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# Exploring the Influence of Learning Difficulties and Self-Directed Learning on Problem-Solving Ability in Elementary School Students: The Mediating Impact of Mathematical Disposition

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**Abstract.** Mathematical disposition can help students overcome difficulties in learning mathematics more effectively. With the mediation of mathematical disposition, the positive influence of self-directed learning can more easily lead to increased students' problem-solving abilities. This research aims to explore the role of mathematical disposition as a mediator in influencing learning difficulties and self-directed learning on problem-solving abilities. The survey method was used to collect data based on probability sampling from 32 students from class 5 at MI Ma'arif Patihan Wetan. Data collection was carried out using a questionnaire consisting of a Likert scale with 4 alternative answers. PLS-SEM analysis was used to analyze data and test and evaluate the construction of variables measuring problem-solving abilities. The results of the analysis show that problem-solving abilities are not significantly influenced by learning difficulties ($\beta$=0.000; $\rho$=0.998) and self-directed learning ($\beta$=0.000; $\rho$=0.061). In addition, mathematical disposition was proven to mediate the influence of learning difficulties ($\beta$=0.443; $\rho$=0.000) and self-directed learning ($\beta$=0.214; $\rho$=0.286) on problem-solving abilities. These findings highlight the importance of mathematical disposition in facilitating problem-solving abilities through learning difficulties and self-directed learning. The practical implication of this research is the need for a holistic approach in developing a positive attitude towards mathematics as an integral part of the learning approach. This research supports efforts to provide a learning environment that supports, motivates, and encourages students to develop positive mathematical dispositions. As well as emphasizing the development of metacognitive skills and utilizing learning technology to facilitate interaction and collaboration between students in exploring mathematical concepts.
**Keywords:** learning difficulties; mathematical disposition; PLS-SEM; problem-solving ability; self-directed learning.

## INTRODUCTION

Mathematics is one of the subjects taught at every level of education from elementary school to college (Sholihah et al., 2023; Sulistyani et al., 2021). Mathematics lessons, especially in elementary schools, are taught to provide students with initial concepts for studying Mathematics at a higher level because Mathematics is a continuous subject. Mathematics is a scientific subject that has learning objectives. The expected objectives of the National Council of Teachers of Mathematics (NCTM) mathematics learning are: (1) problem-solving abilities; (2) debating ability; (3) communication skills; (4) the ability to make connections; and (5) the ability to express (Safitri et al., 2024; Shanta & Wells, 2022).

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Mathematical problem-solving is an important mathematical skill that needs to be mastered by students studying mathematics (Gunawan & Yuspriati, 2024; Nurlina et al., 2024). Mathematical problem-solving skills are crucial for students, not only to make it easier for students to learn mathematics but also useful in other learning and everyday life. Apart from that, problem-solving ability is also important because it proves students' ability to understand a problem, choose methods, and model strategies to solve problems. Poor problem-solving abilities may be one of the causes of not achieving the expected learning outcomes (Ariani et al., 2022; Tiara et al., 2024)

There is a lot of research related to students' difficulties in solving mathematical problems. The findings regarding students' difficulties in solving problems include multiple interpretations of the questions given (Mustafa et al., 2022). Students lack knowledge and understanding when carrying out arithmetic operations, students who have low ability will carry out arithmetic operations randomly without knowing the correct procedures. The biggest obstacle in problem-solving is a lack of reading, computing, and math skills. When students do not understand the text implicitly, they have difficulty starting the thinking process in solving problems. They know minimal keywords. Students are less interested in mathematics questions because the questions are long and complex (Ardi et al., 2019; Sholihah et al., 2023).

Factors that influence low problem-solving abilities are the learning difficulties faced by students (Sulistyani et al., 2021; Suratman, 2023). Learning difficulties are situations where students cannot learn well and correctly due to interference from internal and external factors. These factors prevent students from developing according to their abilities. Internal factors are factors that exist within students, such as interest, motivation, enthusiasm for learning, and so on. Meanwhile, external factors refer to factors outside the student, such as lack of parental support, lack of learning facilities, and the impact of the community environment (Ding et al., 2021; Thompson & Harel, 2021).

