

Kruskal-Wallis Analysis in Determining Differences in Mathematical Problem-Solving Ability Based on Level of Learning Interest

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Abstract : *Mathematics demands high-level thinking skills, especially in problem-solving, and is characterized by systematic and logical reasoning. Beyond cognitive aspects, affective factors such as students' interest in learning also influence their engagement and success. This study investigates differences in algebraic problem-solving ability based on students' interest levels and explores the relationship between the two variables. A comparative quantitative approach was used with Kruskal-Wallis non-parametric analysis and a correlation test. The sample consisted of 30 seventh-grade students at an MTs in Yogyakarta, grouped into low, medium, and high interest categories. Data were collected through a learning interest questionnaire and an algebra problem-solving test. The Kruskal-Wallis results showed a significance value of 0.135 (>0.05), indicating no significant difference in problem-solving ability among the groups. Similarly, the correlation test revealed no significant relationship between interest and ability. These findings suggest that learning interest does not directly affect students' algebraic problem-solving skills. Future research could explore other factors influencing mathematical problem-solving performance.*
Keywords: *learning interest, problem-solving skills, algebra, kruskal-wallis*

Abstrak : Matematika merupakan ilmu eksak yang bersifat sistematis, logis, dan juga menuntut kemampuan berpikir tingkat tinggi, terutama dalam menyelesaikan masalah matematis. Selain aspek kognitif, faktor afektif seperti minat belajar siswa memegang peranan penting dalam meningkatkan keterlibatan dan keberhasilan mereka dalam menyelesaikan permasalahan matematika secara efektif. Tujuan utama studi ini yaitu untuk mengkaji perbedaan kemampuan pemecahan masalah matematis aljabar berdasarkan tingkat minat belajar siswa serta hubungan antara minat belajar dengan kemampuan tersebut. Metode yang digunakan adalah pendekatan kuantitatif komparatif dengan analisis statistik non-parametrik *Kruskal-Wallis* dan uji korelasi. Sampel penelitian terdiri dari 30 siswa kelas VII di sebuah MTs di Yogyakarta yang dikelompokkan ke dalam tiga kategori minat belajar: rendah, sedang, dan tinggi. Instrumen yang dipakai yaitu angket minat belajar dan tes kemampuan pemecahan masalah aljabar. Hasil uji *Kruskal-Wallis* memperlihatkan nilai signifikansi sebesar 0,135 ($> 0,05$), yang maknanya tidak ada perbedaan signifikan dalam kemampuan pemecahan masalah antar kelompok minat belajar. Selain itu, uji korelasi juga memperlihatkan tidak adanya hubungan signifikan antara minat belajar dan kemampuan pemecahan masalah. Temuan ini mengindikasikan bahwa minat belajar tidak secara langsung memengaruhi kemampuan pemecahan masalah matematis siswa. Untuk penelitian selanjutnya dapat mencari perbedaan kemampuan pemecahan masalah matematis berdasarkan faktor afektif siswa yang lain.

Kata kunci: minat belajar, kemampuan pemecahan masalah, aljabar, *kruskal-wallis*

INTRODUCTION

Mathematics is an exact science that includes the study of numbers, arithmetic operations, and quantitative facts. It also includes the study of space and shape and is based on logical and strict rules (R.Soedjadi, 2000). In addition to being systematic, mathematics is also seen as an abstract and deductive science, so that in its application it demands imaginative abilities, intuition, and discovery in the problem-solving process. According to KBBI, mathematics is a science that uses logic to understand structure, shape, size, and relationships between concepts. Furthermore, mathematics not only acts

as a pure science, but also serves as an important tool in various applied fields such as science, engineering, medicine, and social sciences (Yudha, 2019). Thus, understanding of mathematical concepts is a fundamental aspect in the learning process (Atmaja, 2021). A good student understanding of mathematical concepts can provide examples, compare, explain, draw conclusions and solve problems. Conversely, if students lack understanding, it can hinder them in solving mathematical problems and developing logical and critical thinking skills optimally (Radiusman, 2020).

