The influence of mathematical disposition on high school students' understanding of mathematical concepts

Hanifatul Aini *, Nanang Khuzaini
Universitas Mercu Buana Yogyakarta, Bantul, Daerah Istimewa Yogyakarta, 55752, Indonesia
* Corresponding Author. Email: hanifaini09@gmail.com

Received: 9 February 2024; Revised: 20 February 2024; Accepted: 22 February 2024

Abstract: One of the subjects often considered challenging by students is mathematics, leading to difficulties in learning the subject. This is due to students' lack of ability to comprehend mathematical concepts. This research aims to investigate the influence of mathematical disposition on the mathematical concept understanding of high school students. The study utilizes a correlational survey method with a quantitative approach. The study employs a quantitative approach with a correlational survey method. The population includes all twelfth-grade science students at SMA Negeri 1 Sedayu. The sampling technique utilizes random sampling, with a sample size of 65 students selected from two twelfth-grade science classes. The instruments used in the research consist of a mathematical disposition questionnaire and an essay test on the ability to understand mathematical concepts. Data analysis is performed through classical assumption tests and simple regression analysis. The classical assumption tests include normality and linearity tests. The results indicate a significant positive influence of mathematical disposition on students' understanding of mathematical concepts, with a contribution of mathematical disposition to the understanding of mathematical concepts amounting to 34.8%.

Keywords: High school students, Mathematical disposition, Understanding of mathematical concepts


INTRODUCTION

In the education curriculum, especially at the high school level, one of the subjects that plays an important role is mathematics (Khotimah, 2019; Aristiyo et al., 2021). Learning mathematics in high school has one of the goals, one of which is that students must be able to understand mathematical concepts (White-Clark et al., 2008). The importance of understanding mathematical concepts not only impacts students' academic success but also has very significant implications for solving real-world problems and developing critical thinking (Aksu & Koruklu, 2015). For example, in the world of technology, mathematical understanding is the foundation for the development of algorithms, programming, and artificial intelligence. Case studies such as the implementation of mathematical models in data analysis for weather prediction, resource management, and logistics planning are examples of how mathematical understanding is practically used to solve real-world problems. Thus, mathematical understanding is not just about meeting academic requirements but is also key to preparing students to become competent problem solvers and critical thinkers who can contribute to real-world challenges.

In Minister of Education and Culture Regulation Number 58 of 2014, Article 1, states that the aim of students' mathematics subjects is for students to be able to understand mathematical concepts. It is important to note that understanding mathematical concepts plays
a crucial role in the learning process and effective application of mathematics (Perry & Len-Ríos, 2019). This implies that the basic ability that needs to be mastered in learning mathematics is understanding mathematical concepts (Mwakapenda, 2004). Because understanding concepts at the previous level is an important requirement for understanding material at the next level (Nokes & Ross, 2007). In fact, until now, many students have not achieved an optimal understanding of mathematical concepts. Based on previous research by Jeheman, some schools still have not reached an ideal condition regarding conceptual understanding (Jeheman et al., 2019). The majority of students still consider mathematics as a difficult subject (Amalia & Unaenah, 2018). This is because mathematics involves abstract ideas organized hierarchically, ranging from the most basic to the most complex (Monariska, 2017). Therefore, mathematics is often perceived to require high memory and analytical skills in its application (Szabó, 2015). Some students tend to rely solely on memorization and may lack an understanding of the fundamentals or the relevance of the mathematical material they are learning (Liu et al., 2019).

When we discuss students’ low ability to understand mathematical concepts, we need to consider various factors that influence it, both from external and internal factors (Diana et al., 2020). In the category of internal factors, which refer to aspects that come from within students can be affective aspects. One of the affective aspects that has a crucial role in the ability to understand mathematical concepts is a mathematical disposition (Matondang & Sofiyah, 2023). Mathematical disposition includes individual attitudes, interests, beliefs, and perceptions toward mathematics (Code et al, 2016). These aspects are closely related to an individual’s psychological dimensions, such as motivation, self-confidence, perceived ability, interest, and preference toward mathematics. Thus, mathematical disposition reflects students’ awareness to actively participate in the learning process, which can be a determining factor in improving their understanding of mathematical concepts (Leach et al, 2014). In this regard, students are expected to be active by asking questions if they have difficulty understanding the material explained by the teacher. Students’ characters will undergo internal growth after they undergo the process of learning mathematics, which will shape their mathematical disposition (Indriyani et al., 2021). However, if students are passive in the learning process and only receive information from the teacher without active participation, then the mathematical disposition of students will not develop in such a learning environment (Yoon et al., 2011). Students with a high level of mathematical disposition will demonstrate greater responsibility in the learning process and develop strong problem-solving skills in mathematics. Meanwhile, students with a low level of mathematical disposition tend to perceive mathematics as abstract and less useful in everyday life (Susilo et al., 2020).

Previous research by Febriyani et al. (2022) showed that students' mathematical disposition affects the understanding of mathematical concepts, although the effect is not significant. However, this study has limitations on grade VIII junior high school students with a focus on number pattern material. Therefore, to address the gaps in previous research, this study will expand its scope by involving high school MIPA students and statistics material, which is expected to make a greater contribution to educational theory and practice. Through the expansion of research to the high school level and different materials, this research is directed to provide a more comprehensive understanding of the impact of mathematical disposition on understanding mathematical concepts. The results of the study are expected to provide more insight into whether mathematical disposition affects the concept understanding of high school mathematics students or whether previous findings are still relevant. The theoretical contribution of this research involves developing an understanding of the role of mathematical disposition in the context of mathematics education. In addition, this research is expected to be the basis for designing more effective teaching strategies, especially in improving students' understanding of mathematical concepts.