Based on a study (Mustafa et al., 2022), shows that learning difficulties affect students' ability to achieve their learning outcomes. Some students consider mathematics as a difficult subject and are most avoided so that their learning outcomes are low. Students' lack of understanding of multiplication, and material concepts, and frequent forgetting are factors that cause low mathematics scores (Ding et al., 2021; Purnawan, 2022). Difficulties faced by students should be detected early. Difficulty learning mathematics will begin to appear when students are in elementary school. If this is left as it is, it will have worse consequences for students.

Another factor that influences problem-solving abilities is self-directed learning. Learning independence is described as a person's active participation in the learning environment, effective organization, training and application of one's abilities, and having positive motivational beliefs about one's learning abilities (Athikah et al., 2023; Gumilang et al., 2022). Learning independence can be interpreted as a student's attitude which is characterized by: (1) initiative in learning; (2) diagnosing learning needs; (3) determining learning objectives; (4) monitoring, managing, and controlling performance or learning; (5) Treat difficulties as challenges; (6) Select and use relevant learning resources; (7) Determining and implementing learning strategies; (8) Evaluate learning processes and outcomes, as well as self-concept (Amidi et al., 2021; Pokhrel et

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al., 2024). A student is said to be an independent learner if he or she can complete the learning process without depending on teachers, friends, etc.

To improve problem-solving abilities, students must have a mathematical disposition which is the main factor in determining a student's success in learning mathematics (Darwani et al., 2023; Mawardin et al., 2023). Mathematical disposition is a tendency towards a particular field of science showing (1) self-confidence in utilizing relevant fields of knowledge to solve problems, convey reasons, and communicate views. (2) flexibility in examining ideas and trying to find options for solving problems, (3) persistence in carrying out tasks, (4) interest, curiosity, and reasoning in carrying out one's tasks, (5) evaluating the application of related fields of study about other situations and everyday experiences, and (6) appreciate the position of relevant fields of study in culture and values. If students enjoy math class with a positive attitude, their problem-solving abilities will improve greatly. Research conducted by (Saputra, 2022) stated that low mathematical disposition causes low mathematics learning outcomes. Therefore, students need to increase their positive attitude. If students have a highly positive attitude, it can improve their problem-solving abilities better.

Mathematical disposition mediation can play an important role in understanding how learning difficulties and independent learning influence elementary school students' mathematical problem-solving abilities. By understanding these factors, educators can design appropriate interventions to help students overcome barriers to mathematics learning. Through this research, we can identify ways to support the success of students who may face learning difficulties in mathematics. This can help create an inclusive learning environment where every student has an equal opportunity to achieve academic success. Research on the mediation of mathematical dispositions in the context of mathematics learning in elementary school can provide valuable contributions at both theoretical and practical levels. The findings from this research can help enrich our understanding of the mathematics learning process and provide insights for educators to improve their instructional practices.

Regarding the continuity between the concept and the results of previous research, we formulate the following hypothesis:
H-DIR1&4: learning difficulties have a significant effect on overcoming problem-solving abilities and mathematical disposition
H-DIR2&4: self-directed learning has the effect of improving problem-solving abilities and mathematical disposition
H-DIR5: mathematical disposition has the effect of increasing problem-solving abilities
H-IND1&2: mathematical disposition mediates in overcoming learning difficulties and improving self-directed learning on problem-solving abilities

## METHODS

### Research Design and Participant

This research applies a quantitative approach with survey research methods (Apriliani et al., 2023; Putra et al., 2022; Widayanto et al., 2021). This research design uses an explanatory and correlational approach using Partial Least Squares Structural Equation Modelling (PLS-SEM) which is an approach used to explore the relationship between variables in a conceptual model. PLS-SEM is a multivariate statistical method

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used to analyze the relationship between latent or measured variables in a structural model. By using this approach, this research combines explanatory and correlational elements to better understand the complexity of the relationships between variables in a conceptual model. PLS-SEM allows researchers to test models holistically, including identifying cause-and-effect relationships and correlation relationships between variables, thereby providing a deeper understanding of the observed phenomenon. Participants in this research were 32 grade 5 students at MI Ma'arif Patihan Wetan, Ponorogo, East Java, Indonesia.

**Measures**

The data collection technique used in this research is a four-variable questionnaire. Research design with an explanatory and correlational approach to determine the relationship between independent variables (Learning Difficulties and Self-Directed Learning), mediation (Mathematical Disposition), and dependent variables (Problem-Solving Ability). This research uses a Likert scale consisting of 4 alternative answers from strongly agree to strongly disagree (Daryono et al., 2020; Widyastuti et al., 2023). Research instrument variables are shown in Table 1.

