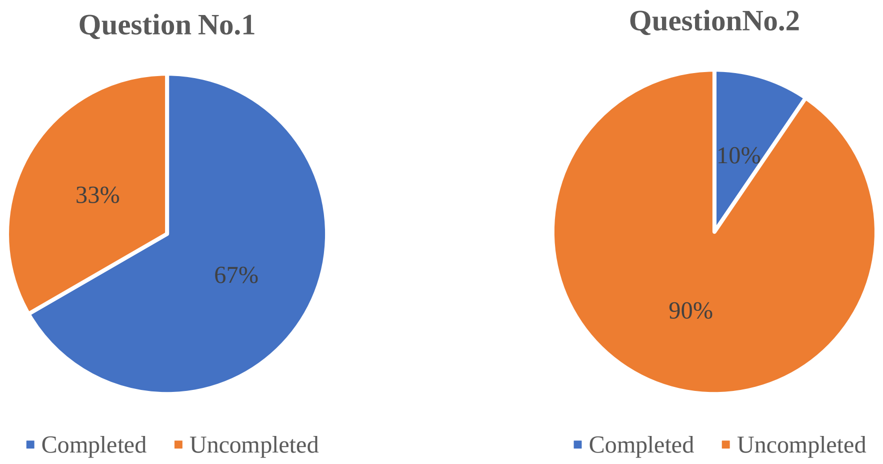

Figure 1. Question Completion Conditions

Based on Figure 1, question 1 was able to be completed by 64% of cadets, while question number 2 was able to be completed by 10% of cadets. This shows that question number 2 is quite difficult for cadets. This condition can be said to affect the results of the MCA and MPSS assessments. Cadets' success in solving questions can be said to depend on how they understand the questions and how they can relate the concepts they have learned to the conditions of the problems raised in the questions. This is in line with the opinion of Vessonen, et. al. that the characteristics of the questions are important for developing a person's problem solving abilities (Vessonen et al., 2024).

Furthermore, the data is processed to determine the MCA and MPSS values (Table 4) and the MCA and MPSS ability level categories (Table 5) of each cadet. Based on the data in Table 5, the percentages of the high, medium, and low categories for MCA and MPSS are identical. This suggests a proportional relationship between MCA and MPSS, indicating that a cadet with strong MCA also tends to have strong MPSS, and vice versa. However, this conclusion requires further support through additional statistical analysis.

Table 4. Score of MCA and MPSS

No.	Score		No.	Score	
	MCA	MPSS		MCA	MPSS
1.	17	15	1.	17	16
2.	21	23	2.	17	16
3.	7	6	3.	17	16
4.	6	3	4.	17	16
5.	4	3	5.	21	20
6.	12	12	6.	15	9
7.	18	17	7.	17	16
8.	12	12	8.	17	16
9.	14	12	9.	17	15
10.	18	12	10.	17	15
11.	11	12			

Table 5. MCA and MPSS Proficiency Levels

Criteria	Number of Cadets	
	MCA	MPSS
Low	3	3
Medium	16	16
High	2	2

Next, the MCA and MPSS scores in Table 4 were analyzed using descriptive statistics to obtain a normality test.

Table 6. Normality Test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
MCA	0,197	21	0,033	0,909	21	0,052
MPSS	0,325	21	0,000	0,793	21	0,001

a. Lilliefors Significance Correction

Based on Table 6, it can be seen that only MCA is normally distributed because the significance value obtained is 0.052 > 0.05. While MPSS is not normally distributed, because the significance value obtained is 0.001 < 0.05. Because the data obtained comes from the same sample, no homogeneity test is carried out. Furthermore, to determine the correlation value, the data was analyzed using Spearman's Rank correlation, and the results are presented in Table 7.

Table 7. Correlation Test

Correlations			MCA	MPSS
Spearman's rho	MCA	Correlation Coefficient	1,000	,901**
		Sig. (2-tailed)		0,000
		N	21	21
	MPSS	Correlation Coefficient	,901**	1,000
		Sig. (2-tailed)	0,000	
		N	21	21

**. Correlation is significant at the 0.01 level (2-tailed).

From Table 7, it is evident that mathematical connection ability has a significant and positive relationship with mathematical problem-solving ability. This is indicated by a significance value of 0.00 < 0.05, confirming the existence of a relationship. Additionally, the correlation coefficient of 0.901 (90.1%) demonstrates a strong positive correlation between MCA and MPSS. In other words, cadets with strong mathematical connection ability tend to have strong problem-solving skills, while those with lower MCA also exhibit lower problem-solving ability. Therefore, it can be assumed that MCA influences MPSS, consistent with previous research findings, and applies to cadets at the Surabaya Maritime Polytechnic.

From the results of the analysis above, it was obtained that MCA has a relationship with the goodness or badness of cadets' problem solving. This is in accordance with previous research although it was not conducted on cadets. MCA has a direct and strong influence on MCA (Hartati et al., 2017). In this study, what directly affects MPSS is not only MPSS, but there are communication skills, and conceptual understanding skills that are equally strong on MPSS (Hartati et al., 2017).

Based on the results of the study, it was also seen that cadets still had difficulty solving question number 2 related to trigonometry which is associated with the concept of cardinal points and distance. In this case, it is seen that cadets do not yet understand the concept of trigonometry with cardinal points. The assumption that solving problems in the world of shipping can be solved with technology on ships which makes it easier to operate ships, makes cadets less likely to consider the importance of mathematics in the field of shipping.

This is related to cadets' ability to understand contextual situations, which includes reasoning skills, representation skills, and the ability to identify relevant concepts (Rahmawati et al., 2017). This aligns with research by Hidayatulloh et al. (2023), which found that students often struggle with solving problems related to vectors. In the field of nautics, vectors are closely associated with the direction of ship motion, which is based on cardinal points. Additionally, logical thinking ability is closely linked to mathematical connection ability, both of which contribute to a person's success in solving mathematical problems (Hasmira, 2023; Irawan et al., 2016). Therefore, MCA and MPSS must be further developed in cadets to enhance their problem-solving skills in nautical and ship operations engineering technology.

CONCLUSION AND SUGGESTIONS

This study examines the relationship between mathematical connection ability (MCA) and mathematical problem-solving skills (MPSS) in cadets of the Ship Operation Engineering Technology program at the Surabaya Maritime Polytechnic. A total of 21 cadets were given two questions designed to measure MCA and MPSS using a developed assessment scale. Correlation analysis revealed a significant positive relationship between MCA and MPSS, with a correlation coefficient of 0.901, indicating that an increase in MCA tends to correspond with an increase in MPSS. However, challenges were identified in understanding trigonometric concepts within nautical applications, particularly in contextual-based problems involving distance and cardinal points. This study highlights the need for enhanced training in MCA and MPSS to equip cadets with stronger mathematical problem-solving and communication skills, particularly in the context of ship operation engineering technology and nautical fields.

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