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The Impact of Anxiety and Self-Motivation Based on Mathematical Literacy

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ABSTRACT

Mathematical literacy skills play an important role in students' learning success as it helps them understand and apply mathematical concepts in everyday life, while anxiety experienced during the learning process can hinder this ability, and strong self-motivation is needed to drive and sustain actions focused on achieving specific goals. Although extensive research on the impact of mathematics anxiety and motivation has been conducted, few studies have explored the simultaneous interaction of these variables in influencing students' mathematical literacy. This study aims to examine how math anxiety and self-motivation interact and influence students' mathematical literacy skills. This qualitative research with a phenomenological approach involved 66 tenth grade students at a public high school in Jakarta, using the instruments of a mathematical literacy test, anxiety and motivation questionnaires, and an interview guide. The data analysis techniques used are data reduction, data presentation and conclusion drawing. The validity and reliability of the questionnaires were tested with Winsteps 3.73, and three representative subjects were selected through Wright Map. Results showed that students with low anxiety and high motivation had the best mathematical literacy, while students with high anxiety and low motivation showed limitations in problem solving and self-confidence. The findings emphasize the importance of emotional aspects and self-motivation in learning, and offer the novelty of combining both factors to understand the dynamics of students' mathematical literacy.

Keywords: Anxiety, mathematical literacy skills, self-motivation

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Introduction

Situations that can potentially make many students panic and worry are called anxiety, such as in the condition of solving mathematical problems (Khasawneh et al., 2021; Rozgonjuk et al., 2020). Mathematical anxiety can hinder students' skills and thus affect academic achievement and mathematical ability (Fergus & Petrick Smith, 2022; Ismail et al., 2022; Pantoja et al., 2020). In addition, math anxiety is a condition where students feel fear and loss of ideas that make them not confident and unable to control their thoughts when dealing with mathematics, where this condition causes a lack of basic understanding and difficulty in memorizing mathematical formulas (Kaskens et al., 2020; Mutlu, 2019; Prahmana et al., 2019; CV Putri & Miatun, 2023). Therefore, overcoming mathematical anxiety is an important step in increasing self-confidence, developing mathematics skills and achieving better academic results (Patkin & Greenstein, 2020).

Anxiety can motivate students to study harder (Broeck et al., 2021). Motivation is an important part of arousing and regulating student behavior in completing tasks consistently and being actively

involved in learning (Hadi & Faradillah, 2020; Tanti et al., 2020) . Motivation is an internal drive to act and is an important factor in improving students' mathematical abilities and academic grades (Mengyao et al., 2024) . However, there are still many students who lack motivation in their academic achievement (Hadi & Faradillah, 2019) . One type of motivation is self-motivation, self-motivation is an interconnected cognitive and affective process that plays a role in encouraging and sustaining actions that focus on achieving specific goals (Schunk & DiBenedetto, 2021) . Low self-motivation among students is a serious problem that should not be ignored, as it has a negative impact on their educational continuity. When students lack internal drive to learn and develop, they tend to lose interest and eventually choose to drop out of the education system. Therefore, self-motivation should be a key focus in educational strategies, as building strong self-motivation will help students stay on track to achieve academic success and prevent them from dropping out of school (Odanga, 2018) .

Students' anxiety and motivation to learn mathematics greatly affects students' mathematical thinking ski lls. The ability to think mathematically that students must have is with mathematical literacy (ML) skills. ML skills are abilities in mathematics that students use as knowledge, methods, and mathematical processes that are applied in various contexts in an insightful way (Novita & Herman, 2021) . Where the abilities possessed by students are used to investigate, analyze , and interpret mathematical concepts in order to solve related problems (Ramadhan et al., 2023; Suprapto et al., 2023) . Therefore, to understand mathematics learning, ML skills are important to help learners solve problems that arise. The PISA (Program for International Student Assessment) results in 2022 indicate that Indonesia ranks 68th out of 81 participating countries, and Indonesian students are classified in the low category in ML (OECD, 2023) . Therefore, it is important for students to have a strong foundation in ML skills because it can help them in their daily lives by providing skills such as analysis, communication, and effective explanation of ideas related to certain problems (Fatwa et al., 2019) .