In previous research, Febriyani et al. (2022) recommended other researchers to be more accurate in obtaining data and using time optimally. Because the insignificant research results
related to the effect of mathematical disposition on students' understanding of mathematical concepts may be caused by inaccurate data. More accurate and relevant research results are expected to provide a strong foundation for designing interventions or learning approaches that can improve the quality of mathematics education at the high school level. Therefore, the researcher is interested in conducting a study that aims to determine whether there is an effect of mathematical disposition on students' understanding of mathematical concepts in senior high school. Through improved data collection methods and a more specific selection of research subjects, this study is expected to make a significant contribution to filling the existing knowledge gaps. With more accurate and relevant research findings, it is hoped to provide a strong basis for formulating more effective education policies and improving the quality of students' understanding of mathematical concepts at the high school level, especially in the science track.

**METHOD**

This research was conducted in the odd semester of the academic year 2023/2024 at SMA Negeri 1 Sedayu, Bantul, Yogyakarta. The reason the researcher chose this school is based on the findings of a preliminary study that revealed several issues faced by some 12th-grade classes at SMA Negeri 1 Sedayu. Some of these issues include: 1) Many students still struggle to work independently, 2) Discipline in studying is low, as supported by interviews with some students who mentioned that they only study mathematics when exams are approaching, and some never study mathematics at home, 3) Some students have low self-confidence; they tend to cheat or ask friends for help when doing assignments or exams, and are reluctant to step forward when asked to solve problems on the board, 4) Many students feel that mathematics is difficult, leading to a lack of interest in the subject, 5) Many students have difficulty understanding the material and solving mathematical problems, resulting in frustration. These findings are reinforced by interviews with mathematics teachers who state that some students still struggle to express conclusions in solving mathematical problems and often require teacher guidance, even for exercises that should be easy. Therefore, there is a suspicion that the low level of understanding of mathematical concepts among students is influenced by their mathematical disposition and warrants further attention.

The research method employed a correlational survey with a quantitative approach. The population for this study consisted of all 12th-grade science classes at SMA Negeri 1 Sedayu, totaling 5 classes. The sampling technique used was random sampling, where the researcher randomly selected 2 classes from a total of 5 classes as research samples. The sample consisted of 65 students. To ensure the representativeness of the sample, randomization was done by ensuring that each class had an equal chance of being selected as part of the sample. This randomization process was carried out using the lottery method, where the researcher wrote the class number on papers of the same size, then the papers were put into a container and two papers were randomly drawn as samples. The reasons for selecting two classes as the sample size may vary depending on the specific considerations of the study, including (1) Sample representation: Two classes were selected with the expectation that they would provide an adequate picture of the student population as a whole. If the classes selected are randomly chosen and proportionally represent the population, the results of the sample can be considered representative of the population as a whole. (2) Efficiency: Selecting two classes as a sample is an efficient choice in terms of time and available resources. Collecting data from two classes may be easier to do than collecting data from the entire population. (3) Statistical Power: A larger sample size tends to increase the statistical power of the data analysis. However, in some cases, by selecting two classes as the sample, sufficient statistical power can still be achieved especially if the variation between classes is large enough (Hong & Park, 2012). (4) Resource Limitations: Limited resources such as time, effort, or funds may be a factor that limits the research. In such a situation, selecting two classes as the sample may be a practical option and allow the research to still be conducted effectively. Thus, selecting two classes as
the sample size is a well-considered decision, given the considerations of sample representation, efficiency of data collection, statistical power, and resource limitations.

In this research, the researcher selected two variables, namely the mathematical disposition variable as the independent variable (X) and the variable of understanding mathematical concepts as the dependent variable (Y). Data collection was carried out using both test instruments and non-test instruments. In collecting data using test and non-test instruments, several stages and procedures need to be considered to ensure the accuracy, reliability, and security of the data collected. The following is a clearer description of how data was collected using test and non-test instruments: (1) Non-test instruments in the form of questionnaires were distributed to students in a controlled classroom environment. This was done during the designated class hours, with the supervision of the teacher or exam supervisor. To maintain the accuracy and reliability of the data, it is important to provide clear instructions to the participants on how to fill in the questionnaire, including an emphasis on the importance of answering the questions as honestly and objectively as possible. (2) To ensure anonymity and confidentiality, participants are guaranteed that their identity will not be known to anyone other than the researcher. This can be achieved by providing each participant with a unique identification number that is not linked to their identity. (3) Participants were given clear instructions regarding the purpose of completing the questionnaire, the importance of honesty in answering, and their right to not participate or withdraw at any time during the data collection process. (4) Questionnaires used as non-test instruments are usually closed-ended, where students are asked to provide answers by ticking the column that corresponds to their experience. By following these procedures, the researcher can ensure that the data collected through test and non-test instruments are guaranteed accuracy, anonymity and confidentiality are maintained, and can be trusted to be used in analysis and concluding research.

