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Analyze of students' mathematical disposition and learning independence through blended learning: A study in West Sumatra, Indonesia

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Abstract

Background: Emphasis on fostering students' mathematical disposition and promoting learning independence in mathematics education has significantly increased in recent years.
Aim: This study aims to determine the relationship between mathematical disposition and learning independence of Mathematics Education students in West Sumatra.
Method: This research is a descriptive correlational study utilizing a survey. The population consisted of all Mathematics Education students enrolled in the academic year 2022, with a sample of 291 students selected through purposive sampling. The data analysis technique used was simple linear regression analysis and Pearson correlation.
Results: The analysis of the regression coefficient data showed that the questionnaire score (b) is 2.15 with a significant level of 0.067. The regression coefficient (b) is positive, indicating a positive influence of mathematical dispositions (X) on learning independence (Y). The correlation coefficient r = 0.73 signifies a strong linear relationship between X and Y.
Conclusion: There is a positive relationship between mathematical disposition and the learning independence of Mathematics Education students in West Sumatra. Higher mathematical disposition leads to greater learning independence among students.

INTRODUCTION

The pandemic has brought about significant transformations in the education system, particularly impacting Mathematics Education students at both public and private universities in West Sumatra. Beyond its implications for health, the pandemic has reverberated across various societal domains, including social, economic, political, and educational realms (Alsubaie, 2022; Debbarma & Durai, 2021; Mardini & Mah'd, 2022; Rachidi et al., 2021; Zuriani Ritonga et al., 2022). In response to this unprecedented situation, the Ministry of Education and Culture issued Circular Number 4 of 2020, mandating universities to shift to online learning to curb the spread of the Covid-19 virus (Kebudayaan, 2020).

This shift to online learning, also known as e-learning, has necessitated innovation in teaching methods, particularly in the field of mathematics education, to enhance students' mathematical abilities, attention, and motivation (Rodriguez et al., 2018; Tong et al., 2021). E-learning, facilitated through web-based Learning Management System (LMS) applications, offers a platform for delivering teaching materials, assignments, and assessments digitally, often supplemented with video-based instruction to enhance student comprehension (Engeness et al., 2020; Hofmeister & Pilz, 2020; Mazin et al., 2020). While e-learning has demonstrated effectiveness in maintaining continuity of learning and reducing costs compared to traditional

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face-to-face instruction (Akinbadewa & Sofowora, 2020; Seage & Türegün, 2019; Shetu et al., 2021), some research suggests that students may prefer hybrid learning models due to the perceived limitations of e-learning, such as the need for more explanation and face-to-face interaction, and a lack of natural socialization opportunities (Misanchuk & Anderson, 2001; Rovai, 2002; Smadi et al., 2022; Tuncay et al., 2011).

Blended learning has gained popularity in tertiary institutions due to its perceived flexibility and ability to cater to diverse student needs. This approach combines elements of e-learning and traditional face-to-face instruction, offering a blend that is considered effective and efficient for learning (Hameed et al., 2008). As blended learning requires students to engage in both online and in-person activities, it fosters a greater level of independence in learning. While course materials and assignments are typically delivered through digital platforms, students must navigate limitations in space, time, and communication, necessitating self-directed study (Mariyani & Sari, 2022). Although tutorials and study groups may provide support, students are encouraged to take initiative in their learning process.

Blended learning, as a system that is still newly developed, if it is not packaged with good planning will certainly make students anxious because besides this learning process can run inefficiently, blended learning is also very different from face-to-face learning. While both blended and face-to-face learning have their advantages and challenges, the key difference lies in their delivery methods, level of interaction, and flexibility in accommodating diverse learning needs and preferences. Students may encounter technical difficulties during online learning, requiring them to adapt due to the lack of preparedness among lecturers (Annur & Hermansyah, 2020). Additionally, Asmuni (2020) suggests that inadequate management of online learning can lead to issues such as insufficient supervision and limited opportunities for active learning. Mathematics serves as a valuable tool in equipping students with problem-solving skills (Nagasaki, 2015), emphasizing the need for students to utilize their own abilities in addressing challenges (Al Aslamiyah et al., 2019). Moore (as cited in (Thoken et al, 2014) highlights the importance of student involvement in setting objectives, selecting materials, and evaluating their learning experiences. Therefore, fostering independent learning is crucial to support blended learning approaches. The effective management of online learning is crucial to address technical challenges and prevent new issues from arising. Additionally, it emphasizes the role of mathematics education in developing problem-solving skills and fostering independent learning, which are essential components supporting blended learning.

