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Exploring the Predictive Role of Mathematical Disposition and Self-Esteem on Students' Mathematical Investigation Ability

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ABSTRACT

Students' mathematical investigation ability is influenced not only by cognitive knowledge but also by affective factors such as mathematical disposition and self-esteem. This study aims to examine the relationship between mathematical disposition and students' mathematical investigation ability, investigate the predictive influence of self-esteem on investigation ability, and analyze the combined contribution of both variables. This quantitative study involved 49 eleventh-grade students from a private high school in Cianjur Regency in the 2024/2025 academic year, with class XI-1 selected through purposive sampling. Research instruments included mathematical disposition and self-esteem questionnaires, as well as a mathematical investigation test on circle material. Interviews with several students were conducted to support the test findings. Data were analyzed using simple and multiple linear regression after verifying classical assumptions. The results showed that mathematical disposition had a significant relationship with mathematical investigation ability (40.2%), while self-esteem demonstrated a non-significant predictive influence (18.7%). Together, mathematical disposition and self-esteem contributed 31.6% to students' mathematical investigation ability. These findings highlight the importance of fostering mathematical disposition as a potential predictor of students' investigation ability.

Keywords: mathematical disposition; mathematical investigative ability; self-esteem

INTRODUCTION

High-level thinking skills are one of the keys to learning mathematics. One way to develop these skills is through mathematical investigation, which involves exploring patterns and regularities in mathematical problems to find logical and systematic solutions (Zulfia, 2021). Astuti et al. (2024) define mathematical investigation as a problem-solving approach that includes information gathering, data analysis, and decision making. Yeo & Yeap in Pratiwi & Hakim (2023) lso explain that mathematical investigation involves four thinking stages: specializing, conjecturing, justifying, and generalizing.

However, classroom observations show that not all students are able to carry out these stages optimally. Most students are not used to putting forward their own ideas or strategies in solving math problems. They tend to wait for instructions or example solutions from the teacher and focus more on the final answer than on the thinking process. This attitude shows that students still face challenges in the conjecturing and generalization stages, two important components in mathematical investigation skills.

This shows that students' difficulties are not only cognitive but also related to affective aspects. One of them is mathematical disposition and self-esteem. Some students lack confidence in proposing solution strategies, feel anxious when working on unfamiliar problems, and prefer to wait for teacher examples.

In addition, there is also a lack of student confidence in their own abilities in working on math problems. Some students show a tendency to underestimate themselves, feel unable to compete with friends who are considered smarter, and are reluctant to appear in front of the class because they are afraid of being wrong. These symptoms reflect the lack of mathematical disposition and self-esteem of students in the context of learning mathematics.

The findings above increasingly suggest that the obstacles experienced by students in mathematical investigations do not only come from cognitive aspects, but are also related to affective aspects that underlie their learning behavior. This is reflected in educational reports that not only contain academic grades, but also the development of students' character and attitudes. One of the affective aspects that serves as a critical determinant of students' mathematical investigation abilities is mathematical disposition.

Mathematical disposition is an affective aspect related to students' attitudes toward learning mathematics (Rezita & Rahmat, 2022). Fairus et al. (2023) state that mathematical disposition includes confidence, interest in learning, problem-solving ability, and thinking flexibility. In line with that, the NCTM in Mahmuzah & Aklimawati (2022) states that mathematical disposition includes beliefs and tendencies to think and act in a positive way, which is characterized by self-confidence, flexibility, perseverance, curiosity, reflection, respect and appreciation of mathematics.

In line with mathematical disposition, self-esteem is also an important affective aspect in learning. Zahroh & Dewi (2022) explain that self-esteem refers to how individuals view and evaluate themselves based on their strengths and weaknesses. Referring to Coopersmith's theory (Irani et al., 2021), self-esteem has four main dimensions, namely power, significance, virtue, and competence. Self-esteem emerges when individuals hold beliefs such as "I can do it" and "I am valuable," which reflect confidence and a sense of worth (Oktavia et al., 2022).

Several studies have examined mathematical disposition and self-esteem. Such as research conducted by Khoirunnisa et al. (2021) found a positive relationship between mathematical disposition and students' mathematical communication skills, while Wibowo (2018) showed a negative relationship between mathematics learning anxiety and mathematical disposition. Rezita & Rahmat (2022) also reported a significant positive relationship between mathematical disposition and students' problem-solving abilities. Meanwhile, Sari et al. (2023) reported a negative relationship between students' self-esteem and self-confidence, showing how psychological aspects influence one another in the learning process.

However, although various studies have examined the role of mathematical disposition and self-esteem in mathematics learning, research linking both variables directly to mathematical investigation ability is still limited. In addition, most previous studies have focused more on analyzing students' mathematical investigation abilities without linking them to affective factors such as mathematical disposition and self-esteem.