A questionnaire was used as the non-test instrument to measure students' mathematical disposition. The questionnaire took a closed form, where students were asked to provide answers by ticking the appropriate column based on their experiences regarding the influence of mathematical disposition in learning mathematics. A Likert scale was employed for scaling the questionnaire, ranging from very positive to very negative. Answer alternatives involved categories such as Strongly Agree (SA), Agree (A), Uncertain (U), Disagree (D), and Strongly Disagree (SD). Each question in the attitude scale was assigned a weight that could be converted from a qualitative scale to a quantitative scale, resulting in quantitative data. This data was then processed for regression testing (Chatterjee & Hadi, 2013). The mathematical disposition scale in this study consists of 12 positive question items and 8 negative question items that have been adjusted to the mathematical disposition indicators.

The indicators of mathematical disposition were selected based on previous research that showed a correlation between mathematical disposition and students’ mathematics performance, such as confidence in mathematics ability is positively correlated with higher mathematics achievement (Chandra & Royanto, 2019), perseverance and discipline in learning mathematics and students' interest in mathematics which is also positively correlated with students' mathematics learning outcomes (Tamardiyah, 2017; Faisah et al, 2023). Where belief (trust) in oneself in mathematics, diligence in studying mathematics, and student's interest in mathematics refer to each other in aspects of mathematical disposition, therefore researchers take indicators of mathematical disposition that are not far from these aspects. The indicators of mathematical disposition used by researchers based on (Sumarmo 2013) consist of several aspects, including: (1) aspects of self-confidence: confidence in solving math problems and being able to provide logical reasons in communicating ideas; (2) relatedness and high curiosity aspects include: asking questions frequently when learning mathematics, high enthusiasm in finding answers to mathematical problems, and enthusiasm in exploring mathematical ideas; (3) flexibility aspects include: trying various alternative methods to solve problems and cooperating in learning mathematics; (4) perseverance aspects include: being able to solve mathematical problems by trying various alternatives and being serious in learning; (5)
reflective aspects include: liking mathematics and reflecting on their learning results; (6) assessing the application of mathematics in everyday life; and (7) appreciating the role of mathematics in life. Regarding the design of the selection of questions for the mathematical disposition questionnaire, it is also very important for researchers to ensure the validity and reliability obtained. The reasons behind the selection of the questions include, among others, the questions are formulated clearly and simply to help make it easier for respondents to understand the questions, the questions are formulated consistently with the concepts related to mathematical disposition and can cover all aspects of mathematical disposition as mentioned earlier, and the questions can also be ensured not to mix with other constructs. Then, the items in the questionnaire are developed through validation and verification by expert validators, pilot testing on a small number of respondents to evaluate the clarity, relevance, and consistency of the items, and finally, from the pilot testing results, the items can be revised or adjusted to improve their clarity and validity. Then, the questionnaire can be finalized for use in the main research.

Meanwhile, the test instrument used in this study serves as a tool to measure the mathematical concept comprehension of each student. The test instrument is in the form of essay questions, taken from the statistics material covering the subtopics of frequency distribution and data centralization in the 2013 curriculum. The selection of instruments to measure students’ understanding of mathematical concepts in the form of essay tests has several fundamental reasons, including the following: (1) Essay tests allow students to provide detailed and in-depth answers. With this format, students are expected to explain mathematical concepts in more detail, expressing their understanding comprehensively; (2) Certain mathematical concepts may require a more complex understanding. Essay tests provide an opportunity for students to demonstrate their understanding of abstract or complex concepts, which may be difficult to measure through multiple-choice tests; (3) Essay tests encourage students to develop critical thinking skills. They must formulate their answers, present arguments, and describe logical steps in solving mathematical problems. This helps evaluate students’ critical thinking abilities; (4) The essay format provides students with the opportunity to showcase their creativity in explaining mathematical concepts. They can use different approaches and express their ideas more freely; (5) Essay tests can help measure students’ understanding in a broader context. Students are not only assessed on basic knowledge but also on their ability to relate mathematical concepts to real-life or applicable situations. Thus, the choice of essay tests as an instrument for measuring students’ understanding of mathematical concepts provides advantages in assessing deeper understanding, critical thinking skills, and creativity in the context of mathematics.

The essay test consists of 7 questions that have been modified and adjusted to the indicators of concept comprehension. Indicators of understanding of mathematical concepts were chosen by researchers based on relevance to the learning objectives that students were studying. At the time of the research, students were studying statistics material on frequency distribution and data-centering measures, so the researcher chose indicators that could reflect what students would get from the material. The concept comprehension indicators are derived from the Ministry of Education and Culture Regulation Number 58 of 2014 and include: (1) restating the concept; (2) presenting a concept in various forms of mathematical representation; (3) developing necessary or sufficient conditions for a concept; (4) using and utilizing specific procedures and operations; and (5) applying the concept to problem-solving. Furthermore, regarding the reasons behind the selection of question design on the concept understanding description test, among others, the questions designed can test the understanding of mathematical concepts in depth, not just remembering facts or algorithms; questions have a level of difficulty that is by the level of understanding to be measured; each question is relevant to the purpose of measuring understanding of mathematical concepts and should not contradict each other; questions that are arranged can stimulate creative and analytical thinking of students and use language that is easily understood by students and does
not cause ambiguity. The questions on the descriptive test of understanding of concepts that have been prepared, instrument validated by mathematician validators then tested on several small samples to evaluate their clarity and ability to express their understanding, after being tested from the results of the trial, the questions were revised and finalized for use in the main research. The researcher also determined clear assessment criteria including conceptual accuracy, clarity in explanation, and ability to apply concepts in relevant contexts.