**Table 1. Research Instrument Variables**

| No | Variable | Indicator | Construct | Referensces |
|---|---|---|---|---|
| 1 | Learning Difficulties (X1) | Concept understanding | LD1 | (Ardi et al., 2019; Mustafa et al., 2022; Sulistyani et al., 2021; Suratman, 2023; Thompson & Harel, 2021) |
| 2 | | | LD 2 | |
| 3 | | Counting | LD 3 | |
| 4 | | | LD 4 | |
| 5 | | Mathematical roperations | LD 5 | |
| 6 | | | LD 6 | |
| 7 | Self-Directed Learning (X2) | Motivation | SDL1 | (Amaliyah et al., 2021; Bishara, 2021; Gumilang et al., 2022; Hershcovits et al., 2020; Muhammad et al., 2021) |
| 8 | | Ability to organize study time | SDL2 | |
| 9 | | | SDL3 | |
| 10 | | Ability to search for information or learning resources | SDL4 | |
| 11 | | | SDL5 | |
| 12 | | Learning strategies | SDL6 | |
| 13 | | | SDL7 | |
| 14 | Problem-Solving Ability (Y) | Understanding the problem | PSA1 | (Ariani et al., 2022; Dagdag et al., 2021; Gunawan & Yuspriati, 2024; Katuuk et al., 2024; Nurlina et al., 2024; Shanta & Wells, 2022) |
| 15 | | | PSA 2 | |
| 16 | | Problem-solving strategies | PSA 3 | |
| 17 | | | PSA 4 | |
| 18 | | | PSA 5 | |
| 19 | | Problem-solving | PSA 6 | |
| 20 | | | PSA 7 | |
| 21 | | | PSA 8 | |
| 22 | Mathematical Disposition (Z) | Interest | MD1 | (Darwani et al., 2023; Hidayanthi et al., 2022; Mawardin et al., 2023; Saputra, 2022; Ulya & Rahayu, 2021) |
| 23 | | | MD 2 | |
| 24 | | perseverance | MD3 | |
| 25 | | Curiosity | MD 4 | |
| 26 | | Confident | MD 5 | |
| 27 | | Appreciation for mathematics | MD 6 | |

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### Data Analysis

Statistical analysis of this research uses the PLS-SEM measurement technique. The outer model testing stage is a measurement model testing stage that aims to prove the validity and estimate the reliability of indicators and constructs. Several requirements that must be met are the indicator loading factor (λ >0.70), and the reflective construct AVE (>0.50) (Apriliani et al., 2023; Daryono et al., 2024; Fauzan et al., 2023; Supriyanto et al., 2022). Reliability estimates use cronbach Alpha, Rho_A, and CR values (>0.70). The inner model testing stage is to test the significance of the direct (H-DIR$_{1-5}$) and indirect effects (the mediating role of H-IND$_{1-2}$).

## RESULT AND DISCUSSION

### Evaluation of Measurement Models

Evaluation of measurement models is very important to ensure that the indicators used to measure latent constructs or variables are by the research objectives and have good quality. Examining construct validity is the primary goal of measuring model evaluation. Analyzing the relationship between the indicator and the measured construct can ensure that the indicator truly reflects the intended aspect of the construct. By analyzing factor loadings, reliability, and discriminant validity, researchers can decide which indicators should be included in the analysis and which should be omitted.