Some relevant research on anxiety, self-motivation and mathematical literacy skills. First, Hidayat and Ayudia (2019) conducted research on anxiety and problem-solving skills, finding that anxiety affects students' problem-solving skills. Because the anxiety variable also exists in this study, so researchers analyze anxiety as one of the factors of mathematical literacy ability. Second, Prasetyo and Dasari (2023) conducted research on math anxiety and learning motivation on student learning outcomes showing that anxiety and motivation have an opposite relationship with learning outcomes, where anxiety has a negative impact on learning outcomes and motivation has a positive impact on student learning outcomes. Both variables in Prasetyo and Dasari's research have a positive influence on mathematical learning outcomes, so researchers try to analyze for mathematical literacy skills. Finally, Gabriel et al. (2020) conducted research discussing the impact of math anxiety on self-regulated learning

and mathematical literacy showing that math anxiety has a negative impact on mathematical literacy by affecting perseverance and self-efficacy. These studies show that some affective aspects affect mathematical literacy, so this study analyzes other types of affective aspects such as anxiety and self-motivation. Thus, the novelty of this study is that it contributes new insights by combining anxiety and motivation into an integrated analytical framework to understand the dynamics that influence students' ML. By analyzing the relationship between the three variables, the research questions in this study are (1) how does mathematical anxiety affect students' self-motivation in learning?; (2) how does self-motivation influence students' ML skills?; and (3) how do mathematical anxiety and self-motivation affect students' ML skills?.

Methods

This study aims to provide new insights into how anxiety and self-motivation interact and impact on students' ML skills. This research uses qualitative methods with a phenomenological approach. Phenomenological approach is a tradition of qualitative research rooted in philosophy and psychology, phenomenology focuses on human life experiences with the aim of understanding research subjects from their point of view (Ataro, 2020) . By using this approach, researchers can explore the meaning behind students' experiences and how anxiety and motivation affect their ML skills.