The data analysis in this research involves several stages, including preliminary analysis tests, correlation tests, and simple linear regression tests. The preliminary analysis includes tests for normality and linearity. Once the research data passes the preliminary analysis tests, the next step is the correlation test to determine correlation values and the coefficient of determination. Finally, the last stage involves conducting a simple linear regression test to obtain the simple regression equation.

RESULTS AND DISCUSSION

Results

Instrument Test

The instrument that has obtained approval and validation from expert validators can only be used in the pre-research phase. Pre-research data is collected from class XII MIPA 3, including a questionnaire on mathematical disposition variables and a test of conceptual understanding in an open-ended format. Subsequently, the researcher conducts instrument testing to assess its validity and reliability.

1. Validity Test

Validity testing is conducted using the Pearson product-moment correlation test on a sample of \( N = 35 \). The result of the validity test is calculated using the formula \( df = N - 2 = 35 - 2 = 33 \). Referring to the "\( R \)" distribution table at a significance level of 0.05, the obtained value from the table is 0.334. The instrument is considered valid if the calculated \( R_{\text{value}} \) is greater than \( R_{\text{table}} \). Out of 24 questions in the mathematical disposition questionnaire, 20 items are deemed valid. Additionally, all 7 questions in the conceptual understanding test are considered valid. Items that do not meet validity criteria are eliminated from the study (Pokorny et al., 2001). Thus, the number of items used for the study in the mathematical disposition variable is 20, while for the conceptual understanding variable, there are seven questions.

2. Reliability Test

Reliability testing is conducted to measure the degree of consistency of the instrument used in the study, using the Alpha Cronbach statistical test (Wadkar et al., 2016). The results of the reliability test are documented in Table 1.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Coefficient (( \alpha ))</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematical Disposition</td>
<td>0.83</td>
<td>Reliable</td>
</tr>
<tr>
<td>Mathematical Concept Comprehension</td>
<td>0.65</td>
<td>Reliable</td>
</tr>
</tbody>
</table>

The reliability test of both scales can be considered reliable because both scales have Cronbach’s alpha values approaching 1. This is in line with (Ghazali 2018), stating that an instrument is considered reliable if Cronbach’s alpha value is ≥ 0.60. Based on Table 1, it is known that Cronbach’s alpha value for the mathematical disposition variable scale is 0.83, and for the conceptual understanding variable scale, it is 0.65. According to (Gugiu & Gugiu 2018), the reliability standard is considered less satisfactory if it is below 0.60, whereas it is considered good if it is above 0.60. Therefore, the scales for the mathematical disposition and conceptual
understanding variables in this study are deemed good. This indicates that all variables are suitable for use in the research.

**Research Data Description**

Descriptive analysis aims to provide an overview of the mathematical disposition variable and the mathematical concept comprehension variable of students in class XII MIPA 2 and XII MIPA 4 at SMA Negeri 1 Sedayu. The descriptive analysis used includes the mean, median, mode, and standard deviation. The calculation results of the descriptive analysis can be seen in Table 2.

Table 2. Data Description

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Mathematical Disposition</th>
<th>Mathematical Concept Comprehension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest Value</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>Lowest Value</td>
<td>60</td>
<td>53</td>
</tr>
<tr>
<td>Mean</td>
<td>75.06</td>
<td>90.60</td>
</tr>
<tr>
<td>Median</td>
<td>74</td>
<td>95</td>
</tr>
<tr>
<td>Mode</td>
<td>73</td>
<td>95</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>7.82</td>
<td>9.59</td>
</tr>
</tbody>
</table>

Based on Table 2, it is known that the average score of mathematical disposition of 75.06 is higher than the median with a score of 74 and also the mode of 73 so it can be said that mathematical disposition is in the right-skewed or positively skewed category. This means that most students have high scores, but there are some students with very high scores that affect the average in a higher direction. Also, the mean score of understanding of mathematical concepts of 90.60 is lower than the median and the mode with a score of 95, so it can be said that understanding of mathematical concepts is in the left-skewed or negatively skewed category. That is, most students have high scores, but there are some students with very low scores that affect the average in a lower direction (Holt & Scariano, 2009). The determination of the level of mathematical disposition refers to the categories shown in Figure 1. Based on Figure 1, it can be seen that the average mathematical disposition is in the moderate category, accounting for 62%. Furthermore, the determination of categories for the conceptual understanding variable is presented in Figure 2. Based on Figure 2, it can be seen that the average for mathematical conceptual understanding is in the high category, which is 57%, and those in the low category are only 5%.

![Figure 1. Categories of Students' Mathematical Disposition](image-url)
Classical Assumption Test

The classical assumption test is a test that must be satisfied first before conducting the feasibility test of a regression model (Ningsih & Dukalang, 2019). The classical assumption tests used by the researcher include the following.

