



The Influence of Learning Independence and Self-efficacy on Students' Mathematical Understanding Ability Based on Kinach's Theory

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ABSTRACT

This study aims to analyze the influence of learning independence and self-efficacy on students' mathematical understanding ability based on Kinach's theory. This study employs a quantitative approach with data analysis techniques consisting of simple linear regression and multiple linear regression. The study population includes all 10th-grade students at state Islamic senior high schools (MA Negeri) in Cianjur Regency, with a sample of 34 students from class XA selected through purposive sampling. The instruments used consist of a mathematical understanding ability test based on Kinach's theoretical indicators in the topic of Arithmetic Sequences and Series, as well as questionnaires on learning independence and self-efficacy. The data were analyzed using simple and multiple linear regression tests, preceded by prerequisite tests including normality, linearity, heteroscedasticity, and multicollinearity. The results show that learning independence has a positive and significant influence on students' mathematical understanding ability based on Kinach's theory, with a contribution of 36.3%. Likewise, self-efficacy has a positive and significant influence, contributing 69.4%. Furthermore, learning independence and self-efficacy simultaneously have a significant influence on students' mathematical understanding ability based on Kinach's theory, with a combined contribution of 69.7%. These findings indicate that the higher the students' levels of learning independence and self-efficacy, the better their mathematical understanding ability as conceptualized in Kinach's theory.

Keywords: learning independence; mathematical understanding based on kinach's theory; self-efficacy

INTRODUCTION

Mathematical understanding ability is one of the essential skills students must possess in order to solve mathematical problems (Giriansyah et al., 2023). According to Septian et al., (2020) students' mathematical understanding refers to their ability to comprehend mathematical subject matter through their own thinking processes. This ability also includes the capacity to restate the material in other, more understandable forms and to apply it appropriately. Mathematical understanding is a key objective in learning, emphasizing that the material taught to students should not merely be memorized. Rather, through understanding, students are able to gain deeper insights into the concepts being studied (Noorfitriani & Rosyid, 2020). Moreover, mathematical understanding is crucial in the learning process as it plays a role in solving various problems, whether related to mathematics, other disciplines, or everyday life. This aligns with the vision of mathematics education development, which aims to address current challenges and societal needs (Sumarmo, 2013).

During the researcher's School Field Introduction Program (Pengenalan Lapangan Persekolahan/PLP) at one of the Madrasah Aliyah Negeri schools in Cianjur Regency, it was found that students often experienced difficulties when faced with mathematics problems presented in unfamiliar contexts. They frequently struggled to grasp the underlying concepts, which was attributed to a lack of deep conceptual understanding. This difficulty arose because students were accustomed to practicing similar types of problems or following repetitive patterns, leading them to memorize procedures or steps rather than truly understanding the meaning behind the concepts. Purwasih (2015) also stated that one of the factors contributing to the low level of students' mathematical understanding in Indonesia is the tendency to learn mathematical concepts and formulas by rote memorization without truly comprehending their meaning, content, and application.

In addition to cognitive abilities, affective abilities are also a crucial element in the learning process (Nabillah & Abadi, 2019). In schools, the educational process does not solely focus on cognitive development but also emphasizes affective aspects, which are concerned with character formation and are also assessed through evaluations recorded in student report cards. Affective competence plays a vital role in the *Merdeka Curriculum*, as affective evaluation helps measure students' attitudes, values, and emotions elements essential for character development and holistic learning (Demusti et al., 2024). Affective ability encompasses everything related to attitudes, character, behavior, interests, emotions, and the values inherent in each individual (Salsabila et al., 2023). In the *Merdeka Curriculum*, attitudes are assessed through character strengthening aligned with the *Profil Pelajar Pancasila* (Pancasila Student Profile), which consists of six dimensions: having faith in God Almighty and noble character, collaboration, global diversity, critical thinking, creativity, and independence (Inayati, 2022).