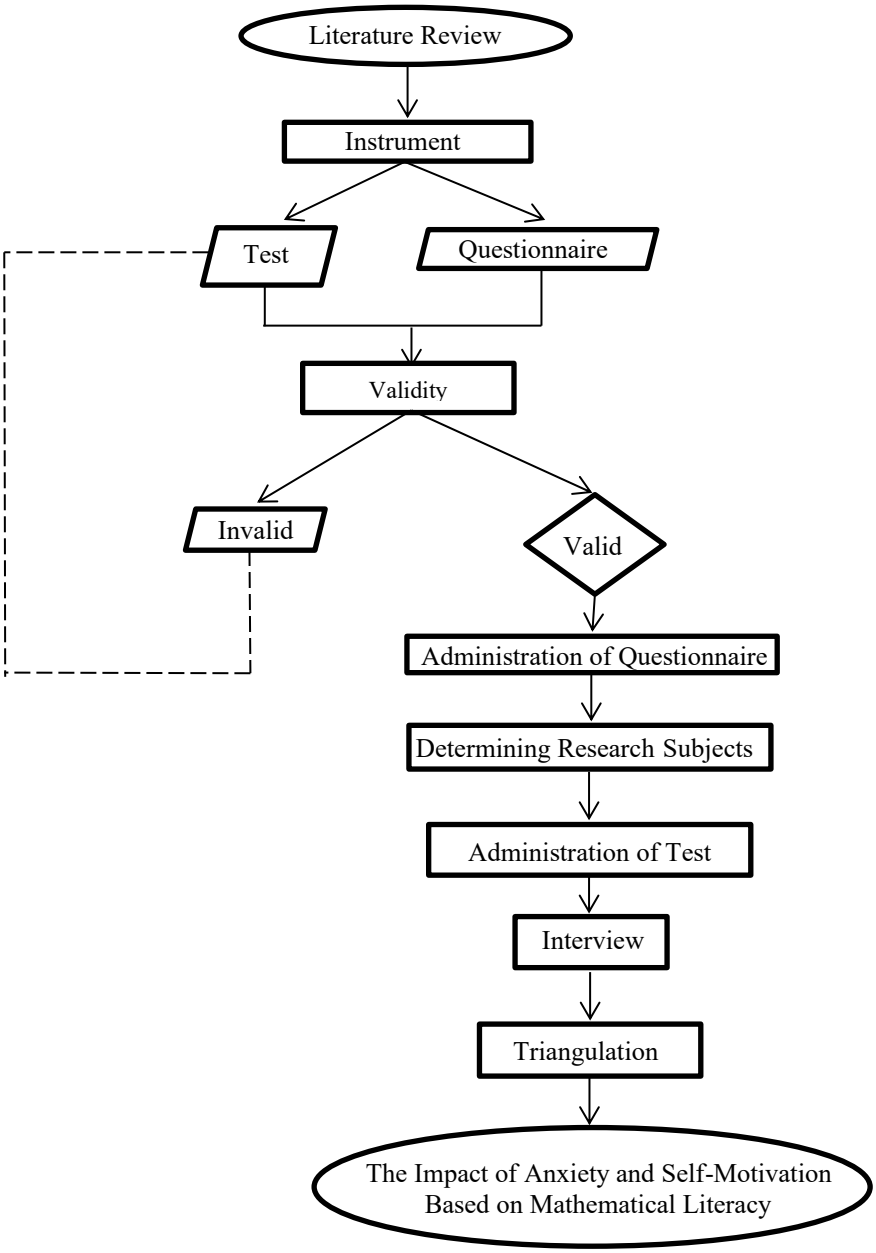

Figure 1. *Research Procedure*

This research was conducted for six months with procedures ranging from researchers compiling instruments and questionnaires, data collection, and data analysis. Data collection in this study used ML test, anxiety and motivation questionnaire, and interview guideline. The ML ability instrument was

adopted from (Kristianti & Handayani, 2023) and (Widyaningrum et al., 2024) and has been tested for validity and reliability. Meanwhile, the anxiety questionnaire (HE Putri et al., 2020) and self - motivation questionnaire (Marsh et al., 2013) require validity and reliability testing due to differences in language and research subjects. In the first validation process, namely content validity, the questionnaire was validated by two validators, namely an English teacher and a Mathematics lecturer, who stated that the questionnaire was suitable for use but with some improvements.

I answered the question in front of the class with confidence even though my answer was wrong. By doing so, I came to understand how to do it correctly.	I always answer questions in front class with full believe myself , even though answer the Possible wrong
A1	***A2***

Figure 2 . *(A1) Before Validity; (A2) After Validity*

Figures 2 show improvements in the sentences provided by the validator. A1 is a questionnaire of mathematical anxiety about cognitive aspects and has not been validated by expert validators. A2 is a questionnaire from A1 that has been validated by expert validators and has been changed into a language that is easy to understand. The questionnaire that will be distributed to the population is a questionnaire that has been modified and adapted to language that is easy to understand. Furthermore, the second validity of the questionnaire, namely construct validity, was tested by distributing questionnaires to high school students with a total of 863 respondents, and the data were processed using Winsteps software.