1. Normality Test

The purpose of the normality test is to assess whether the data used in the study exhibits a normal distribution or not (Mishra et al., 2019). It is important to perform normality tests because if the data is not normally distributed, the statistical tests used may become invalid, especially when the sample size is relatively small (Putry et al., 2020). The normality test employed in this study utilizes the one-sample Kolmogorov-Smirnov technique with unstandardized residual values (Savitri et al., 2021). The decision-making criterion utilized is that the sample distribution is considered normal if the significance value (Sig.) is > 0.05, and vice versa. A calculation summary of the Normality Test results using SPSS 20 software can be observed in Table 3.

<table>
<thead>
<tr>
<th>Unstandardized Residual</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
</tr>
<tr>
<td>Asymp. Sig. (2-tailed)</td>
</tr>
</tbody>
</table>

Based on Table 3, it is found that the Asymp. Sig. value is 0.384, which is greater than the significance level of 0.05. Therefore, it can be concluded that the residual variable data follows a normal distribution.

2. Linearity Test

The linearity test is used to determine whether there is a linear correlation in the data or not, between the independent variable (X) and the dependent variable (Y) in the data (Uyanik & Güler, 2013). A good correlation should exhibit a linear relationship between the independent variable (X) and the dependent variable (Y) (Leonardo et al., 2021). The basis for decision-making from the linearity test used by the researcher is that if the Deviation from Linearity Sig. value is > 0.05, there is a significant linear relationship between the independent and dependent variables, and vice versa. The results of the linearity test using SPSS 20 software can be seen in Table 4.
Based on the output above, the significance value of the deviation from linearity is 0.219. The significance value of 0.219 > 0.05, so it can be concluded that there is a significant linear relationship between the variable mathematical disposition ($X$) and the variable understanding of mathematical concepts ($Y$).

3. Heteroskedasticity test

The final classical assumption test is the heteroskedasticity test. The heteroskedasticity test is used to determine whether there is a difference in residual variances among observations in a regression model (Astivia & Zumbo, 2019). A good regression model is considered to have constant variance (homoskedasticity), while heteroskedasticity indicates inconsistent variance variation (Račkauskas & Zuokas, 2007). If the probability value (Sig.) > 0.05, it can be concluded that there is no heteroskedasticity (Ghozali, 2018). The heteroskedasticity test conducted by the researcher used the Glejser test, which involves regressing variable $X$ against its absolute residuals (Febrianto et al., 2018). The results of the Glejser Test can be seen in Table 5.

<table>
<thead>
<tr>
<th>Model</th>
<th>$t$</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.873</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>-2.166</td>
<td>0.034</td>
</tr>
</tbody>
</table>

4. Dependent Variable: ABS

Based on Table 5 above, the significance value (sig.) of the mathematical disposition variable is 0.034, where 0.034 < 0.05, indicating the presence of heteroskedasticity symptoms in the regression model. A good regression model is homoskedasticity or does not exhibit heteroskedasticity (Ghozali, 2018). If indications of heteroskedasticity are identified in the regression model, necessary actions should be implemented to guarantee a more precise interpretation of the regression equation (Kaufman, 2013). One method that can be used to address heteroskedasticity is by transforming the data (Kaufman, 2013). There are two commonly used data transformation methods: semi-log (transforming the dependent variable into natural logarithms) and double-log (transforming both the dependent and independent variables into natural logarithms). However, it's important to note that data transformation has the potential to affect the form of the regression model (Ghozali, 2018).

The researcher chose to perform a semi-log transformation by converting the understanding concept variable (dependent variable) into natural logarithms, resulting in the dependent variable becoming $LN_Y$. The following are the results of handling heteroskedasticity symptoms after applying the semi-log data transformation method.

<table>
<thead>
<tr>
<th>Model</th>
<th>$t$</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.486</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>-1.991</td>
<td>0.051</td>
</tr>
</tbody>
</table>

In Table 6, it is found that the significance value for the mathematical disposition variable has changed to 0.051, where 0.051 > 0.05. Therefore, the model proposed in the study no
longer exhibits heteroskedasticity, indicating that the data has passed the classical assumption tests.

**Hypothesis Test**

The data used in the simple linear regression analysis are the most recent data after successfully passing the heteroskedasticity test, namely using the dependent variable, which was originally "Y," now changed to "LN_Y," while the independent variable remains the same (since the heteroskedasticity test treatment used the semi-log data transformation method).

The hypothesis test used is a simple linear regression test. Simple linear regression is conducted to examine whether the independent variable can significantly influence the dependent variable, where both the independent and dependent variables tested are single. The hypothesis is as follows:

- **H₁**: There is an influence between the mathematical disposition variable (X) and the student's understanding of mathematical concepts variable (Y)
- **H₀**: There is no influence between the mathematical disposition variable (X) and the student's understanding of mathematical concepts variable (Y)

The analysis of simple linear regression in this study uses the SPSS application version 20. The results of this analysis are presented in Tables 7, 8, and 9.

### Table 7. Regression Output (ANOVA)

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>.282</td>
<td>1</td>
<td>28.751</td>
<td>.000b</td>
</tr>
<tr>
<td>1</td>
<td>.618</td>
<td>63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>.901</td>
<td>64</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Dependent Variable: LN_Y  
b. Predictors: (Constant), Mathematical Disposition

The significance test uses the F test with the formula \( df - n = 65 - 2 = 63 \). By referring to the "F" distribution table at a significance level of 0.05, the obtained value from the table is 3.99. Based on Table 7, \( F_{\text{calculated}} = 28.751 > F_{\text{table}} = 3.99 \). Meanwhile, the significance level is 0.000 < 0.05. Thus, \( H₀ \) is rejected, and \( H₁ \) is accepted, meaning there is an influence between mathematical disposition (X) and students' understanding of mathematical concepts (Y). The subsequent regression analysis is the data coefficients regression test. The results of the data coefficients regression test are presented in Table 8.