In addition to aspects of student learning independence, mathematical dispositions are also important and demanded in blended learning. Mathematical disposition is an aspect that supports the success of learning mathematics, because students with a mathematical disposition can face problems, foster a sense of responsibility in learning mathematics, and develop good work habits (Hamidah & Pabrawati, 2019). Therefore, all these positive attitudes can support the success of learning mathematics and have an impact on student performance (Trisnowali, 2015). Judging from the many positive attitudes contained in mathematical dispositions, to more clearly measure various aspects of mathematical dispositions, the indicators that can be used according to (Lestari & Yudhanegara, 2017) are: 1) Confidence, students use mathematical beliefs when solving mathematical problems, arguments, and exchange of ideas; 2) Flexibility, students' flexibility in learning mathematical ideas and finding other alternative methods to solve problems; 3) Perseverance, student persistence in doing math homework; 4) Student

interest, interest and curiosity, as well as student creativity in doing math assignments; 5) Reflection, students monitor and reflect on their performance; 6) The value of the application of mathematics, students can evaluate the application of mathematics in other situations and everyday experiences; and 7) Appreciate the role of mathematics and let students experience the role of mathematics in the culture and value of mathematics as a tool and language.

Traditionally, blended learning has been used to make higher education more accessible to students (Graham et al., 2013), because online activities allow students to experience learning materials whenever and wherever they want (Norberg et al., 2011). However, more recent conceptualizations of blended learning go beyond the notion of flexibility in terms of time and place. In addition to this increased accessibility, blended learning also offers opportunities to meet individual needs and achieve real personal instruction (Watson, 2008). For example, the popular flipped classroom approach to blended learning aims to free up classroom time for student questions, in-depth discussions, and personal feedback, by asking students to prepare learning activities online, according to their individual level of understanding (Kim et al., 2013).

The research conducted by Haka et al., (2020) focused on evaluating the impact of blended learning delivered through Google Classroom on students' creative thinking abilities and learning independence. Through their study, they found a positive effect, indicating that this mode of instruction not only enhanced students' creative thinking skills but also promoted their autonomy in learning. Similarly, Kurniawati et al., (2019) conducted a study aimed at assessing the effectiveness of blended learning in enhancing student learning outcomes. Their findings suggested that the learning process facilitated by blended learning methods was highly effective. They observed satisfactory student learning outcomes, noted differences in achievement between male and female students, and received very positive responses from students regarding their learning experiences.

Furthermore, Huda et al., (2019) investigated the impact of blended learning and e-learning on students' understanding of mathematical concepts, particularly focusing on linear equations of two variables. Their research demonstrated that these innovative approaches effectively improved students' comprehension of mathematical concepts, providing valuable insights into effective teaching methodologies in mathematics education. Additionally, Smith & Johnson (2018) explored the impact of blended learning on student engagement and achievement across various subject areas. Their study highlighted the role of blended learning in enhancing student engagement and ultimately improving academic performance. Moreover, Chen et al., (2021) conducted research on adapting blended learning approaches to address diverse learning needs. Their study emphasized the importance of personalized learning experiences and collaborative learning environments in the context of blended learning.

Collectively, these research studies underscore the significant impact of blended learning on various aspects of student learning, including creative thinking abilities, learning outcomes, understanding of subject matter, engagement, and addressing diverse learning needs. They provide valuable insights into the effectiveness of blended learning methodologies and their potential as versatile educational tools across different disciplines. However, there is a notable gap in the existing literature regarding the specific relationship between students' mathematical dispositions and their learning independence within the context of blended learning. While previous research has examined the impact of blended learning on various aspects of student performance and engagement, such as creative thinking abilities and learning outcomes, there

appears to be a lack of focus on how students' attitudes, beliefs, and perceptions towards mathematics influence their ability to work independently in blended learning environments. Understanding this relationship is crucial for informing instructional practices and interventions aimed at fostering students' holistic development and academic success.Thus, this research aims to address this gap by specifically analyzing the main impact of mathematical dispositions on student learning independence in blended learning lectures. By investigating this relationship, the study seeks to contribute novel insights into the dynamics between students' mindset towards mathematics and their autonomy in learning, providing valuable implications for educators, policymakers, and practitioners in mathematics education.