Field observations indicate that one of the ongoing issues in the learning process is the suboptimal learning independence of students. Learning independence is the ability of an individual to engage in learning activities independently without relying on others to overcome obstacles (Linajari & Arif, 2022). Learning independence is crucial because each student needs to develop their own abilities in order to achieve learning goals (Arista et al., 2022). Novantri et al., (2020) argue that students with varying levels of learning independence moderate, high, and low demonstrate different outcomes in mathematical learning.

Based on the researcher's observations during the School Field Introduction Program and discussions with the mathematics teacher at one of the Madrasah Aliyah Negeri schools in Cianjur Regency, it was found that the issues encountered were not only related to students' mathematical understanding ability but also encompassed affective aspects, particularly in relation to solving mathematics practice problems. Some students were still unsure of their abilities and preferred to copy answers from their peers rather than attempting the exercises on their own. During lessons, students tended to rely on others, such as waiting for answers from their classmates, and thus, they did not show initiative to study independently or seek solutions on their own. This was particularly evident when students encountered difficult problems at the start, as they were reluctant to exert more effort or try to understand the material in depth. As a result, students did not gain mastery experiences that come from their own efforts in overcoming difficulties and solving challenges during

mathematics problem-solving. This situation contrasts with the concept of self-efficacy, which, according to Sahin et al., (2024) refers to an individual's belief in their ability to perform tasks or complete work to achieve desired outcomes. Students with high self-efficacy tend to remain calm while completing tasks, persist in their thinking, and actively seek solutions, demonstrating a serious attitude, determination, and emotional control. In contrast, students with low self-efficacy often lack confidence in their abilities, which leads them to rely more on the answers of their peers. Therefore, self-efficacy needs to be enhanced so that students can apply their mathematical learning to daily life, making the learning process more effective (Lusiana & Setyaningsih, 2020).

Based on the issues observed, affective abilities, including learning independence and self-efficacy, are factors that influence students' cognitive abilities. Anzani et al., (2024) revealed that learning independence has an impact on students' ability to understand mathematical concepts. Additionally, Fitriani & Pujiastuti (2021) examined the influence of self-efficacy on mathematical learning outcomes. The results of their study indicated that self-efficacy significantly affects mathematical learning outcomes. Similarly, Primanda et al., (2023) stated that both self-efficacy and learning independence have a positive impact on students' cognitive learning achievements at SMK Negeri Surakarta, both partially and simultaneously.

Based on previous research, learning independence, self-efficacy, and mathematical understanding ability are closely related in the mathematics learning process. A high level of learning independence promotes an increase in self-efficacy, which is the confidence in mastering mathematical material. This, in turn, contributes to the improvement of mathematical understanding ability, enabling students to be more effective in solving problems and applying mathematical concepts (Jumraeni et al., 2023).

Mathematical understanding ability plays a crucial role and must be possessed by students in the mathematics learning process. Kinach's theory provides a strong foundation for developing understanding in the context of this research. Kinach (2002) argues that student understanding should not only evaluate the final outcome but also allow for analysis of how students construct understanding through interaction, reflection, and explanation. This makes the theory highly relevant in the context of mathematics learning, which requires deep conceptual understanding. Furthermore, to this day, the levels of mathematical understanding proposed by Kinach have become an instrument widely used by many mathematics teachers to assess students' mathematical understanding levels (Firmansyah et al., 2018).

This study presents novelty compared to previous research by expanding the variables used from two to three, allowing for a more comprehensive and in-depth analysis of the relationships between the variables involved in the research context. Additionally, the ability variable used in this study is specifically based on Kinach's theory, which has not been extensively researched, but is relevant and interesting for further investigation.

Based on the issues previously explained, the aim of this study is to examine whether there is a significant influence of learning independence on students' mathematical understanding ability based on Kinach's theory, whether there is a significant influence of self-efficacy on students' mathematical understanding ability based on Kinach's theory, and

whether there is a simultaneous and significant influence of both learning independence and self-efficacy on students' mathematical understanding ability based on Kinach's theory.