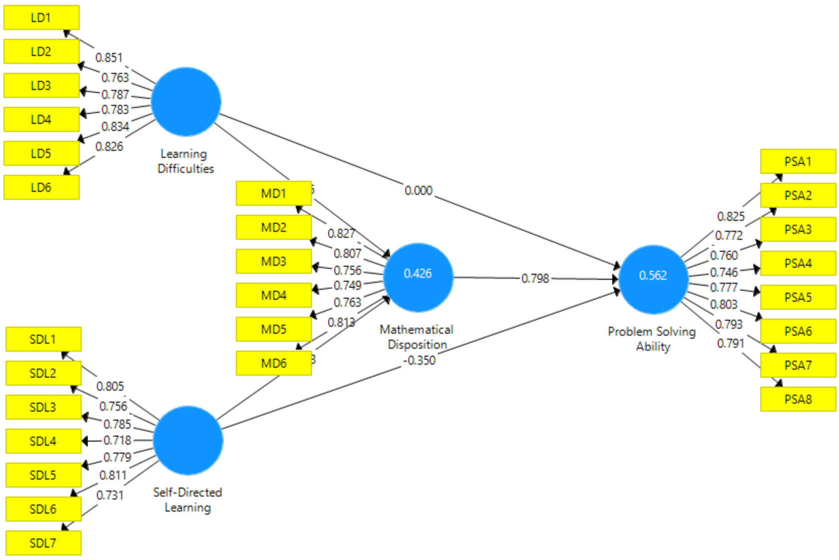


**Figure 1. Evaluation of the Measurement Model**

Convergent validity in PLS-SEM indicates how well the indicators or manifestation variables used to measure the construct correspond to the actual construct. The higher the convergent validity, the better the measurement quality of the construct. Researchers can test the consistency between indicators used to measure the same construct by measuring convergent validity. Convergent validity helps ensure that the interpretation of PLS-SEM analysis results truly reflects the construct you want to measure. This is important to ensure the accuracy and reliability of research findings. Table 1 below shows the results of convergent validity, reliability, and AVE testing on the PLS algorithm output.

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**Table 2. Outer Model: Convergent Validity and Reliability**

| No | Variable | Indicator | Conver Validity | | Consistency Reliability | | |
|---|---|---|---|---|---|---|---|
| | | | FL (≥0.70) | AVE (≥0.50) | CA (≥0.70) | rho_A (≥0.70) | CR (≥0.70) |
| 1 | Learning Difficulties (X1) | LD1 | 0.851 | 0.653 | 0.896 | 0.926 | 0.918 |
| 2 | | LD2 | 0.763 | | | | |
| 3 | | LD3 | 0.787 | | | | |
| 4 | | LD4 | 0.783 | | | | |
| 5 | | LD5 | 0.834 | | | | |
| 6 | | LD6 | 0.826 | | | | |
| 7 | Self Directed Learning (X2) | SDL1 | 0.805 | 0.593 | 0.888 | 0.915 | 0.910 |
| 8 | | SDL2 | 0.756 | | | | |
| 9 | | SDL3 | 0.785 | | | | |
| 10 | | SDL4 | 0.718 | | | | |
| 11 | | SDL5 | 0.779 | | | | |
| 12 | | SDL6 | 0.811 | | | | |
| 13 | | SDL7 | 0.731 | | | | |
| 14 | Problem-Solving Ability (Y) | PSA1 | 0.825 | 0.614 | 0.910 | 0.915 | 0.927 |
| 15 | | PSA2 | 0.772 | | | | |
| 16 | | PSA3 | 0.760 | | | | |
| 17 | | PSA4 | 0.746 | | | | |
| 18 | | PSA5 | 0.777 | | | | |
| 19 | | PSA6 | 0.803 | | | | |
| 20 | | PSA7 | 0.793 | | | | |
| 21 | | PSA8 | 0.791 | | | | |
| 22 | Mathematical Disposition (Z) | MD1 | 0.827 | 0.619 | 0.877 | 0.885 | 0.907 |
| 23 | | MD2 | 0.807 | | | | |
| 24 | | MD3 | 0.756 | | | | |
| 25 | | MD4 | 0.749 | | | | |
| 26 | | MD5 | 0.763 | | | | |
| 27 | | MD6 | 0.813 | | | | |

Based on Table 2 below, the overall Loading Factor value for each sub-variable is ≥0.70 (0.718 to 0.851). The average average extracted variance (AVE) value for each variable has a value of ≥0.50 (0.593 to 0.653). So it can be concluded that each sub-variable and variable in the instrument has met the requirements for convergent validity. Based on the factor loading coefficient value, the most dominant statement item measuring the success of problem-solving abilities in grade 5 students is the concept understanding construct of 0.851 (LD1). This can be interpreted that the concept understanding construct can measure students' problem-solving abilities by 85.10%. Meanwhile, the weakest item is the construct of the ability to search for information or learning resources at 0.718 (SDL4 or 71.80%). A variable is declared reliable if it has CA, Rho_A, and CR values ≥0.70. The SmartPLS output in Table 2 shows that all variables have CA values (0.877 to 0.910), rho_A (0.885 to 0.926), and CR (0.907 to 0.927). It can be concluded that the internal consistency of the instrument's reliability in 3 aspects has a

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value of ≥0.70 so it has good reliability in measuring problem-solving abilities.