Based on the explanation above, it is necessary to look at the relationship or influence between learning independence and mathematical disposition in the implemented blended learning lectures. This study analyzes the impact of mathematical dispositions on the learning independence of Mathematics Education students in post-Covid-19 Blended Learning lectures in West Sumatra.

METHODS

Design

This research employs a correlational design to investigate the relationship between learning independence and mathematical disposition among Mathematics Education students during the recovery from the Covid-19 pandemic. Correlational research aims to determine whether and to what extent there is a relationship between two or more variables without manipulating them. In this case, the independent variable is mathematical disposition, while the dependent variable is learning independence.

Participants

The participants in this study consist of 291 students from Mathematics Education Departments and Study Programs in West Sumatra. These participants were selected using purposive sampling, a technique where subjects are chosen based on specific criteria. Purposive sampling allows researchers to select participants who are most likely to provide relevant and meaningful data for the study.

Instrument

The main instruments used in this research are questionnaires designed to measure learning independence and mathematical disposition. These questionnaires were developed based on relevant indicators and statements adapted to the conditions and learning situations, particularly using blended learning methods during the Covid-19 pandemic. The questionnaires include both positive and negative statements and are structured as closed standard questionnaires.

Data Analysis

The data analysis for this study involves conducting simple linear regression analysis to determine the effect of mathematical disposition on learning independence among Mathematics Education students. Simple linear regression examines the functional or causal relationship between one independent variable (mathematical disposition) and one dependent variable (learning independence). The correlation coefficient (r) is used to assess the strength and direction of the linear relationship between the variables. A positive value of r indicates a

positive linear relationship, while a negative value indicates a negative linear relationship. The closer the value of r is to 1 or -1, the stronger the linear relationship between the variables. The research flowchart is presented in Figure 1, illustrating the step-by-step process of the study.

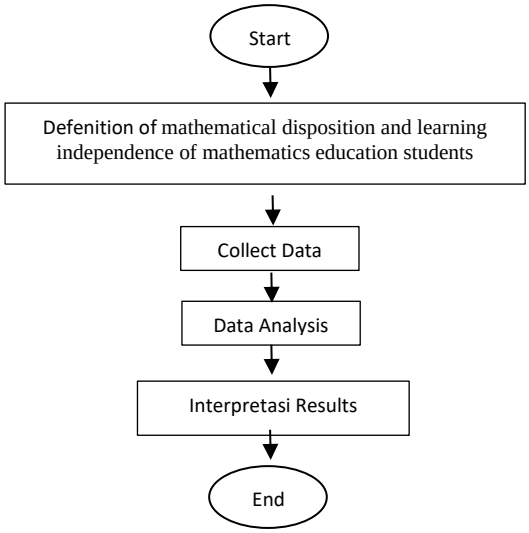

Figure1. Research Flowchart

RESULTS AND DISCUSSION

Questionnaire data was processed and analyzed quantitatively descriptively. The data from this study consisted of two data, namely the learning independence questionnaire data and the mathematical disposition data.

Mathematical Disposition

Mathematical disposition is illustrated in Figure 2.