RESEARCH METHODS

This study was conducted at one of the Madrasah Aliyah Negeri schools in Cianjur. This study employs a quantitative approach with data analysis techniques consisting of simple linear regression and multiple linear regression. In this study, the independent variables (X_1) are learning independence and (X_2) self-efficacy, while the dependent variable (Y) is students' mathematical understanding ability based on Kinach's theory. The model used in the study is shown as follows:

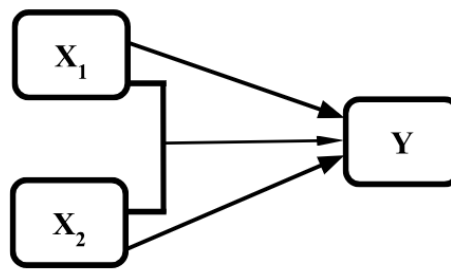


Figure 1. Conceptual Framework

The population of this study consists of tenth-grade students at one of the Madrasah Aliyah Negeri schools in Cianjur Regency for the 2024/2025 academic year, totaling 394 students. The sample in this study comprises 34 students from class XA in the second semester, with 14 male students and 20 female students. The sampling technique used is purposive sampling, where students from class XA were selected because they had already studied the material on Arithmetic Sequences and Series, making them representative of the overall population of tenth-grade students, in terms of academic ability, social background, and other characteristics.

This study uses two types of instruments, namely tests and questionnaires. The test in this study is a mathematical understanding ability test for students based on Kinach's theory, while learning independence and self-efficacy are analyzed using questionnaires. The type of test used in this study is an essay test on the material of Arithmetic Sequences and Series, consisting of 5 questions, with 2 questions related to Arithmetic Sequences and 3 questions related to Arithmetic Series. The test items were designed based on the indicators of Kinach's theory (2002) which include: 1) content understanding, 2) concept understanding, 3) problem-solving understanding, 4) epistemic understanding, and 5) inquiry understanding. Meanwhile, the instruments for learning independence and self-efficacy in this study use a 24-statement questionnaire divided into two parts. The first questionnaire contains 16 statements on learning independence, designed based on the indicators by Woi & Prihatni (2019), which include: not always depending on others; being progressive; persistent; having initiative to learn; self-control; the ability to make decisions; being responsible; and self-affirmation. The second questionnaire contains 8 statements on self-efficacy, designed based on the indicators by Bandura (1997), which include: mastery experience; vicarious experience; verbal persuasion; and physiological and affective states.

RESULTS AND DISCUSSION

This study aims to examine the influence of learning independence on students' mathematical understanding ability based on Kinach's theory, to investigate the influence of self-efficacy on students' mathematical understanding ability based on Kinach's theory, and to simultaneously examine the influence of learning independence and self-efficacy on students' mathematical understanding ability based on Kinach's theory. In the initial phase, an analysis of the influence of independent variables on the dependent variable is conducted, which requires the implementation of classical assumption tests. These assumption tests involve research data that include regression variables, namely learning independence (X_1), self-efficacy (X_2), and students' mathematical understanding ability based on Kinach's theory (Y). Data analysis in this study was conducted using simple linear regression and multiple linear regression tests. Before conducting the linear regression tests, assumption tests must be performed through classical assumption tests. These tests include several key stages aimed at ensuring that the data meet the necessary assumptions, so that the regression analysis results are more valid and can be interpreted properly (Mardiatmoko, 2020). The prerequisite tests for simple linear regression are normality test, linearity test, and heteroscedasticity test (Ranti et al., 2022). Meanwhile, the prerequisite tests for multiple linear regression include normality test, heteroscedasticity test, multicollinearity test, and autocorrelation test (Sholihah et al., 2023).