### Table 8. Regression Test (Coefficients)

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>3.863</td>
<td>32.340</td>
<td>.000</td>
</tr>
<tr>
<td>Mathematical Disposition</td>
<td>.008</td>
<td>5.362</td>
<td>.000</td>
</tr>
</tbody>
</table>

a. Dependent Variable: LN_Y

From Table 8, the results of the simple linear regression test yield a regression equation model between mathematical disposition and understanding of mathematical concepts. The equation is

\[ Y = 3.863 + 0.008X \]  \hspace{1cm} (1)

Where \( Y \) is the mathematical disposition variable, and \( X \) is the understanding mathematical concepts variable. The value of \( a \) (unstandardized coefficients) in this regression equation is 3.863. In this context, if there is no mathematical disposition (X), the consistent value of understanding mathematical concepts (Y) is 3.863. The value of \( b \) in the regression equation is 0.008. This value indicates that for each increase of 1 in the mathematical disposition score (X), the understanding of mathematical concepts (Y) increases by 0.008. The subsequent regression analysis result is the model summary, presented in Table 9.
The model summary regression test table indicates an R-value of 0.522, where the $R - value = 0.560 > 0.05$, indicating a strong relationship between mathematical disposition and the understanding of concepts. The coefficient of determination (R Square) is 0.313, meaning that the effective influence of mathematical disposition on the understanding of mathematical concepts is 31.3%, while 68.7% is influenced by other factors not examined by the researcher. The accuracy level of the regression prediction in this study is 0.09908. This can be observed from the value of the std. error of the estimate, which is 0.09908 in Table 9.

### Discussion

Based on the presentation of the research results above, shows that there is a proven significant positive influence between mathematical disposition and students’ ability to understand mathematical concepts, particularly in statistics. This is evidenced by the results obtained from the $F_{test}$, where the calculated $F_{value} = 28.751$ is greater than the tabulated $F$ value = 3.99, thus accepting the alternative hypothesis ($H_1$). Furthermore, from the analysis using simple regression, the coefficient value ($Y$) is obtained as 0.008, and the constant is 3.863, so the regression equation is $Y = 3.683 + 0.008X$. This equation means that if mathematical disposition increases by 1 unit, the understanding of students' mathematical concepts will increase by 0.008. This implies that students with high mathematical dispositions tend to have a better understanding of mathematical concepts, and vice versa.

In the context of mathematics learning in high schools, mathematical disposition, which encompasses attitudes of self-confidence, communication skills, a tendency to inquire, enthusiasm, perseverance, collaborative abilities, determination, liking, self-reflection, and the ability to apply and appreciate the role of mathematics, plays a crucial role in enhancing students’ understanding of mathematical concepts. Students with high mathematical dispositions, characterized by a confident approach to solving mathematical problems, are inclined to feel more capable and assured when tackling complex mathematical tasks (Yustiana et al, 2021). The ability to provide logical reasoning in communicating mathematical ideas also aids students in articulating their thoughts clearly, reinforcing conceptual understanding, and supporting the learning process (Nokes & Ross, 2007). Moreover, students’ habit of asking questions frequently in mathematical learning demonstrates curiosity and a willingness to delve deeper (Umah et al., 2023). High enthusiasm in seeking mathematical answers and exploring mathematical ideas can motivate students to actively engage in the learning process (Doño & Mangila, 2021). The ability to persistently attempt various alternative solutions to solve mathematical problems contributes to building students' problem-solving skills (Nguyen et al., 2020). Collaborative learning in mathematics also creates a collaborative environment that supports the exchange of ideas and understanding among students. Overall, fostering a positive mathematical disposition in students is essential for creating an environment that encourages active participation, inquiry, and effective problem-solving, ultimately contributing to a deeper understanding of mathematical concepts.

Students with a positive mathematical disposition, such as perseverance in learning mathematics, enjoyment of mathematics, and the ability to reflect on their learning, are more motivated to continuously improve their understanding of mathematical concepts (Woodward et al., 2018). This also enables them to relate mathematical concepts to everyday situations, enriching their understanding of the relevance of mathematics (Graumann, 2011). With a foundation of high mathematical disposition, students are likely to be more open to flexible thinking and exploration of various alternative ways to solve mathematical problems. As a result, students with a high level of mathematical disposition can achieve a better
understanding of mathematical concepts compared to those with a low mathematical disposition (Yustiana et al., 2021). Therefore, paying attention to and developing students' mathematical disposition is a crucial aspect in efforts to enhance the effectiveness of mathematics learning in high schools.