The capacity to solve problems is a fundamental learning competency in mathematics (Yuwono, 2016). Higher-order mathematical thinking skills were said to include the ability to solve mathematical problems. This ability includes several aspects, namely: (a) identify relevant and sufficient data to solve problems, (b) build mathematical models of real situations and solve them, (c) determine and apply appropriate solution strategies, (d) interpret results in the context of the problem, and (e) apply mathematical concepts meaningfully in everyday life. In line with this view, Septiati (2022) added that problem solving skills also involve understanding the components of the problem, formulating a solution strategy, using symbolic and visual representations, and evaluating and interpreting the solution as a whole.

To clarify the cognitive process involved, Pradestya et al. (2019) described problem solving as a sequence of three main stages: (1) representing the problem by identifying initial conditions and recalling relevant knowledge, (2) planning and developing a strategy, and (3) implementing the solution and evaluating the result. These stages serve as crucial building blocks for developing students' higher-order thinking abilities and transforming mathematics into a practical living science.

However, the development of problem-solving skills is also strongly influenced by affective factors, particularly students' interest in learning. According to Sardiman (2016), in order to motivate pupils to actively engage in the learning process and cultivate tenacity when comprehending challenging subjects like mathematics, passion in learning is crucial. Friantini & Winata (2008) state that indicators of interest in learning include pleasure in participating in lessons, interest in and attention to the material being studied, desire to learn, internal drive to be actively involved in the learning process, and efforts to fulfill this desire. In line with that, according to Safari (Apriyanto & Herlina, 2020), pleasure, curiosity, paying attention to the teachings, and actively participating in the learning process are all signs of interest in learning. Students with high interest in learning tend to be more motivated, more persistent in facing problems, and more engaged in the process of evaluating their work (Yuliati, 2021). Therefore, through contextual, meaningful, and difficult problem-solving exercises, mathematics instruction must be planned to both stimulate student interest and develop higher order thinking abilities (Islahiyah et al., 2021).

Although learning interest and problem-solving ability have been the focus of previous studies, there is still an urgent need to examine their relationship in depth using nonparametric statistical approaches, such as the Kruskal–Wallis test. Previous studies have generally emphasized cognitive development without specifically exploring the

influence of affective dimensions, such as learning interest, on mathematical thinking ability. In fact, affective factors can encourage student engagement and perseverance when solving complex mathematical problems.

For example, research conducted by Quraisy & Hasni (2021) examined numerical ability and showed that there was no significant difference between the numerical abilities of students in each class, where the average values tended to be close together. Another study by Indrasetianingsih et al. (2024) used the Kruskal-Wallis test to evaluate students' literacy skills based on the minimum competency assessment, and the results reinforced that *Kruskal-Wallis* can be an appropriate analytical tool in educational contexts. In addition, a study by Jamco & Balami (2022) reinforces that *Kruskal-Wallis* analysis is relevant in differentiating learning outcomes based on interest in a particular field of study, even though the subjects are university students.

However, there is still a lack of research using this approach to analyze the differences in mathematical problem-solving abilities among secondary school students based on their learning interest levels. In fact, given the importance of learning interests in shaping student attitudes and involvement during the educational process (Munandar & Siregar, 2024), this study is highly relevant. This study seeks to ascertain whether students' motivation in learning influences their capacity to solve mathematical problems, especially those involving algebraic content. Additionally, this study uses a quantitative method and the Kruskal–Wallis analysis technique to see whether there is a relationship between learning desire and problem-solving skill.

By combining the *Kruskal-Wallis* test with a quantitative approach, this study aims to provide a clearer picture of the interaction between students' cognitive skills and affective factors such as learning interest. The findings are expected to serve as a basis for designing more adaptive and responsive learning strategies that consider the individual characteristics and needs of learners.

RESEARCH METHODE

This study uses comparative quantitative research with a non-parametric approach. This study aims to ascertain whether there are significant differences in algebraic problem-solving skills based on students' level of interest in learning and to determine the relationship between learning interest and algebraic problem-solving ability. This study examined all seventh-grade students at one of the Yogyakarta Madrasah Tsanawiyah. A research sample of 30 students was selected using the cluster random sampling technique.