Classical Assumption Test

This study uses classical assumption tests, which include: normality test with Kolmogorov-Smirnov, linearity test with the Linearity Test, heteroscedasticity test using Breusch-Pagan-Godfrey, and multicollinearity test through VIF and Tolerance values. The autocorrelation test was not performed because the data is not time series data.

The following is the summary of the classical assumption test output using IBM SPSS Statistics Version 30, presented in table 1:

Table 1. Output of Classical Assumption Tests

Classical Assumption Test	$X_1 \rightarrow Y$	$X_2 \rightarrow Y$	$X_1, X_2 \rightarrow Y$	Conclusion
Normality	0,200	0,200	0,200	Met
Linearity	0,358	0,976	-	Met
Heteroscedasticity	0,358	0,080	0,710 dan 0,159	Met
Multicollinearity	-	-	Tolerance = 0,410 VIF = 2,441	Met

The Influence of Learning Independence on Students' Mathematical Understanding Ability Based on Kinach's Theory

The following is the output of the simple linear regression test on the influence of learning independence on students' mathematical understanding ability based on Kinach's theory using IBM SPSS Statistics Version 30, presented in table 2:

Table 2. Output of Simple Linear Regression Test of X_1 on Y

Independent Variable	Coefficient (B)	Sig. (p.value)	R Square
Learning Independence	0,268	0,001	0,363

The regression coefficient (B) of 0,268 indicates that learning independence has a positive effect. This means that for every one-unit increase in learning independence, students' mathematical understanding ability based on Kinach's theory increases by 0,268. The significance value obtained is $0,001 < 0,05$ therefore H_0 is rejected. Thus, it can be concluded that learning independence has a significant influence on students' mathematical understanding ability based on Kinach's theory. The coefficient of determination (R Square) is 0,363, indicating that the variable of learning independence contributes 36,3% to students' mathematical understanding ability based on Kinach's theory.

The indication of this influence is supported by the results of the learning independence questionnaire. The data show that the highest score was obtained from the positive statement: *"I will try to face mathematics tasks and complete them as best as I can."* This statement reflects the aspect of responsibility in learning independence, suggesting that students with a strong sense of responsibility tend to be more committed to completing mathematics tasks. These findings are supported by the study of Diana et al., (2020) which revealed that the higher the level of students' learning independence, the better their ability to solve mathematical problems. Conversely, students with low learning independence tend to have less optimal problem-solving abilities.

The Influence of Self-efficacy on Students' Mathematical Understanding Ability Based on Kinach's Theory

The following is the output of the simple linear regression test on the influence of self-efficacy on students' mathematical understanding ability based on Kinach's theory, using IBM SPSS Statistics Version 30, as presented in table 3:

Table 3. Output of Simple Linear Regression Test of X_2 on Y

Independent Variable	Coefficient (B)	Sig. (p.value)	R Square
Self-efficacy	0,538	0,001	0,694

The regression coefficient (B) of 0,538 indicates that self-efficacy has a positive effect. This means that for every one-unit increase in self-efficacy, students' mathematical understanding ability based on Kinach's theory increases by 0,268. The significance value obtained is $0,001 < 0,05$ therefore H_0 is rejected. Thus, it can be concluded that self-efficacy has a significant influence on students' mathematical understanding ability based on Kinach's theory. The coefficient of determination (R Square) is 0,694 indicating that the variable of self-efficacy contributes 69,4% to students' mathematical understanding ability based on Kinach's theory.

The indication of an influence of self-efficacy on students' mathematical understanding ability based on Kinach's theory is also supported by the results of the self-efficacy questionnaire. The data show that the highest score was obtained from the positive statement: *"I feel more motivated after seeing my classmate successfully solve a math problem that I found difficult."* This statement reflects the vicarious experience indicator, suggesting that the success of others can enhance students' confidence in understanding and solving mathematical problems. This is consistent with the findings of Dinther et al., (2011) who noted that a key factor contributing to low student self-efficacy is the lack of mastery

experiences during primary and secondary education. In other words, repeated failures can lead to a decrease in students' self-efficacy levels.