Table 1. *Misfit Order of The Items*

	Item	MNSQ Outfits (0.50 > x < 1.50)	ZSTD Outfits (-2.00 > x < 2.00)	PT.MEASURE-CORR (0.50 > x < 0.85)
Anxiety	1	1.13	2.91	0.24
	3	1.29	6.01	0.34
	5	0.85	-3.69	0.86
	8	0.80	-4.78	0.37
	12	1.29	6.38	0.37
	15	0.87	-3.14	0.87
	16	0.86	-3.33	0.29

	21	1.37	7.79	0.18
	26	1.15	3.39	0.39
	27	2.00	9.90	-0.57
	28	1.45	9.49	-0.02
	29	1.73	9.90	-0.13
	30	1.33	6.55	0.29
Self	7	2.69	9.90	-0.20
Motivation	8	1.53	9.90	0.42

Table 1 shows that there are three criteria to determine item fit or misfit when using Winsteps . Items that are misfit or do not meet the criteria cannot be used, while results that meet the criteria can be considered fit and retained. The item was then tested using a summary table in WinsSteps and declared reliable.

Data analysis was conducted at a public high school in Jakarta with a population of 66 tenth-grade students from two different classes. The data that has been obtained will be processed in Ms. Excel, which will then be analyzed with Winsteps 3.73 software. The researcher will choose the Wright Map contained in the Winsteps software to select three students who will be used as research subjects based on the anxiety and motivation categories, namely high, medium, and low. Wright Map is a visualization tool that maps the distribution of students' abilities to the difficulty level of the item (Omolade, 2025) .

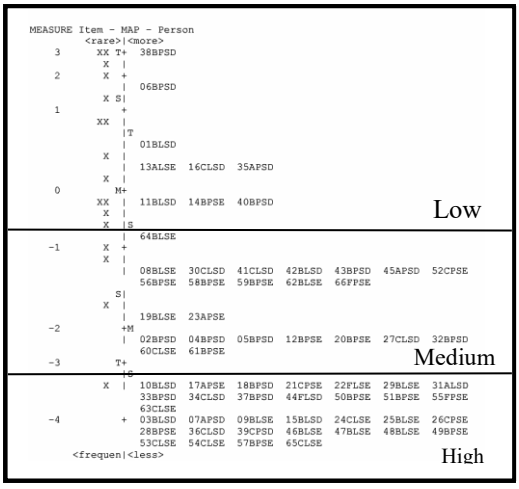

Figure 3. *Wright Map Anxiety Results*

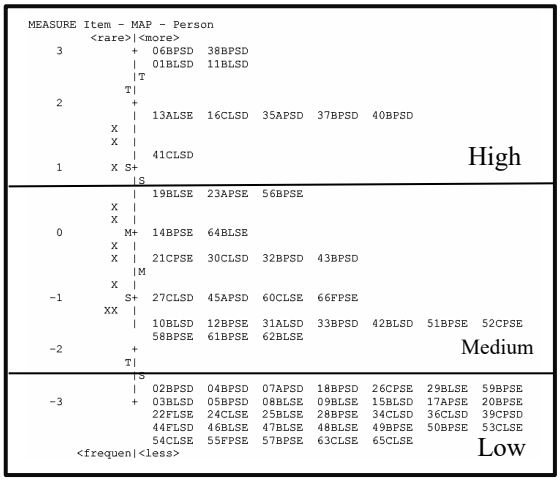

Figure 4. *Wright Map Self-Motivation Results*

Based on Figures 3 and 4, it can be seen that students with high anxiety are the most numerous compared to other levels, while students with high self-motivation are the least numerous among other levels. From this data, three subjects will be selected based on the anxiety and motivation categories that

have been determined to be given a ML ability test and continued with interviews conducted by researchers on the subject. The following is the code of the subject that has been selected:

Table 2. *Subject of Anxiety-Motivation*

Category	Code
Low Motivation and High Anxiety	S1
Moderate Motivation and Moderate Anxiety	S2
High Motivation Low Anxiety	S3

Table 2 is a subject that has been selected based on the Wright Map results that have been presented according to the anxiety and motivation categories. Based on this table, there are subjects who have low levels of motivation and high levels of anxiety, where subjects who have high anxiety will cause negative feelings when participating in the mathematics learning process (Suren & Ali Kandemir, 2020) .