Theoretically, mathematical investigative ability is influenced not only by cognitive abilities but also by affective factors that shape how students think and make decisions. The NCTM in Mahmuzah & Aklimawati (2022) mathematical proficiency model emphasizes that positive dispositions encourage students to persist, explore, and try new strategies, potentially influencing the investigative process. Similarly, Coopersmith's self-esteem

theory places self-confidence as the foundation of academic behavior, including the courage to propose conjectures and generalize. Therefore, the relationship between these two affective variables could theoretically act as a factor influencing students' investigative ability, rather than simply being correlated.

However, most previous research has only examined disposition or self-esteem separately, often linking them to basic abilities such as communication or problem-solving. Very few studies have examined these two variables together or linked them to the more complex stages of mathematical investigation (specializing, conjecturing, justifying, and generalizing). This research gap highlights the need for a more comprehensive analysis to examine how these two affective aspects operate simultaneously to influence mathematical investigation.

Therefore, this study aims to examine the influence of mathematical disposition and self-esteem on students' mathematical investigation abilities. Based on the problems that have been described previously, this study aims to examine the influence of mathematical disposition and self-esteem on students' mathematical investigation abilities.

RESEARCH METHODS

This study employed a causal quantitative design aimed at examining the causal relationship between mathematical disposition (X_1) and self-esteem (X_2) on students' mathematical investigation ability (Y) without providing any direct treatment to the participants. The relationship between variables in this study is described through the framework of thought in Figure 1.

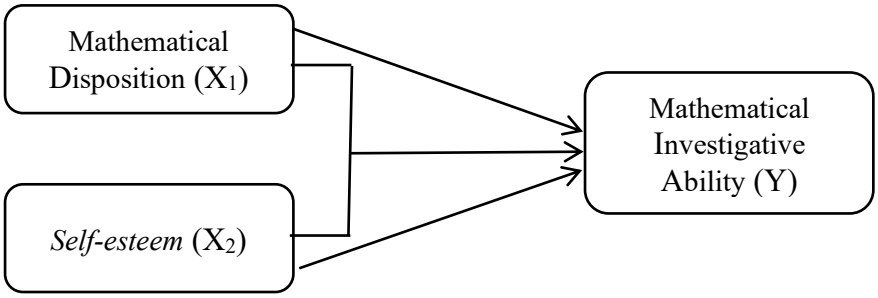

Figure 1. Thinking Framework

The study was conducted from February 23 to 25, 2025 at a private high school in Cianjur Regency. The population in this study were all 49 students in grade XI of the 2024/2025 academic year. Purposive sampling was used to select the research sample. Class XI.1 was selected because the researcher was familiar with the characteristics of the students and the class had previously studied material aligned with the research instrument.

Two instruments were used in this study: questionnaires and descriptive test items. The mathematical disposition questionnaire consisted of 12 items based on the indicators of the NCTM in Mahmuzah & Aklimawati (2022) while the self-esteem questionnaire contained 8 items referring to Coopersmith's dimensions as presented in Irani et al. (2021).

Mathematical investigation ability was measured using three contextual descriptive questions based on circle material, which included four indicators of mathematical investigation ability according to Yeo & Yeap in Pratiwi & Hakim (2023), namely specialization, conjecturing, justification, and generalization. Scoring followed a rubric

adapted from Polya's problem-solving stages, as used by Febriani & Najibufahmi (2022). Prior to use, the test items were examined for content validity, reliability, discrimination power, and difficulty level. The test results showed that all questions were valid, reliable, and suitable for use in research. In addition, semi-structured interviews were also conducted with several students as supporting data to strengthen the findings from the questionnaire and descriptive questions.

The questionnaire instrument in this study was developed by the researcher based on the mathematical disposition indicators from NCTM in Mahmuzah & Aklimawati (2022) and the self-esteem dimensions according to Coopersmith. To ensure the appropriateness of the instrument, content validity and reliability were assessed through expert judgment by two supervisors. The two lecturers assessed the suitability of the items, the clarity of the language, the representativeness of the indicators, and the consistency of the instrument. Based on the assessment results, the instrument was declared valid and reliable and suitable for use in research. Therefore, this study does not report statistical indicators such as Cronbach's Alpha or validity indices, because the validation process relied entirely on expert judgment approved by both supervisors.

Interview participants were also selected using purposive sampling based on three levels of mathematical investigation ability high, medium, and low with one student representing each category. The interviews were then analyzed using a thematic analysis approach to strengthen the quantitative analysis results.