The potential factors that can mediate or moderate the influence of mathematical disposition on students' understanding of mathematical concepts include: (1) Intrinsic Motivation: Motivation that originates from students' internal drive to learn because of their interest and personal satisfaction may function as an intermediary in connecting mathematical disposition to the comprehension of mathematical concepts (Lüftenegger et al., 2015). Students with a positive mathematical disposition are more likely to be intrinsically motivated to understand mathematical concepts deeply. Furthermore, the extent of intrinsic motivation will serve as a moderating factor in the connection between mathematical disposition and the comprehension of concepts. Students possessing a strong mathematical disposition might discover it more effortless to sustain intrinsic motivation when confronted with mathematical challenges (Fadillah & Wahyudin, 2022). (2) Metacognitive Abilities: Metacognitive abilities, include being conscious of thought processes and grasping learning strategies (Popandopulo, 2021). (3) Prior Mathematical Skills: The proficiency level of students' previous mathematical skills can function as a moderating element since those with advanced initial skills might be more adept at leveraging their mathematical disposition to enhance their grasp of mathematical concepts (Xhomara, 2020). (4) Self-Efficacy: Students' confidence in their ability to understand mathematics (self-efficacy) can moderate the relationship. Students with confidence are prone to initiating efforts to delve into a more profound comprehension of mathematical concepts, persisting in the presence of challenges, and using the learning environment to enrich their understanding of mathematical concepts (Maifi et al., 2021). (5) Critical Thinking Skills: Critical thinking skills can mediate or moderate the impact of mathematical disposition on conceptual understanding. Students possessing critical thinking abilities demonstrate an enhanced capacity to connect mathematical concepts with real-world situations (Ismail et al., 2018). (6) Learning Environment Support: Support from the learning environment, whether from family or school, can moderate the relationship between mathematical disposition and conceptual understanding. This support encompasses educational resources, guidance from teachers, and family encouragement (Yu & Singh, 2018). These factors play important roles in influencing how mathematical disposition translates into students' understanding of mathematical concepts. Understanding the interplay between these factors can help educators tailor teaching strategies to optimize students' mathematical learning experiences.

Furthermore, regarding the form of contribution given by aspects in mathematical disposition to students' concept understanding, including: (1) Self-confidence: Students who are confident in their mathematical abilities tend to allow them to tackle complex math tasks without hesitation, contributing to a deeper understanding of concepts. Their confidence in their abilities shapes a positive attitude toward mathematical challenges (Maifi et al., 2021). (2) Curiosity: Strong curiosity encourages students to explore math concepts more extensively. Curious students are more likely to ask questions, seek additional information, and engage in active learning. This curiosity-driven exploration improves concept understanding as they go deeper into the subject matter (Sengupta-Irving & Enyedy, 2015). (3) Perseverance: Perseverance is essential in overcoming mathematical hurdles and challenges. Students with the disposition to remain persistent demonstrate determination and resilience in the face of adversity (Hutauruk & Priatna, 2017). This resilience contributes to a deeper understanding of math concepts as they continue to work through problems, fostering a passion for learning. (4) Interest in Asking Questions: The habit of asking questions frequently reflects a genuine interest in understanding mathematical concepts thoroughly. Students who frequently question mathematical principles demonstrate a desire to dive deeper into the topic (Lehrer et al., 2013). (5) Enthusiasm: High enthusiasm for mathematical exploration and problem-solving encourages students to actively participate in the learning process (da Ponte et al., 2014).
Enthusiastic students are more likely to explore alternative methods and approaches, forming a flexible mindset. (6) Collaboration Skills: The ability to work together in mathematics learning enhances students' understanding of concepts. Collaboration skills enable the exchange of ideas, diverse views, and shared problem-solving strategies (Harper & Crespo, 2020). Engaging in a collaborative learning environment contributes to a broader understanding of concepts as students learn from each other. (7) Interest: A genuine interest in mathematics generates intrinsic motivation to explore the subject further. Students who are highly interested in mathematics are more likely to invest time and effort in understanding concepts (Sengupta-Irving & Enyedy, 2015). (8) Self-Reflection: The ability to reflect on the learning process allows students to identify strengths, weaknesses, and areas of improvement. Students who can self-reflect can adjust their learning strategies, resulting in a better understanding of mathematical concepts (Lee, 2021). (9) Application and Appreciation of Mathematics: The ability to apply mathematical principles to real-world situations and appreciate the role of mathematics in everyday life contributes to a practical and meaningful understanding of concepts. Students who realize the relevance of mathematics are more likely to relate abstract concepts to real-life experiences (Gijsbers et al., 2020). Overall, each aspect of mathematical disposition plays a distinctive role in shaping students' concept understanding, bringing a positive and holistic approach to mathematics learning. The combination of confidence, curiosity, perseverance, curiosity, enthusiasm, collaboration skills, perseverance, interest, self-reflection, and application and appreciation of mathematics contribute synergistically to a deeper and more meaningful understanding of mathematical concepts.

In this study, the contribution of mathematical disposition to the ability to understand mathematical concepts was 31.3%, while the remaining 68.7% was influenced by other factors not examined by the researcher. The amount of contribution produced in this study tends to be more significant than the results of previous research conducted by (Febriayani et al. 2022) where in their research the contribution made by mathematical disposition to understanding mathematical concepts was only 4%, which means that mathematical disposition has an insignificant effect. The similarity between this research and previous research is that both explore the relationship between mathematical disposition and understanding of mathematical concepts. Although there is a difference in the size of the resulting contribution, both consistently show that mathematical disposition plays an important role in influencing students' understanding of mathematical concepts. The difference in contribution size may be due to variations in methodology, sample population, or other research factors. However, both generally support the idea that mathematical disposition influences students' understanding of mathematical concepts, although the level of impact may vary.