Results and Discussion

The data presented in this study are descriptive of the results of research instruments and interviews conducted with research subjects. Three subjects took the test using an instrument in the form of a description of ML skills that had been compiled in accordance with competency indicators and standards. Participants were given a score of 0-3 for each indicator, with each question covering all indicators, so that the maximum score that could be obtained was 12.

Table 3. *Results of Mathematical Literacy Remaining Score*

Subject Code	Indicators			
	1	2	3	4
S1	1	1	1	0
S2	2	2	2	2
S3	3	3	3	3

Table 3 shows the subjects' scores based on ML indicators. The first indicator of ML is comprehension, followed by analysis, representation, and communication.

Fulfillment of Food Needs

Fulfilling food needs and maintaining food security is very important for Indonesia. This is because the population is very large with a wide and dispersed geographical coverage. Indonesia needs food in sufficient quantities and spread out and meet the criteria for consumption and logistics. Achieving food sovereignty is not an easy step. The government provides assistance to farmers in the form of fertilizer subsidies and free seeds as well as agricultural tools and improvement of immigration channels. It aims to increase the production of rice, corn and soybeans. The following data and targets will be achieved from 2014 to 2019.

Food increase every year must increase in order to meet the target. If the annual food increase is constant (forming an arithmetic sequence) and the target is expected to be achieved, what is the target annual increase of corn, soybean, rice?

Figure 5. *ML Skill Question*

The figure 5 is a question that will be given to the subject and contains four indicators of ML skills. The following is a presentation of the results of the analysis of written answers and interviews from each subject

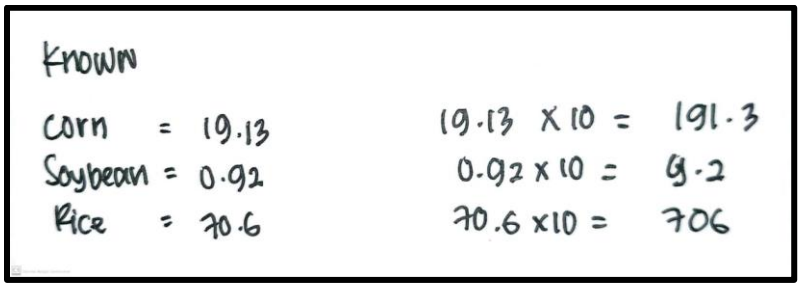

Figure 6. *Answer of S1*

Figure 6 shows S1 had a fairly good understanding of the relevant information, was able to perform basic level analysis to process the data, and was able to represent the initial steps quite clearly. However, in the communication aspect, there were obstacles in providing a complete final solution, which was reflected in the problem solving that stopped before arriving at a complete answer regarding increasing the annual target of corn production due to its inability to solve the given problem with the right solution.

Researcher : *What was the first step you took to understand this math problem, especially when you felt anxious while working on the problem?*

S1 : *First, I read the problem first to understand the problem, and I felt difficult and confused about the problem, which made me not know the formula to solve the problem. Therefore, I solved it using the method that I knew.*

Based on the results of S1 interview answers, it can be seen that S1 mathematical literacy skills are still lacking in understanding the mathematical information and concepts presented in the problem, this is in line with Simamora & Tilaar (2021) , which states that students are less able to reason to understand the problems contained in the problem.

The incompleteness of the answer explains that high anxiety often has a negative impact on math solving, such as feeling anxious and having difficulty concentrating during learning. This is in line with research (Nurjanah & Alyani, 2021) , which shows that students with high anxiety always feel anxious and feel unable to follow a series of lessons to get ideas for solving problems. In addition, low self-motivation makes S1 lack the confidence to achieve a certain goal (Nurwendah & Suyanto, 2019) . This was reinforced by the emergence of nervousness and uneasiness when interviewed, S1 felt unable to think calmly during the learning process so that he did not have the confidence to solve the problem.