The Influence of Learning Independence and Self-efficacy on Students' Mathematical Understanding Ability Based on Kinach's Theory

The following is the output of the multiple linear regression analysis examining the influence of learning independence and self-efficacy on students' mathematical understanding ability based on Kinach's theory using IBM SPSS Statistics Version 30, as presented in table 4:

Table 4. Output of Multiple Linear Regression Test of X₁ and X₂ on Y

Independent Variable	Coefficient (B)	Sig. (p.value)	R Square
Learning Independence	-0,041	0,001	0,697
Self-efficacy	0,584	0,001	

Based on the significance value of $0,001 < 0,05$ H_0 is rejected. Therefore, it can be concluded that learning independence and self-efficacy have a significant influence on students' mathematical understanding ability based on Kinach's theory. The regression coefficient (B) for learning independence is -0,041 indicating a negative effect. This means that for every one-unit increase in learning independence, students' mathematical understanding ability based on Kinach's theory decreases by -0,041. The regression coefficient (B) for self-efficacy is 0,584 indicating a positive effect. This means that for every one-unit increase in self-efficacy, students' mathematical understanding ability based on Kinach's theory increases by 0,584. The coefficient of determination (R Square) is 0,697 indicating that learning independence and self-efficacy together contribute 69,7% to students' mathematical understanding ability based on Kinach's theory.

Based on the learning independence questionnaire, students who consistently strive to face mathematical tasks demonstrate a high level of learning independence. This suggests that students with a higher level of learning independence tend to have better mathematical understanding. The results of the self-efficacy questionnaire also support this finding. Students feel more motivated when they observe their peers successfully solving mathematical problems they find difficult, indicating that students with higher self-efficacy are more confident and motivated in learning mathematics, which contributes to better mathematical understanding.

Therefore, learning independence and self-efficacy play a crucial role in enhancing students' mathematical understanding based on Kinach's theory. Mathematical understanding relies not only on teacher instruction but also on students' independent efforts through practice, reflection, and belief in their abilities. Independent students are more proactive in seeking solutions, while students with high self-efficacy are more confident in facing challenges. These two factors mutually support each other in shaping a better mathematical understanding.

The findings of the study by Zulkarnain et al., (2023) which examined the effect of self-efficacy and learning independence on students' mathematical problem-solving abilities, showed an effect size of 61.9%. These findings are theoretically aligned with this study,

which focuses on the affective aspects of learning independence and self-efficacy, and are considered conceptually relevant because they mutually support the improvement of students' mathematical abilities. Therefore, if students are accustomed to developing their mathematical understanding based on Kinach's theory, they will become more independent in learning. Santoso et al., (2021) revealed that independent students are more proactive in exploring problem-solving strategies. Moreover, self-efficacy plays a role in building students' mathematical understanding based on Kinach's theory, which is consistent with the study by Nurani et al., (2021) which found that students with high self-efficacy tend to have a better understanding of mathematical concepts compared to students with low self-efficacy.

Thus, learning independence, self-efficacy, and students' mathematical understanding based on Kinach's theory are interconnected. These three aspects can assist teachers in developing effective learning strategies in mathematics instruction, which in turn can enhance students' mathematical abilities and increase their motivation in facing academic challenges.

CONCLUSION

The results of this study show a significant effect of learning independence on students' mathematical understanding based on Kinach's theory, amounting to 36.3%; a significant effect of self-efficacy on students' mathematical understanding based on Kinach's theory, amounting to 69.4%; and a significant effect of both learning independence and self-efficacy on students' mathematical understanding based on Kinach's theory, amounting to 69.7%.

These findings indicate that the higher the level of students' learning independence and self-efficacy, the better their mathematical understanding based on Kinach's theory. Based on these findings, it is recommended that teachers encourage greater learning independence and enhance students' self-efficacy to support better mathematical understanding based on Kinach's theory.

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