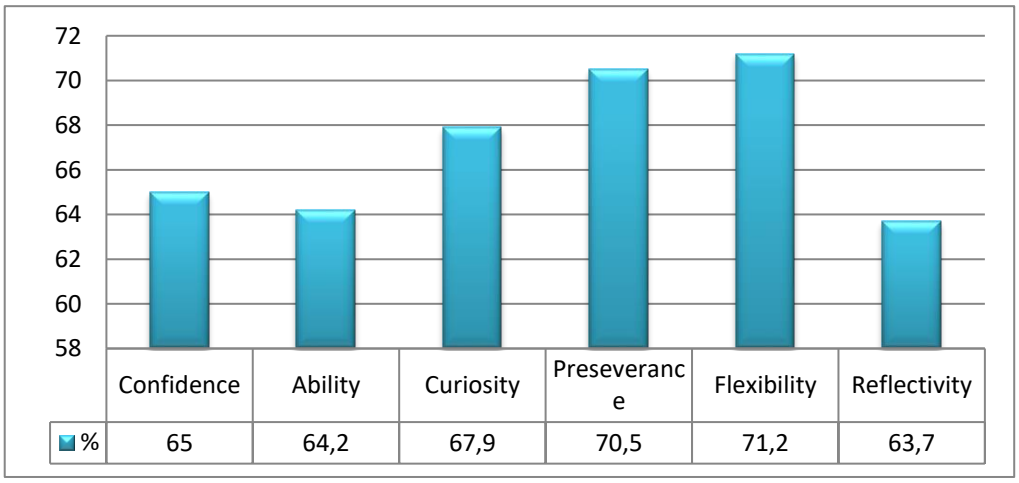

Figure 2. Students' Mathematical Disposition

Figure 1 it is known that overall the level of mathematical disposition of mathematics education students who learn through classical online learning has high criteria with an average percentage of 67.08%. From these results it was found that learning mathematics using blended learning still produces a high mathematical disposition. This can be due to effective applications for use in online learning (Annur & Hermansyah, 2020). The self-confidence possessed by

Mathematics Education students in West Sumatra in using mathematics or when solving mathematical problems through online learning has high criteria with an average percentage of 65%. This can be seen from the average student trying to work on the practice questions given by the lecturer which the students disclosed at the end of the questionnaire. High self-confidence may be due to the easy use of Google Classroom/WhatsApp/Zoom as mentioned by (Utami, 2019) in the results of her research, the media used in online learning is easy for students to use because students can easily access the materials, assignments, and important announcements through PC or smartphones.

Learning Independence

Students' learning independence is illustrated in Figure 3.

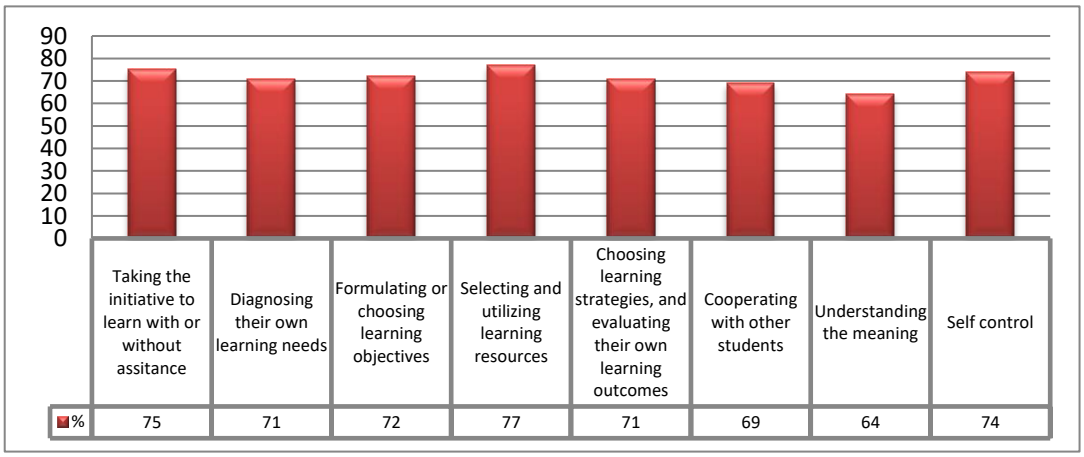

Figure 3. Students' Learning Independence

From figure 2, it is known that overall the level of learning independence of mathematics education students who study through classical online learning has high criteria with an average percentage of 71.63% with high criteria. This shows that student learning independence is very good in carrying out blended learning. This is because online learning media (Google Classroom/WhatsApp/Zoom) is effective in helping students carry out independent learning through its features and ease of use. In accordance DiCicco (2016) argues that online learning allows students to take the lead in learning, helps create greater opportunities for student learning independence, helps students integrate their abilities from one material to another in their learning activities. This is supported by Nurhemah (2018) who states that the use of smartphone media has a significant effect on learning independence.