The Fornell-Larcker test, employed within PLS-SEM, assesses the discriminant validity of constructs within a model by gauging their ability to be distinctly identified from one another. This evaluation entails comparing how much variance each construct explains relative to the others. If a construct's variance explanation surpasses that of another construct, it signifies strong discriminant validity for the former. Based on Table 3, the correlation value for the Learning Difficulties variable (X1) → Learning Difficulties has a value of 0.808 which is higher than the correlation value of Mathematical Disposition with other variables (0.596; 0.422; 0.155) as well as for assessing the correlation of other variables.

**Table 3. Discriminant Validity: The Fornell Larcker**

| Variable | X1 | Z | Y | X2 |
|---|---|---|---|---|
| Learning Difficulties | **0.808** | | | |
| Mathematical Disposition | 0.596 | **0.787** | | |
| Problem-Solving Ability | 0.422 | 0.674 | **0.784** | |
| Self Directed Learning | 0.155 | 0.354 | -0.067 | **0.770** |

One of the main purposes of HTMT testing is to measure discriminant validity in the model. HTMT is used to examine the extent to which the constructs measured by different indicators represent the same or different constructs in the model. HTMT is also useful for assessing multicollinearity between constructs in the model. Multicollinearity can occur when constructs are strongly related to each other, which can cause problems in the estimation and interpretation of results in SEM analysis. Based on Table 4 from the analysis, the overall value of the HTMT matrix is <0.90 (0.217 to 0.739). So, it can be concluded that Fornell-Larcker and HTMT correlate with all variables in this research data instrument that meets the discriminant validity test in measuring problem-solving abilities.

**Table 4. Discriminant Validity: The HTMT**

| Variable | X1 | Z | Y | X2 |
|---|---|---|---|---|
| Learning Difficulties | | | | |
| Mathematical Disposition | 0.625 | | | |
| Problem-Solving Ability | 0.432 | 0.739 | | |
| Self Directed Learning | 0.217 | 0.377 | 0.264 | |

## Evaluation of Structural Models

Structural evaluation in testing on PLS-SEM has the main objective, namely assessing the accuracy of the predictions of the proposed model. This is done by evaluating the extent to which the model can explain variations in empirical data and predict endogenous variables well. Overall, structural evaluation aims to increase understanding of the phenomenon under study in the research context. By analyzing the relationships between variables, researchers can identify the factors that contribute to the phenomenon and develop deeper insight into the dynamics involved.

$R^2$ (coefficient of determination) provides an idea of how well the PLS-SEM model explains the variation in observed endogenous variables (constructs). $R^2$ allows comparison between different PLS-SEM models. Researchers can use $R^2$ values to compare the effectiveness of different models in explaining variations in observed

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constructs. Based on Table 5, the $R^2$ coefficient on the problem-solving ability variable obtained a value of 0.562, meaning that the variables of learning difficulties, independent learning, and mathematical disposition influence the problem-solving ability variable by 56.20% and the remaining 43.80% is influenced by other variables outside the research model.

$f^2$ (effect size) is one of the measures in PLS-SEM to evaluate the strength of the influence of latent variables on the observed construct. Specifically, $f^2$ measures the predictive power of a latent variable on a particular construct in the model. More specifically, $f^2$ is calculated by dividing the square of the latent variable regression loading on a particular construct by the amount of residual error (error variance) of that construct. The results provide an idea of how much the latent variables contribute to explaining the observed construct variations. $f^2$ helps in determining how significantly the latent variable contributes to the observed construct. $f^2$ allows comparison between the contributions of several latent variables to the same construct. so that it can be known and determined which latent variables have the strongest influence on the observed construct. So, the output effect size shows that the most dominant variable influencing problem-solving ability is mathematical disposition ($f^2$ = 0.834).