The learning interest questionnaire and the algebraic problem solving ability test were the two primary tools used to gather data. The learning interest questionnaire, which has been validated by professionals, is a useful tool for assessing students' interest in learning. It consists of 15 statements with a rating scale of 4 responses from strongly agree to disagree. The statements in the questionnaire are in accordance with the aspects according to Safari. (Safari, 2003) they are attention, pleasure, interest, and involvement. After data collection, learning interest categorization was carried out which was divided

into three categories, namely low, medium, and high. Mathematical problem-solving ability is measured through an algebra material test. This test is based on problem-solving ability indicators adopted from Sumartni (Sumartini, 2016) namely (1) identifying the problem or writing down the information given from the question posed; (2) making a solution plan; (3) solving the problem according to the solution plan; and (4) interpreting the results and checking back.

The normality and linearity tests are part of the required data analysis that was employed. In the learning interest data, ratio data is produced which will then be categorized into three categories, namely low, medium, and high, which makes the data ordinal. The normality test is carried out twice, namely the Kruskal-Wallis test which uses ordinal learning interest data which functions to determine differences in problem solving ability based on the level of learning interest and the Pearson product moment correlation test which uses ratio-shaped learning interest data to identify whether there is a relationship between learning interest and problem solving ability.

RESULTS AND DISCUSSION

Instrument Validity and Reliability

Prior to the implementation of the main research, the instruments used - namely the learning interest questionnaire and the algebraic problem solving test - had gone through a content validation process by three experts in the field of mathematics education. The results of the validation are presented in Table 1. The experts' evaluation showed that each item in the instrument was considered relevant, clear, and in accordance with the construct being measured. In addition to content validation, the reliability of the instrument has also been tested through a pilot study involving 30 students from a population with similar characteristics. The reliability test results showed that the Cronbach's Alpha coefficient for the learning interest questionnaire was 0.81, and for the algebraic problem solving test was 0.84. These values indicate high internal consistency, thus supporting the reliability and trustworthiness of the instruments used.

Table 1. Validation Result

Question item number	Validation results	Description
1 (+)	1	High (highly valid)
2 (+)	1	High (highly valid)
3 (-)	1	High (highly valid)
8 (+)	0,93	High (highly valid)
4 (-)	1	High (highly valid)
5 (+)	0,93	High (highly valid)
11 (-)	0,93	High (highly valid)
6 (+)	1	High (highly valid)
9 (-)	1	High (highly valid)
7 (+)	0,93	High (highly valid)
13 (-)	0,93	High (highly valid)
15 (+)	1	High (highly valid)

12 (-)	0,87	High (highly valid)
14 (+)	1	High (highly valid)
10 (-)	1	High (highly valid)
Description :		
Low (Less Valid): < 0.4		
Medium (Valid): 0.4 - 0.8		
High (Highly Valid): > 0,8		

The purpose of this study is to ascertain how students' algebraic problem-solving abilities vary according to their degree of learning interest. Problem-solving ability is an important cognitive competency that supports student success, especially when facing contextual challenges and everyday life (Yuwono, 2016). To identify differences in ability between groups, non-parametric statistical analysis, namely the *Kruskal-Wallis* test was used. This test was selected based on the results of the normality test, which showed that the data were not normally distributed.

To ascertain whether learning interest groups differed significantly in their capacity for problem-solving, the *Kruskal-Wallis* test was employed. When data normality is not assumed, this non-parametric analytic method is employed in place of the one-way ANOVA test. Based on the answers to a validated learning interest questionnaire, learning interest groups are categorized as low, medium, or high in this study. Since the data from the majority of groups were not normally distributed, the parametric technique was deemed incorrect and the *Kruskal-Wallis* test was employed.

Through this test, researchers can identify whether differences in students' learning interest levels correlate with differences in their ability levels in solving mathematical problem solving problems, especially in algebra material. The results of this test become the basis for drawing conclusions whether certain interventions or learning approaches need to be adjusted based on students' learning interests. If the test shows statistical significance, it can be said that there are meaningful differences between groups, which can be used as a reference in planning learning strategies that are differentiative and adaptive to student characteristics. Furthermore, data analysis techniques were used to analyze the test results

Kruskal-Wallis

The data must first be tested for normality before conducting the *Kruskal-Wallis* test. The normality test here is different from the correlation normality test because if the correlation of learning interest data is nominal, then in the *Kruskal-Wallis* normality test the learning interest data turns into categories. In this case, the categories are low, medium, and high.