Recent research by Wang et al., (2021) emphasizes that online learning platforms empower students to take ownership of their learning process, thereby enhancing their learning independence. Similarly, a study by Li & Zhang (2020) underscores the positive impact of online learning on fostering students' autonomy in learning activities. Moreover, research conducted by Zhang & Wang (2022) highlights the significant role of smartphone-mediated learning in promoting students' independence in learning. These studies collectively support the notion that online and smartphone-mediated learning environments contribute to greater student autonomy and independence in their learning journey.

Based on the data obtained from the learning independence questionnaire scores and mathematical dispositions that have been carried out, the analysis was carried out using simple linear regression analysis, can be seen in Table 1.

Table 1. Results of Simple Regression Analysis

Dependent Variable	Free Variables	Regression Coefficient	T	Sig
Learning Independence (Y)	Constant	-20.13	5.21	0.067
	Mathematical disposition (X)	2.15		

Table 1 shows that learning independence (Y) and student mathematical disposition (X) can be expressed in a simple linear regression equation as follows:

$$Y = a + bX$$
$$Y = -20.13 + 2.15X$$

The regression coefficient (b) for mathematical disposition (X) is 2.15, and the significance level is stated as 0.06. A positive regression coefficient suggests a positive relationship between mathematical disposition and learning independence. Specifically, for every one-unit increase in the mathematical disposition score (X), the learning independence score (Y) is expected to increase by 2.15 units. However, it's worth noting that a significance level of 0.06 is relatively high, which may suggest that the relationship between mathematical disposition and learning independence might not be statistically significant at conventional levels (usually set at 0.05). Therefore, it's essential to interpret the results cautiously and consider the potential implications of the significance level on the validity of the findings. To further analyze the data and test the hypothesis, additional statistical tests should be conducted, such as assessing the p-value associated with the regression coefficient (b) to determine its statistical significance. Additionally, examining the confidence interval for the regression coefficient and conducting diagnostic tests for regression assumptions (e.g., normality, linearity, homoscedasticity) can provide further insights into the relationship between mathematical disposition and learning independence among mathematics education students.

Based on the analysis of the Pearson correlation value, the correlation coefficient value of r = 0.73 is obtained, which means that close to 1, then a linear relationship between learning independence and a strong mathematical disposition. The significance level is 0.067 which means that the correlation between variables and is significant. Thus, it can be interpreted that learning independence has a positive effect on mathematical disposition. This result is consistent with findings from Sutrisno Ab (2021) which indicated that mathematical disposition positively influences learning independence. The study highlighted that variations in learning independence levels can be attributed to differences in mathematical disposition among students. Furthermore, research by Warmi & Santoso (2020) underscored the role of blended learning in enhancing student learning independence. Additionally, Muhammad (2020) demonstrated that blended learning approaches significantly impact student autonomy and independence in learning activities. These studies collectively support the notion that blended learning, which integrates online and face-to-face components, contributes to the development of student learning independence.

In general, the variation in learning independence can be attributed to the level of mathematical disposition, with higher levels of mathematical disposition positively influencing learning independence. Recent research by Chen et al., (2021) highlights the significant impact of positive attitudes towards mathematics on students' self-directed learning behaviors. Similarly, findings from a study by Liu & Wu (2020) suggest that a strong appreciation for mathematics correlates with greater autonomy and initiative in learning activities. These recent

studies underscore the importance of fostering positive mathematical disposition in promoting student learning independence.

Mathematical disposition plays a critical role in shaping positive attitudes, beliefs, and behaviors towards learning mathematics. This positive disposition contributes significantly to the development of learning independence, as students with a robust mathematical disposition are more inclined to take initiative, set goals, and autonomously manage their learning processes (Chen et al., 2021). Without addressing and enhancing students' mathematical disposition, it becomes increasingly challenging to cultivate learning independence effectively. This underscores the interconnected nature of attitudes, beliefs, and actions in mathematics learning and highlights the importance of holistic approaches in fostering independent learning (Liu & Wu, 2020). Furthermore, the concept of learning independence aligns with the idea of a constructive, effective, and efficient learning process, wherein students are actively involved in developing their learning plans and goals, as well as managing their cognitive and affective aspects (Yıldızlı & Saban, 2016). These recent studies emphasize the critical role of mathematical disposition in supporting students' autonomy and independence in their learning journey.