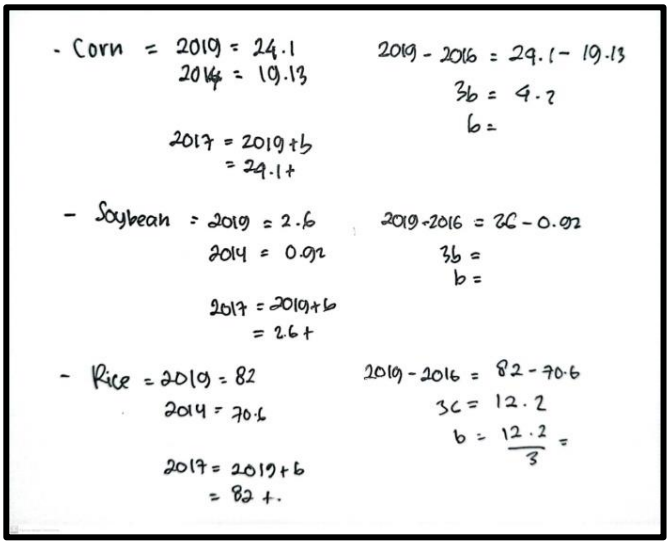

Figure 7. *Answer of S2*

Figure 7 shows that S2 has a fairly good understanding of the content of the problem and performs the analysis process correctly. The presentation of data is quite good and systematic, as well as communication which is seen through a sequence of steps that are logical and easy to understand. This score shows that S2 is a student who has a moderate level of anxiety and self-motivation.

Researcher : *What was the first step you took to understand this math problem, especially when you felt anxious while working on the problem?*

S2 : *The first step I took was to read the question carefully because there was a lot of information there, then I started to enter information according to the question's instructions such as the beginning and end-of-year targets for corn, rice and soybeans. I felt anxious when I was confused about the formula in the middle of working and I made sure the question was correct.*

The interview showed that S2's mathematical literacy skills were quite good in understanding the information and objectives of the problem, but still wrong in determining the formula to work on it. Students are able to understand the problem well and can determine the purpose of the question being asked, but are still not correct in deciding the concept or formula to be used (Simamora & Tilaar, 2021) .

The moderate level of anxiety possessed by S2 makes him feel tense during the process of solving problems (Hakim & Adirakasiwi, 2021) . Because S2 has a moderate level of self-motivation, S2 takes the initiative to solve problems gradually and follow the flow of logic to solve problems. Highly self-motivated students set challenging goals for themselves to improve performance and achieve a goal (Nurwendah & Suyanto, 2019) . Self-motivation becomes the driving energy that directs student behavior to achieve their learning goals, not just a momentary desire but a sustainable and directed force.

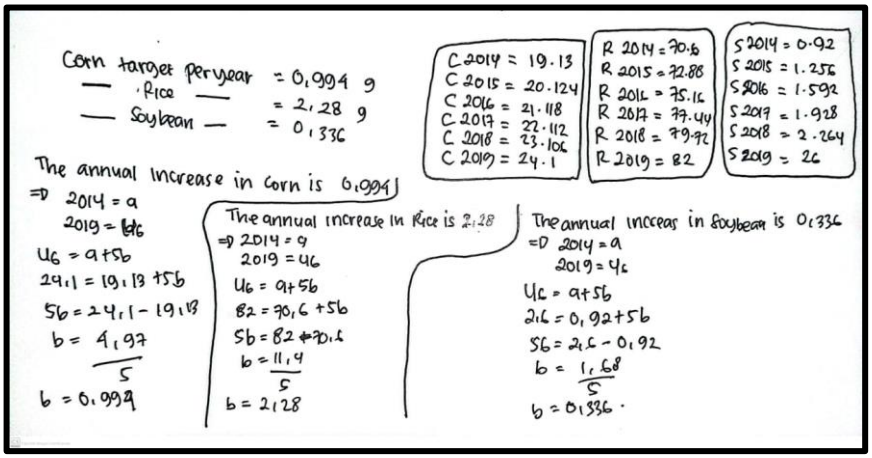

Figure 8. *Answer of S3*

Figure 8 demonstrated excellent understanding, analysis, representation, and communication with a score of 3 on each indicator. Thus indicating no significant obstacles in understanding and completing the given questions.

