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The Relationship Between Self-Determination and Metacognition of Junior High School Students in Mathematics Learning Based on Gender

Iryana Muhammad[1], Al Jupri[2*], Jarnawi Afgani Dahlan[3], dan Turmudi[4]
[1*,2,3,4] Universitas Pendidikan Indonesia, Bandung, Indonesia
**Corresponding author*
Email: iryana.muhammad@upi.edu[1] , aljupri@upi.edu[2*] jarnawi@upi.edu[3] , turmudi@upi.edu[4]

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ABSTRACT

This research is a quasi-experimental research that aims to determine the relationship between metacognitive abilities and students' self-determination in mathematics subjects based on gender. The population in this study were all students in class VIII of Lhokseumawe City Islamic Middle School with a sample of 27 students. Data was obtained from the results of a self-determination ability questionnaire and a metacognitive questionnaire which was then carried out by Spearman correlation testing. The results of the correlation between metacognitive abilities and self-termination obtained a significance value which shows that there is a correlation between metacognitive abilities and students' self-determination in learning mathematics. For the correlation between metacognitive abilities and students' self-determination in learning mathematics in terms of gender using the Spearman correlation test for each gender, correlation values were obtained for males (r_1) and females (r_2). Based on the results of the difference test between the means of two independent groups, a z-count value was obtained which shows that there is no difference in correlation between the two groups.

ABSTRAK

Penelitian ini merupakan penelitian quasi eksperimen yang bertujuan untuk mengetahui hubungan kemampuan metakognitif dengan determinasi diri siswa pada mata pelajaran matematika berdasarkan gender. Populasi dalam penelitian ini adalah seluruh siswa kelas VIII SMP Islam Kota Lhokseumawe dengan sampel 27 siswa. Data diperoleh dari hasil angket kemampuan determinasi diri dan angket metakognitif yang selanjutnya dilakukan pengujian korelasi spearman. Hasil korelasi kemampuan metakognitif dengan self-termination diperoleh nilai signifikansi yang menunjukkan terdapat korelasi antara kemampuan metakognitif dengan self-determination siswa dalam belajar matematika. Untuk hubungan korelasi antara kemampuan metakognitif dengan determinasi diri siswa dalam pembelajaran matematika ditinjau dari gender dengan uji korelasi spearman untuk setiap jenis kelamin diperoleh nilai korelasi untuk laki-laki (r_1) dan perempuan (r_2). Berdasarkan hasil uji beda dua rata-rata dua kelompok yang saling independen diperoleh nilai z-hitung yang menunjukkan tidak terdapat perbedaan korelasi antara kedua kelompok tersebut.

INTRODUCTION

Mathematics subjects equip students with ways of thinking, reasoning, and logic through certain mental activities that form a continuous flow of thinking and culminate in the formation of a flow of understanding of mathematics learning material in terms of facts, concepts, principles, operations, relations, problems, and certain mathematical solutions that are formal-universal. Based on the results of interviews with teachers, it can be concluded that problems in learning mathematics do not always start with students having difficulty understanding the content of mathematics well, but this does not rule out the possibility that it is caused by affective abilities. Based on students' psychological affective abilities, namely students' readiness to study affective dimensions, also needs to be studied in students, because these psychological characteristics can provide teachers with an idea of students' psychology (Afgani et al., 2019). As an attitude when dealing with mathematics in the form of students' abilities in determining the important parts that must be learned, this is part of students' metacognitive abilities in mathematics. Metacognitive ability is the ability to know the important parts of learning, as well as the success factors of children in the future depending on how optimal the development of all aspects of students is at this time (Hoorfar & Taleb, 2015: Tjalla & Putriyani, 2018).

Metacognitive processes in learning and solving mathematical problems include decisions to determine alternative solutions, complete answers, stop trying to find solutions, and spend free time. (Morsanyi et al., 2019). Metacognitive is the ability to understand and determine one's cognitive activity in the learning process so that with metacognitive abilities, students can know how to learn, their abilities and learning modalities, and the best learning strategies for effective learning. Metacognitive abilities have an important role in regulating and controlling one's cognitive processes in learning and thinking so that learning and thinking done by students in learning mathematics become more effective and efficient (Firmasari & Juandi, 2021; Kholid & Kurniawan, 2022a; Saputra & Andriyani, 2018; Zakiah, 2020; Tjalla & Putriyani, 2018). Two metacognitive skills are important in problem-solving, namely self-monitoring and planning. Self-monitoring refers to an individual's ability to check the problem-solving process directly. Planning involves breaking down a complex problem into sub-sub objectives to solve them separately and sequentially to enrich the final solution.

By having metacognitive abilities, students will know what is important and what is not important in identifying knowledge that supports problems that must be solved regarding learning mathematics. Thus, metacognitive abilities become one of the important abilities that must exist in students in the process of self-organization to be able to control the process of thinking themselves in each stage of the problem-solving process when learning mathematics, hence the metacognitive abilities possessed by students in learning mathematics will make them able to condition and cognitively sort out what is needed and what stages must be taken in learning to solve problems