**Table 5. Measurement of Structural Model**

| **Variable** | **$R^2$** | | **$f^2$** | |
|---|---|---|---|---|
| | **Value** | **Dicision** | **Value** | **Decision** |
| Problem-Solving Ability | 0.562 | Moderat | - | - |
| Self-Directed Learning | - | - | 0.243 | Medium |
| Learning Difficulties | - | - | 0.000 | Small |
| Mathematical Disposition | 0.426 | Moderat | 0.834 | Large |

**Measurement of Direct Effects**

Direct effect testing is an important part of the analysis to understand the direct relationship between the independent and dependent variables in the model. Bootstrapping is a commonly used method to calculate standard estimates and confidence intervals for model parameters in PLS-SEM. The normalized path coefficient describes the strength and direction of the relationship between the independent and dependent variables in the model. A larger coefficient indicates a greater influence of the independent variable on the dependent variable.

The original sample value ($\beta$-$_{values}$) shows how much influence the independent variable has on the dependent variable. The positive or negative sign of the path coefficient indicates the direction of the relationship between the independent and dependent variables. The T-$_{statistic}$ value is used to test the statistical significance of the direct effect. This statistical test allows us to determine whether the direct effect is significant. The $\rho$-$_{value}$ is a measure that determines the statistical significance of the direct effect. A low p-value (<0.05) indicates that the effect is statistically significant.

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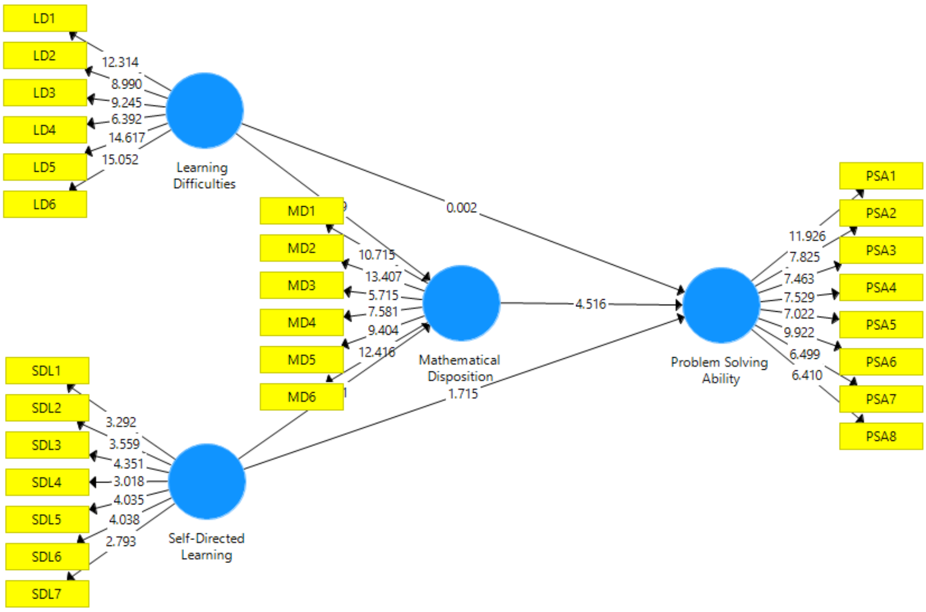


**Figure 2. Evaluation of Path Analysis**

Based on Table 6, the H-DIR1 hypothesis (learning difficulties (X1) → problem-solving ability (Y) obtains ß-values = 0.000, T-statistics = 0.002 (≤1.96), and ρ-values = 0.998 (>0.05). This shows that the learning difficulty variable has a positive and insignificant effect on overcoming problem-solving abilities. When the learning difficulty variable (X1) increases, the problem-solving ability variable will also increase but not significantly. Hypothesis H-DIR2 (self-directed learning (X2) → problem-solving ability (Y) obtained ß-values = -0.350, T-statistics = 1.871 (≤1.96), and ρ-values = 0.061 (>0.05). This shows that the learning difficulties variable has a negative and insignificant effect on problem-solving abilities when the variable self-directed learning (X2) has decreased, then variable problem-solving abilities will also decrease but not significantly. Hypothesis H-DIR3 helps learning difficulties (X1) → mathematical disposition (Z) obtains a value of ß = 0.555, T-statistics = 4.988 (≥1.96), and the value ρ = 0.000 (<0.05). This shows that the learning difficulty variable has a positive and significant effect on mathematical disposition. When the learning difficulty variable (X1) increases, the mathematical disposition variable will also increase significantly.