Researcher : *What was the first step you took to understand this math problem, especially when you*

felt anxious while working on the problem?

S3 : *First of all, I read the question first and then I understand the picture in the question to make sure the information in the question is correct in the picture. Because the question was told to find the annual target of corn, rice and soybeans, so I immediately worked on it with the formula for the arithmetic sequence that I had learned before .*

The results of the interview show that S3's mathematical literacy skills are good at understanding the information and objectives of the problem so that S3 can determine the formula to be used to solve the problem. Similarly, Simamora & Tilaar (2021) state that students are able to understand the problem well so that they are able to decide the purpose of the problem posed and are able to determine the concepts and formulas that will be used to solve the problem.

S3 shows that low anxiety frees up students' cognitive capacity to think clearly and focus fully on problem solving, allowing accurate presentation of information without being distracted by excessive worry, because according to Artama et al (2021) , low anxiety will affect the high learning outcomes obtained. On the other hand, high self-motivation can encourage and improve skills to perform better in academics (Moneva et al., 2020) . This was also seen in the interview session, where S3 answered questions confidently and was able to explain the steps taken to solve the problem smoothly and smoothly.

Based on the results of the answers and interviews, proving that math anxiety and self-motivation have a significant influence on students' ML skills, where both are closely related and affect how students learn, students with low levels of anxiety tend to exhibit high self-motivation and superior ML skills. Therefore, a calm, supportive and stress-free learning environment is essential to facilitate optimal learning (Ebadi et al., 2019) . In contrast, students with moderate levels of anxiety require support and structured learning strategies to maintain self-motivation and improve their ML skills to a better level, avoiding potential increases in anxiety that could hinder progress. Furthermore, students with high anxiety and low self-motivation require more intensive interventions, focusing not only on mathematics content but also on reducing anxiety and fostering self-motivation from within, given that negative affective states can be a major barrier in developing adequate ML skills. Anxiety management and increased self-motivation are key to boosting students' mathematical literacy skills, therefore educators need to create a positive classroom atmosphere, build students' confidence, provide emotional support, and adapt teaching methods to accommodate students' varying levels of anxiety and self-motivation thereby increasing student engagement to achieve effective mathematics learning for all students (Gholami et al., 2021; Hammoudi, 2020; Saha et al., 2024).

Conclusion

The conclusion of this research answers the research questions above, namely. First, math anxiety negatively affects students' self-motivation. Based on the interview results, students with high math anxiety (S1) tend to have low self-motivation. Anxiety makes them feel unconfident, confused, and difficult to understand the concepts and information needed to learn mathematics. In contrast, students with low anxiety (S3) actually have high self-motivation because they feel calm and confident that they can understand the material. Second, self-motivation has a positive effect on mathematical literacy skills. Students with high self-motivation (S3) are able to think clearly, understand the meaning of the problem well, and determine the correct formula to solve the problem. Meanwhile, students with low self-motivation (S1) had difficulty in understanding mathematical information and concepts. Students with moderate motivation (S2) showed a fairly good understanding, but still needed support to improve the accuracy in determining the formula. Third, math anxiety and self-motivation are closely related and together affect students' mathematical literacy skills. The combination of low anxiety and high self-motivation (S3) produces good mathematical literacy skills because students can think calmly, understand the problem, and determine the formula correctly. Conversely, high anxiety and low self-motivation (S1) inhibit students' understanding and confidence, resulting in low mathematical literacy skills. For students with moderate anxiety and motivation (S2), their mathematical literacy skills are quite good, but not optimal, so they still need support to improve the accuracy of problem solving.

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