The research procedures consisted of four main stages: (1) preparation, which included instrument development and validation; (2) data collection through the administration of mathematical disposition and self-esteem questionnaires, along with a mathematical investigation test; (3) scoring and data processing using predetermined rubrics and coding guidelines; and (4) data analysis, which involved descriptive statistics, classical assumption testing, and simple and multiple linear regression. In addition, semi-structured interviews were conducted with selected students as supporting data.

The data that had been obtained first through the scoring process were then analyzed using descriptive statistics to determine the characteristics of the data for each variable. Furthermore, to ensure that the requirements of regression analysis are met, classical assumption tests are carried out including normality tests (Shapiro-Wilk), linearity tests (ANOVA), heteroscedasticity tests (Glejser test and Weighted Least Squares/WLS), and multicollinearity tests (using VIF and Tolerance). After all assumptions were met, hypothesis testing was conducted using simple linear regression (partial effects) and multiple linear regression (simultaneous effects) between mathematical disposition and self-esteem on mathematical investigation ability. All data analysis was carried with the assistance of IBM SPSS Statistics Version 27.0.1.0 software.

RESULTS AND DISCUSSION

This section presents the research results obtained from data analysis, both through classical assumption tests and hypothesis tests. In addition, the discussion is structured to interpret the results in relation to previous theories and findings.

The classical assumption test was conducted to ensure the feasibility of the regression model, including the normality test, linearity test, heteroscedasticity test, and

multicollinearity test. The results of the normality test showed a significance value greater than 0.05, so it can be concluded that the data is normally distributed. The results of the linearity test showed a linear relationship between the independent and dependent variables. The heteroscedasticity test also showed that there were no symptoms of heteroscedasticity, indicated by a significance value above 0.05. Meanwhile, the multicollinearity test showed a VIF value of 1.887 and a Tolerance of 0.530, both of which were within safe limits. Thus, all classical assumptions were met, so the data was suitable for hypothesis testing.

After all classical assumptions are met, the next step is to conduct hypothesis testing to determine the effect of independent variables on dependent variables.

The Effect of Mathematical Disposition on Students' Mathematical Investigation Ability

Based on the results of the simple linear regression test, the equation model obtained was:

$$Y = -37{,}555 + 1{,}496X_1$$

This equation shows that every one unit increase in mathematical disposition (X1) will increase mathematical investigation ability (Y) by 1.496 units. The significance test result of 0.006 (<0.05) indicates that the effect of mathematical disposition on mathematical investigation ability is statistically significant. In addition, the R Square value of 0.402 indicates that 40.2% of the variation in mathematical investigation ability can be explained by mathematical disposition, while the rest is influenced by other variables outside the model.

These results indicate that mathematical disposition has a significant effect on students' mathematical investigation ability. The higher the mathematical disposition, the higher the students' mathematical investigation ability. This is supported by the results of the questionnaire which shows that the highest disposition indicator lies in students' self-confidence and perseverance in learning mathematics.

This finding is reinforced by qualitative data from interviews. For example, student S9 expressed that he was confident in understanding investigative questions, was able to develop a solution strategy, and re-check his answers. Meanwhile, student S13 showed a persistent and reflective attitude by describing the problem and comparing the results of his work with his friend's answers, which reflects perseverance and curiosity, which are two main characteristics of mathematical disposition.

This finding is in line with Fairus et al. (2023) who stated that mathematical disposition reflects a positive view of mathematics, including self-confidence, flexibility of thinking, and perseverance. Mustika (2024) also emphasized the importance of self-confidence and perseverance in solving mathematics problems. In addition, Zumaroh & Haqiqi (2022) stated that positive disposition can support the strengthening of students' conceptual and problem-solving abilities. Therefore, teachers need to encourage the growth of mathematical disposition through learning that provides space for exploration, reflection, and students' courage in conveying ideas and problem-solving strategies openly.

The Effect of Self-Esteem on Students' Mathematical Investigation Ability

In addition to mathematical disposition, another affective variable tested was self-esteem. Based on the results of the simple linear regression test, an equation model was obtained:

$$Y = -12{,}393 + 1{,}130X_2$$

The coefficient value of 1.130 indicates that every one-unit increase in self-esteem (X2) predicts an increase in mathematical investigation ability (Y) of 1.130 units. However, the significance value of 0.083 (> 0.05) indicates that the effect is not statistically significant. The R Square value of 0.187 indicates that 18.7% of the variation in mathematical investigation ability can be explained by self-esteem, while the rest comes from other factors outside the regression model. Thus, although the statistical effect is not significant, qualitative findings from the questionnaire and interviews still show the practical influence of self-esteem during the investigation process. Students with high self-esteem tend to show self-confidence, dare to try their own strategies, and be independent when working on investigative problems. Conversely, students with low self-esteem often feel doubtful, tend to be passive, and rely on help from friends or teachers. This is in line with Zahrani (2018) which states that self-esteem is formed from self-evaluation based on previous experiences. Therefore, even students with generally high self-esteem may not show optimal investigative performance if they lack relevant learning experiences.