**Table 6. Result of Path Coefficient: Direct Effect**

| **Hypothesis** | **Path Analysis** | **β-Values (+/-)** | **Std.** | **T-Statistics (>1,96)** | **P-Values (<0,05)** | **Decision** |
|---|---|---|---|---|---|---|
| H-DIR$_1$ | LD → PSA | 0.000 | 0.182 | 0.002 | 0.998 | Rejected |
| H-DIR$_2$ | SDL → PSA | -0.350 | 0.187 | 1.871 | 0.061 | Rejected |
| H-DIR$_3$ | LD → MD | 0.555 | 0.111 | 4.988 | 0.000 | Accepted |
| H-DIR$_4$ | SDL → MD | 0.268 | 0.236 | 1.136 | 0.256 | Rejected |
| H-DIR$_5$ | MD → PSA | 0.798 | 0.166 | 4.799 | 0.000 | Accepted |

Based on Table 7 regarding indirect effects, hypothesis H-IND1 the role of mathematical disposition as a mediator plays a positive role (ß-values = 0.443) and significant (T-statistics 3.894>1.96 and ρ-values = 0.000<0.05) between the factors of

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learning difficulties ( X1) on problem-solving ability (Y). So H-IND1 states that there is a positive and significant influence on the role of mathematical disposition in mediating learning difficulties on problem-solving abilities. Then the Hb hypothesis of the role of mathematical disposition as a mediator plays a positive role (ß-values = 0.214) and is not significant (T-statistics 1.066>1.96 and ρ-values = 0.286>0.05) between the self-directed learning factor (X2) on problem-solving abilities ( Y). So H-IND2 states that there is no positive and significant influence on the role of mathematical disposition in mediating learning difficulties on problem-solving abilities.

**Table 7. Result of Path Coefficient: Indirect Effect**

| Hypothesis | Path Analysis | β-Values (+/-) | SDV | T-Statistics (>1,96) | P-values | Decision | Mediating Role |
|---|---|---|---|---|---|---|---|
| H-$IND_1$ | LD□MD □PSA | 0.443 | 0.114 | 3.894 | 0.000 | Accepted | Full Mediation |
| H-$IND_2$ | SDL□MD□PSA | 0.214 | 0.201 | 1.066 | 0.286 | Rejected | Full Mediation |

The results of this research are the most influencing factors in measuring learning difficulties are indicators of conceptual understanding. So students need to improve their understanding of mathematical material. Learning difficulties have a positive influence on improving problem-solving abilities, but it is not significant. This research is in line with research (Suratman, 2023) which states that learning difficulties cannot significantly improve problem-solving abilities because students who experience learning difficulties will feel hopeless and doubt their ability to learn mathematics.

Then another factor that is less significant in measuring learning difficulties is counting. So students need to reduce their fear of mathematical formulas. This research is in line with study (Woodcock & Moore, 2021) regarding learning difficulties which are less significant in measuring numeracy indicators which states that students who experience difficulties in numeracy tend to have a fear of solving mathematical problems.

The influence of learning difficulties has a significant urgency in improving mathematical disposition. A positive mathematical disposition, such as interest, motivation, and a good attitude towards mathematics is a key factor in students' success in understanding and mastering mathematical concepts (Hidayanthi et al., 2022; Ulya & Rahayu, 2021). Difficulty learning mathematics can hinder the development of a positive mathematical disposition by causing students to feel less confident, frustrated, and less interested in mathematics. This negative impact can affect students' motivation and involvement in learning mathematics, as well as influence their perception of their ability to overcome mathematical challenges. Therefore, educators need to identify and overcome mathematics learning difficulties effectively, as well as provide appropriate support to students to help them develop a positive and confident mathematical disposition (Darwani et al., 2023; Mawardin et al., 2023).

The most influencing factor in measuring self-directed learning is the learning strategy indicator. This research is not in line with research (Hershcovits et al., 2020) which states that students only learn when in class and listening to the material provided by the teacher. They will not relearn what they have learned at school. So students need to change the habit of just waiting for an explanation from the teacher to receive learning.

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Email: madrasah@uin-malang.ac.id

Then another significant factor in measuring self-directed learning is motivation. So students need to increase their motivation to learn and not give up on studying mathematics. This research is in line with study (Bishara, 2021) which states that a lack of motivation, or the need for additional support from friends, teachers, or parents can reduce a person's interest in these subjects. Satisfying support provides extra help and positive motivation. When someone successfully solves a math problem that was previously considered difficult, they will feel more confident and motivated to continue learning.