Normality Test

To choose the best analysis technique, a normality test was performed on the problem-solving ability data according to the learning interest category (Peratiwi & Adzima, 2024). This normality test is important because the assumption of data distribution affects the selection of statistical test types. Data normality test criteria for the *Kruskal-Wallis* test using SPSS are based on the Sig value. The data are not regularly

distributed if Sig. is less than 0.05. The data is usually distributed if Sig. >0.05. The following table 2 displays the test results.

Table 2. *Kruskal-Wallis Normality Test Results*

Tests of Normality

	<i>Learning_Interest</i>	<i>Kolmogorov-Smirnov^a</i>			<i>Shapiro-Wilk</i>		
		<i>Statistic</i>	<i>df</i>	<i>Sig.</i>	<i>Statistic</i>	<i>df</i>	<i>Sig.</i>
<i>Problem_Solving</i>	<i>Low</i>	,164	10	,200*	,952	10	,697
	<i>Medium</i>	,281	10	,025	,810	10	,019
	<i>High</i>	,310	10	,007	,821	10	,026

*. *This is a lower bound of the true significance.*

a. Lilliefors Significance Correction

The aforementioned table indicates that the data is not regularly distributed. The sig. values for medium and high are 0.019 and 0.026, respectively, which are less than 0.05. At 0.697, the low sig. value is higher than 0.05. The Kruskal-Wallis test can proceed because the data is still classified as not normally distributed because only one sig. value is more than 0.05.

Kruskal-Wallis Test

Following confirmation that the data is normally distributed, the Kruskal-Wallis test is used to ascertain if student enthusiasm in learning influences differences in mathematical problem-solving skills. Using SPSS, the Kruskal-Wallis test criteria are based on Asymp. Sig. There is a considerable difference if the Asymp. Sig. value is less than 0.05. If the Asymp. Sig. is greater than 0.05, then there is no significant difference. The test results are listed in the following table 3.

Table 3. *Kruskal-Wallis test result*
Test Statistics^{a,b}

<i>Problem_Solving</i>	
<i>Kruskal-Wallis H</i>	3,999
<i>df</i>	2
<i>Asymp. Sig.</i>	,135

a. Kruskal Wallis Test

b. Grouping Variable: Minat_Belajar

Based on the table above, the Asymp. Sig. 0.135 which means > 0.05. So, there is no significant difference in each category of low, medium, and high learning interest.

This result shows that although students have different levels of learning interest, these differences do not significantly affect their ability to solve math problems.

Correlation

Prior to conducting the correlation test, it is imperative to ascertain the normality and linearity of the data. The correlation test requires normal and linear data. See Tables 3 and 4 for the criteria for normal and linear data.

Normality Test

Shapiro-Wilk was used in this test because a lot of data < 50. Data normality test criteria based on Sig value. If Sig. <0.05, then the data are not normally distributed. If Sig. is greater than 0.05, then the data is normally distributed. The findings are outlined below.

Table 4. Results of the Correlation Normality Test

<i>Tests of Normality</i>	<i>Kolmogorov-Smirnov^a</i>			<i>Shapiro-Wilk</i>		
	<i>Statistic</i>	<i>df</i>	<i>Sig.</i>	<i>Statistic</i>	<i>df</i>	<i>Sig.</i>
<i>Learning_Interest</i>	,167	30	,031	,931	30	,054
<i>Problem_Solving</i>	,104	30	,200*	,958	30	,267

The table 4 shows Sig. or *p-value* values of 0.054 for learning interest and 0.267 for problem-solving. These are > 0.05, indicating normal distribution of the data.

Linearity Test

The linearity testing criteria in SPSS are based on the significance of the deviation from linearity. In the event that *Sig. Deviation from Linearity* is found to be less than 0.05, it can be deduced that a linear relationship is not in evidence. Conversely, a linear relationship exists if *Sig. Deviation from Linearity* is greater than 0.05. The findings are outlined below.