In learning mathematics, the importance of students' attitudes or dispositions towards the subject cannot be overstated, as they significantly influence the development of independent learning. Sutrisno Ab, (2021) emphasizes the necessity of cultivating positive attitudes towards mathematics, noting that without such positivity, it becomes challenging to motivate students to engage in learning activities related to the subject. Similarly, recent research by Li & Zhang, (2020) underscores the crucial role of positive attitudes in fostering students' willingness to actively pursue independent learning in mathematics. Furthermore, Feldhaus (2012) asserts that students with a mathematical disposition demonstrate a tendency and habit of regarding mathematics as rational, useful, valuable, and beneficial, fostering traits such as persistence and self-confidence. This aligns with findings from a study by Chen et al., (2021), which highlights the positive impact of mathematical disposition on students' motivation and self-directed learning behaviors in mathematics education. These recent studies collectively emphasize the significance of nurturing positive attitudes towards mathematics as a foundational element for promoting independent learning among students.

Developing a positive mathematical disposition by fostering a favorable attitude towards mathematics is essential for instilling intrinsic motivation in students and promoting their learning independence. Recent research by Li & Zhang (2020) highlights the significance of positive attitudes towards mathematics in enhancing students' motivation and engagement in learning activities. Additionally, findings from a study by Chen et al., (2021) emphasize the role of mathematical disposition in fostering students' self-directed learning behaviors, contributing to their autonomy in mathematics education. Moreover, Sukmadewi (2014) emphasizes that the development of mathematical dispositions is integral to character development in mathematics education. This aligns with research by Wang et al., (2021), which underscores the importance of character education in promoting students' appreciation for the utility of mathematics in real-life contexts. By fostering traits such as curiosity, attention, perseverance, and confidence in learning mathematics, students are better equipped to engage in independent learning activities. These recent studies collectively reinforce the notion that

nurturing a positive mathematical disposition is essential for fostering intrinsic motivation and promoting learning independence among students in mathematics education.

The contribution of this research lies in several key areas. Firstly, it provides empirical evidence of the positive relationship between mathematical disposition and learning independence among Mathematics Education students in West Sumatra. By conducting a descriptive correlational study using survey data and statistical analysis techniques, the research offers valuable insights into these variables' dynamics within the context of mathematics education. Secondly, the findings contribute to validating the theoretical framework emphasizing the importance of fostering mathematical disposition in promoting learning independence. This supports existing theories and concepts in mathematics education. Thirdly, the results inform educational practices by highlighting the significant impact of mathematical disposition on learning independence. This insight can guide the development of instructional approaches and interventions to promote independent learning in mathematics. Lastly, focusing on Mathematics Education students in West Sumatra, the research offers insights into the unique dynamics and challenges within this regional context, providing guidance for educators and stakeholders to address the specific needs of students in the region.

CONCLUSIONS

Based on the analysis of the regression coefficient data, the questionnaire score (b) is 2.15 with a significant level of 0.067. The regression coefficient (b) is positive, so there is a positive influence from mathematical disposition (X) on learning independence (Y), meaning that the greater the value of X, the greater the value of Y. The closeness of the linear relationship between X and Y can be seen from the correlation coefficient r = 0, 73 which means where r is close to 1, so that a strong linear relationship between X and Y is obtained. The conclusion is that there is a positive relationship between mathematical disposition and the learning independence of Mathematics education students in West Sumatra. The higher the ability of students' mathematical dispositions, the more likely these students is to be independent in learning.

The implication of this research is the obligation of lecturers/educators to integrate technology in lectures, so that they are ready to face the challenges of a sudden changing era. Suggestions for further research need to pay attention to the following matters: However, it is important to acknowledge the limitations of this study, particularly regarding the scope of the sample population. Future research endeavors should strive to address these limitations by expanding the sample to include not only students from urban areas but also those residing in remote or underserved areas, such as 3T (tertinggal, terluar, terdepan) regions in Indonesia, as well as globally. This broader sampling approach would enable a more comprehensive understanding of the impact of technological integration on student learning independence across diverse contexts.

AUTHOR CONTRIBUTIONS STATEMENT

YY worked as the main drafter in this research. Data collection and instrument design assisted by MK and JA.

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