The urgency of the influence of self-directed learning on mathematical disposition shows how important it is to provide opportunities for students to take an active role in the mathematics learning process (Amaliyah et al., 2021; Athikah et al., 2023). Self-directed learning allows students to develop independence, intrinsic motivation, and a sense of responsibility for their learning. By having control over their learning process, students can design learning experiences according to their learning styles and needs (Man et al., 2023; Sukardjo & Salam, 2020). This can help them develop positive mathematical dispositions, such as high interest, self-confidence, and persistence in facing mathematical challenges. Thus, self-directed learning is the key to forming students' attitudes toward mathematics.

The most influencing factor in measuring mathematical disposition is interest. So students need to maintain a comfortable classroom atmosphere and enjoy learning mathematics. This research is in line with research (Mawardin et al., 2023) which states that a comfortable classroom atmosphere will make it easier for students to concentrate and encourage student involvement in the learning process. So students need to maintain a comfortable classroom atmosphere and enjoy learning mathematics.

Then another significant factor in measuring mathematical disposition is an appreciation for mathematics. So students need to maintain an attitude of respect for mathematics as an important thing to learn because it can improve logical thinking abilities. This is by research (Saputra, 2022) which states that if there is a positive attitude towards mathematics lessons, students can achieve the best results in solving mathematics problems. Students' positive attitude in appreciating mathematics lessons can be shown through a sense of confidence in solving mathematics problems, and a great sense of curiosity. towards mathematics problems, and enjoyment of mathematics.

The influencing factor in measuring problem-solving abilities is understanding the problem. So students need to improve their habit of reading mathematics books when studying at home. This research is in line with study (Tiara et al., 2024) related to problem-solving abilities which measure indicators of problem understanding. Then another significant factor in measuring problem-solving abilities is problem-solving strategies. So students need to change the habit of always copying their friends' work. This research is in line with research (Shanta & Wells, 2022) which revealed that problem-solving strategies are one of the fundamental abilities to improve high-level thinking abilities such as creative thinking abilities and critical thinking abilities.

The urgency of mathematical disposition as a mediator between the influence of self-directed learning on problem-solving abilities emphasizes the importance of students' attitudes and motivation in developing mathematical skills (Aini & Khuzaini, 2024; Marisa et al., 2023). A positive mathematical disposition plays a key role in

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facilitating an effective self-directed learning process. When students have a strong mathematical disposition, they tend to be more motivated to take initiative in their learning, set clear goals, and take the necessary steps to achieve those goals. This allows them to develop mathematical problem-solving skills independently, by searching for solutions, experimenting with different approaches, and critically evaluating the results (Setiawan & Surahmat, 2023; Zulaiha, 2021). Therefore, a positive mathematical disposition is a strong mediator in the influence of self-directed learning on students' problem-solving abilities, as well as increasing the overall effectiveness of mathematics learning.

Based on the research above, it can be concluded that learning difficulties will not have a significant impact if there is no positive attitude towards mathematics. Then Self-directed learning does not have a significant impact in increasing problem-solving abilities. This is because students' learning independence is still low and there is a lack of motivation both from themselves and others. Mathematical disposition has a very important role in its influence on learning difficulties and self-directed learning on problem-solving abilities

## CONCLUSION

This research highlights the importance of paying attention to mathematical disposition factors in the context of mathematics learning, especially in mediating the impact of learning difficulties and self-directed learning on problem-solving abilities. Implications include an emphasis on developing positive attitudes towards mathematics as an integral part of a holistic learning approach. In addition, this research encourages strengthening students' self-directed learning skills, so that they can overcome learning obstacles more effectively. By strengthening mathematical dispositions and self-directed learning, students can become more confident and skilled at solving mathematical problems, opening the door to greater achievement in this area.

This research recommends teachers take a series of holistic steps. Teachers need to provide a learning environment that supports, motivates, and encourages students to develop a positive mathematical disposition through the use of learning approaches that are interesting and relevant to everyday life. In addition, learning programs must also emphasize the development of metacognitive skills such as self-reflection and learning planning which can help students overcome learning difficulties and take control of their learning. Apart from that, teachers can also utilize learning technology to provide access to varied and supportive resources, as well as facilitate interaction and collaboration between students in exploring mathematical concepts.

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