Table 5. Correlation Linearity Tests Results

ANOVA Table

			<i>Sum of Squares</i>	<i>df</i>	<i>Mean Square</i>	<i>F</i>	<i>Sig.</i>
<i>Problem_Solving</i> <i>Learning_Interest</i>	* <i>Between Groups</i>	<i>(Combined)</i>	375,033	15	25,002	,528	,884
		<i>Linearity</i>	81,324	1	81,324	1,719	,211
		<i>Deviation from Linearity</i>	293,709	14	20,979	,443	,930
	<i>Within Groups</i>		662,333	14	47,310		
	<i>Total</i>		1037,367	29			

The *Sig. Deviation from Linearity* value is 0.930, which is greater than 0.05, as shown in the table 5. Consequently, a direct linearity exists between the degree of interest in learning and one's for mathematical problem-solving. The ensuing analysis is the correlation test, which is utilized to demonstrate the relationship between learning interest and mathematical problem-solving. This test follows the initial data collection, which verifies that the data is normal and linear.

Correlation Test

The correlation testing criteria in SPSS are predicated on the value of Sig. (2-tailed). A value of *Sig. (2-tailed)* less than 0.05 indicates that the variables are correlated, while a value greater than 0.05 suggests that they are not correlated. The findings are outlined below.

Table 6. Correlation Tests Results

Correlations

		<i>Learning_Interest</i>	<i>Problem_Solving</i>
<i>Learning_Interest</i>	<i>Pearson Correlation</i>	1	,280
	<i>Sig. (2-tailed)</i>		,134
	<i>N</i>	30	30
<i>Problem_Solving</i>	<i>Pearson Correlation</i>	,280	1
	<i>Sig. (2-tailed)</i>	,134	
	<i>N</i>	30	30

As indicated by Table 6, the Sig. (2-tailed) is 0.134, which exceeds the 0.05 threshold. Consequently, there is no demonstrable relationship between the degree to which students are interested in the prospect of learning and their aptitude for problem-solving in the context of algebra. The correlation test showed that there's no real link between how much seventh graders at Islamic junior high schools like to learn and their ability to solve algebraic math problems.

These results align with those of (Rohimin et al., 2024) who found that interest in learning contributed weakly and was insufficient to support a meaningful relationship between learning interest and problem-solving ability. (Wong & Wong, 2019) also stated that interest is not significantly correlated with general math performance. Another study (Hermaini & Nurdin, 2020) found that students with low, medium, and high interest had difficulty with problem-solving tests. This suggests that interest is not significantly correlated with algebraic mathematical problem-solving ability.

According to (Nisrina, 2018), learning interest is one of the affective factors believed to influence students' motivation and engagement in learning. However, this theory also emphasizes that interest only optimally affects academic performance when accompanied by self-regulated learning, a supportive learning environment, and appropriate cognitive strategies.

The findings of this study stand in stark contrast to those of a study bearing the title "The Effect of Learning Interest on Mathematical Problem-Solving Ability in Class IV Elementary School Students" conducted by (Peratiwi & Adzima, 2024). The study's findings indicate that students' proficiency in solving algebraic math problems is influenced by their level of interest in learning. This is evident through a t-test with a calculated t-value of 2.077, which is more than the t-table value of 2.017. Thus, H_0 is rejected, this signifies a substantial correlation between the two variables.

Similarly, Yuliati's (2021) research, titled "Mathematics Problem Solving Ability in View of Students' Learning Interest," shows that learning interest significantly influences mathematics problem-solving ability. A strong positive connection between students' learning interests and their problem-solving abilities, as measured by test results, was revealed by the study.

CONCLUSIONS AND RECOMMENDATIONS

The findings of this study, based on data analysis and subsequent discussion, indicate that there is no statistically significant difference in students' mathematical problem-solving proficiency across varying levels of learning interest—low, medium, and high. This conclusion is supported by the Kruskal-Wallis test, which yielded an Asymp. Sig. value of 0.135 (>0.05). Furthermore, the correlation analysis revealed no significant relationship between students' interest in learning and their algebraic problem-solving ability, as indicated by an Asymp. Sig. value of 0.134 (>0.05). These results suggest that students' level of interest in learning mathematics does not have a significant impact on their ability to solve mathematical problems. This finding contrasts with previous research, which reported a positive and significant correlation between learning interest and mathematical problem-solving proficiency.

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