Citing research by (Kholiday et al. 2021), which emphasizes the importance of mathematical dispositions to students' understanding of mathematical concepts, this initiative will help prepare students to succeed in solving mathematical problems by understanding the underlying concepts well. In the long run, this could improve educational outcomes and student success in different areas of life. Here are some potential impacts of implementing these recommendations: (1) Paying attention to and developing students' mathematical dispositions, whether through learning that strengthens aspects such as confidence, perseverance, and curiosity, can improve their ability to understand mathematical concepts (Graven, 2012). This can result in improved academic performance in mathematics exams, assignments, and projects. (2) A focus on developing mathematical dispositions can also create a positive learning environment in the classroom. When students feel confident, enthusiastic, and excited about learning mathematics, this can affect the overall classroom atmosphere (Woodward et al., 2018). A positive environment can increase motivation to learn, improve student engagement, and create an atmosphere that supports academic and personal growth. (3) By strengthening students' mathematical dispositions, this initiative can contribute to long-term educational outcomes. Students who have strong mathematical dispositions tend to have a more solid foundation in the understanding of mathematical concepts (Fadillah & Wahyudin, 2022). This
can not only help them in achieving academic success today, but also equip them with the necessary skills and attitudes to face future challenges, both in academic and professional contexts.

In education, educators have a major role in utilizing students' mathematical dispositions to improve conceptual understanding (Mukuka et al., 2023). The following are some recommendations and concrete strategies that can be implemented by teachers in the classroom, namely creating learning activities that can encourage students to be more confident in solving mathematical problems, which can encourage students' curiosity by providing space for open questions and discussions by providing mathematical problems that can stimulate their curiosity to explore mathematical concepts in depth, building a classroom environment that allows students to exchange ideas or views with other students, providing mathematical tasks related to contextual problems (Sussman et al., 2019). According to (Reinke, 2019), mathematical problems presented with contextual problems can motivate students to develop a deeper understanding of concepts. In addition, educators can also facilitate reflection activities by asking students questions such as "What have you learned?" or "How can you approach this problem differently?" because it can help students develop metacognitive skills and strengthen their conceptual understanding, utilize technology such as interactive mathematics software that can make learning more interesting and help students develop concept understanding with a visual and interactive approach, and provide positive reinforcement for any progress made by students in the form of praise, recognition, or awards. Positive reinforcement can motivate students to continue developing positive mathematical dispositions.

CONCLUSION

The results of the data analysis and discussion from the study conducted on twelfth-grade science students at SMA Negeri 1 Sedayu, Bantul, Yogyakarta, indicate a significant positive influence of mathematical disposition on the understanding of mathematical concepts. Therefore, it is hoped that schools in the future can implement policies and provide adequate facilities for teachers to use appropriate teaching concepts to enhance students' mathematical disposition and understanding of mathematical concepts. For teachers, it is essential to pay more attention to approaches to students to foster interactions that encourage the creation of effective and efficient learning processes, which can consistently strengthen students' mathematical disposition. For students, it is crucial to gradually develop their mathematical disposition and get accustomed to solving story problems to enhance their understanding of mathematical concepts. Furthermore, the researcher hopes that further research can be conducted in more depth by exploring additional factors that influence students' mathematical disposition. One suggestion for the development of this research is to investigate the role of the learning environment, both in terms of family and school, in shaping students' mathematical disposition. In addition, research can look at how previous learning experiences and social interactions in the school environment can influence students' attitudes and perceptions toward mathematics. Research can also consider psychological factors, such as motivation, self-confidence, and self-perception, which can moderate or mediate the relationship between mathematical disposition and understanding of mathematical concepts. By involving these additional variables, it is hoped that research will be more comprehensive in understanding the complexity of mathematical disposition and its impact on students' mathematics learning at the secondary school level. It is also expected to provide students and teachers with deeper insights into the importance of mathematical disposition in strengthening mathematical concept understanding and improving their learning achievement.

ACKNOWLEDGMENTS

On this occasion, the author would like to express gratitude to those who have consistently provided support and prayers, which have been instrumental in the successful progress of this
research. Thanks are also extended to the school principal and mathematics teachers who granted permission for data collection and research activities at SMA Negeri 1 Sedayu, as well as to the twelfth-grade science students who served as research subjects. Thank you for your participation and enthusiasm throughout this process. The author hopes that this article can be beneficial to all readers.

DECLARATIONS

Author Contribution: HA: Conceptualization, Writing - Original Draft, Editing; Methodology, and Visualization; NK: Writing - Review & Editing, Formal analysis, and Validation and Supervision.

Funding Statement: -

Conflict of Interest: The authors declare no conflict of interest.

Additional Information: Additional information is available for this paper.

REFERENCES


Diana, P., Marethi, I., & Pamungkas, A. S. (2020). Kemampuan pemahaman konsep matematis siswa: ditinjau dari kategori kecemasan matematik [Students' mathematical conceptual
understanding ability: viewed from the category of mathematical anxiety]. *SJME (Supremum Journal of Mathematics Education)*, 4(1), 24–32. https://doi.org/10.35706/sjme.v4i1.2033