The interview results also revealed a negative trend in the self-esteem coefficient. Some students with high self-esteem did not demonstrate improved investigative skills. S13 felt confident simply because he had studied the material, but failed to verify his results when they differed from his friends'. S14 also demonstrated self-confidence that relied on his friends' answers, not on his own understanding. Meanwhile, S9, who had moderate self-esteem, appeared more thorough, independent, and capable of completing each stage of the investigation effectively. This suggests that self-esteem that is not aligned with academic competence may reduce students' reflectiveness and therefore does not significantly enhance investigative ability.

Referring to Coopersmith's theory (Irani et al., 2021), self-esteem includes perceptions of one's strength, significance, virtue, and competence. Meanwhile, Sulaiman et al. (2021) emphasized that this perception is greatly influenced by the environment, including support from teachers and peers. Therefore, although the statistical findings show no significant effect, self-esteem still plays an essential role in shaping a supportive learning atmosphere that encourages students' investigative development.

Thus, teachers still need to pay attention to the development of students' self-esteem by providing positive learning experiences, strengthening self-confidence, and creating a safe and supportive classroom environment for students to explore and think independently.

The Effect of Mathematical Disposition and Self-Esteem on Students' Mathematical Investigation Ability

After each variable is tested partially, the next analysis is to see the influence of both simultaneously. Based on the results of the multiple linear regression test, an equation model is obtained:

$$Y = -37{,}532 + 1{,}504X_1 - 0{,}012X_2$$

The equation shows that mathematical disposition (X_1) has a positive influence on students' mathematical investigation ability, with a coefficient of 1.504 and a significance value of 0.041 (<0.05), which means it is statistically significant. Meanwhile, self-esteem (X_2) has a negative coefficient of -0.012 with a significance of 0.987 (>0.05), so it does not have a significant effect partially.

However, the results of the F test show a significance value of 0.027 (<0.05), which means that together, mathematical disposition and self-esteem have a significant effect on students' mathematical investigation ability. The Adjusted R Square value of 0.316 indicates that 31.6% of the variation in mathematical investigation ability can be explained by the two independent variables in this model.

Mathematical disposition has a positive effect, while self-esteem actually shows a negative direction of influence. This means that the higher the students' mathematical disposition, the better their investigative ability. On the other hand, increasing self-esteem does not always correlate with increasing investigative ability, in fact in this context it tends to be the opposite. This difference in the direction of influence shows that mathematical disposition plays a more dominant role in shaping students' investigative ability. High disposition tends to encourage students to demonstrate abilities such as perseverance, curiosity, and the ability to reflect on their thinking processes, which are in line with the indicators of mathematical investigative ability according to Yeo & Yeap in Pratiwi & Hakim (2023). Questionnaire and interview data support this, students with high dispositions show independent learning habits, are able to formulate strategies, and dare to test their ideas. On the other hand, although some students have high self-esteem, they actually show doubts about their own learning outcomes. This can be explained through Coopersmith's theory (Irani et al., 2021) which states that only the competence dimension of self-esteem is directly related to academic achievement. Other dimensions such as power, virtue, and significance tend not to have a direct impact on investigative mathematical ability, especially if they are not supported by contextual learning experiences.

The interviews also confirmed why the self-esteem coefficient in the simultaneous model moved negatively. For some students, self-confidence emerged not from conceptual understanding, but from following friends or simply relying on memory. Mathematical dispositions that include perseverance and independence exerted a stable positive influence, while self-esteem that lacked competence did not contribute to the investigation process. Therefore, in the simultaneous model, disposition became a more dominant factor.

Thus, although mathematical disposition and self-esteem simultaneously have a significant effect, the contribution of mathematical disposition appears to be stronger and more direct to students' mathematical investigation abilities. The implication of this finding is the importance of teachers in balancing affective and cognitive approaches in mathematics learning. It is not enough to just build self-confidence through verbal motivation, but it is also necessary to design learning strategies that encourage reflection, exploration, and the courage to convey ideas. This is in line with the view of Sugiarni et al. (2021) that learning success is the result of the interaction between students' internal factors and a supportive learning environment.

CONCLUSION

Based on the research data, it was obtained that mathematical disposition had a significant and positive effect on students' mathematical investigation abilities with a contribution of 40.2%, self-esteem did not have a significant effect partially, but still contributed 18.7% to students' mathematical investigation abilities. While simultaneously, mathematical disposition and self-esteem had a significant effect on students' mathematical investigation abilities with a contribution of 31.6%. This study shows the importance of affective disposition in supporting mathematical investigation abilities. Further researchers can expand the scope by adding other variables or using mixed methods for more comprehensive results.

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