Mathematics is a tool for developing students' ways of thinking, thus the role of mathematics as a basic science has a value strategy in developing ways of thinking logically, acting critically, and behaving rationally (National Council of Teachers of Mathematics, 2000), therefore, the ability to make choices within themselves is very helpful for students in learning mathematics. Humans who involve experience to choose, or experience internal perceived locus of causality (internally felt locus of causation) apart from cognitively in terms of psychology, some elements become factors of student readiness in learning and guide themselves in preparing for the direction to be achieved in learning, one of these factors is the ability of self-determination (Deci & Ryan, 2008). Therefore, mathematics

teachers are required not only to master mathematical material, but also to understand students' psychological states (Hidayat & Maharani, 2023). Self-determination includes three psychological needs: competence, autonomy, and relationship needs (Legault, 2017; Mamahit & Situmorang, 2017). The need for autonomy reflects an individual's desire to have control over their actions and decisions. This means that a person feel more motivated and committed when they can choose the activities they do and have freedom in determining how they do them. In other words, autonomy provides a sense of freedom and ownership over their behavior, increasing satisfaction and performance. The need for competence reflects the desire to interact with the environment effectively and feel capable of carrying out challenging tasks. Individuals who feel competent tend to have a high sense of self-confidence in their ability to achieve desired results. They are also motivated to continue learning and improving their skills, as well as to avoid failure and achieve success in various aspects of life. The need to experience relatedness or social connection involves feeling connected to other people and belonging to a particular group or community. Humans are social creatures, and feeling accepted, valued, and supported by the social environment is essential to their emotional well-being. When individuals feel that they have strong, positive relationships with others, they tend to be happier, less stressed, and more motivated to contribute to group activities.

These three needs, if successfully applied, can increase self-motivation and mental health; conversely, if they fail, they will reduce motivation (F. Rahman et al., 2020; Wilujeng, 2018). The ability of self-determination is the ability, in the form of self-encouragement to make choices, to assess one for the abilities possessed, and to be able to push oneself toward achieving goals. Self-determination theory assumes that all humans have three basic psychological needs important for their well-being and intrinsic motivation. These needs are the need for autonomy, the need for competence, and the need to feel connected to their social environment.

Self-determination theory emphasizes the importance of these three basic needs in influencing an individual's motivation and psychological well-being. When the needs for autonomy, competence, and relatedness are met, individuals tend to be more intrinsically motivated, more satisfied with their lives, and better able to achieve their personal and professional goals. Conversely, when one or more of these needs is not met, individuals may experience decreased motivation, dissatisfaction, and various psychological problems

Self-determination comes in the form of intrinsic motivation, which shows a person's desire to seek new knowledge and discover new things within himself. Motivation can also be said to be a series of efforts to provide certain conditions so that someone wants and wants to do something, and if he doesn't like it, then he will try to avoid the feeling of dislike (Kanda, 2020). Self-determination theory posits that intrinsic motivation is a form of self-determination, reflecting a person's desire to seek new knowledge and discover new things within themselves. Intrinsic motivation refers to an internal drive that makes someone interested in an activity for its own sake, rather than for external rewards or pressures. For example, someone who reads a book because they enjoy the process of learning and the knowledge gained, rather than to earn good grades or praise from others, is driven by intrinsic motivation. Motivation can also be described as a series of efforts to create specific conditions that make someone want to engage in an activity (Kanda, 2020). If a person dislikes an activity, they will try to avoid the feeling of dislike. For instance, in a work context, an employee who feels uncomfortable with assigned tasks might look for ways to avoid those tasks or seek another job that better aligns with their interests and skills.

The ability to self-motivate is a crucial aspect of self-determination. When individuals can create conditions that support intrinsic motivation, they are more likely to feel satisfied and motivated in the long term. Conversely, reliance on external motivation, such as material rewards or social recognition, tends to result in more fragile and less enduring motivation.The theory distinguishes motivation into three forms: amotivation, intrinsic motivation, and extrinsic motivation(Mamahit & Situmorang, 2017). Amotivation is the attitude of someone who has no motivation for something. Intrinsic motivation is more about someone's encouragement to do something because of an inner urge or interest. Or, it is because the individual feels happy about doing something. On the other hand, extrinsic motivation refers to a person's drive to do something due to outside factors or a specific purpose, such as getting a reward and avoiding punishment (Reiss, 2012). Many things affect the level of self-determination, there are at least three forms of student responses in responding to the process of goals: first, students who go through a conscious process to achieve what goals will be achieved; second, students who go through the process are not sure or have difficulty recognizing what life goals they want to achieve; and third, students who go through a conscious process of what goals will be achieved but don't do anything to achieve them (Annisa et al., 2023). Therefore, people who have high self-determination will also have high qualities when making choices and decisions and will be free from undue bad influences. Subsequently, the behavior adopted by a person tends to show his true desire, not because of coercion or intervention (Habibi et al., 2018).

If students have a good and high level of self-determination, they will be enthusiastic or motivated to achieve goals, especially satisfying learning outcomes as expected. This is because motivation is a stimulus that comes from within and outside of humans to obtain the desired goals (Feronika et al., 2021). The results of the study show that students who are motivated towards their assignments will be able to carry out these tasks properly and independently and have a high level of creativity in carrying out their assignments, so students are expected to be able to produce satisfying learning achievements.

The relationship between self-determination and students' metacognition in mathematics is a compelling area of study that offers valuable insights into how students learn and perform in this subject. Exploring this relationship further can help educators understand how intrinsic motivation influences students' ability to plan, monitor, and evaluate their own learning processes in mathematics. This understanding can lead to the development of targeted instructional strategies that not only enhance students' mathematical skills but also foster a deeper, more self-directed approach to learning. Additionally, studying this relationship can reveal how fostering metacognitive skills and self-determination can contribute to improved problem-solving abilities, greater persistence in tackling challenging tasks, and overall academic success in mathematics.. As previous research has related to the correlation between math anxiety and metacognitive abilities, Mathematical anxiety and metacognitive processes (Morsanyi et al., 2019); Analysis of students' self-determination in learning mathematics (Wilujeng, 2018); Self-Determination and Knowledge Technology Pedagogical Content (TPACK) (Lestari et al., 2021). Based on the results of previous studies, epistemologically, it is known that psychological factors have a large influence on one's self in making decisions, and cognitive factors are also an important factor for students in solving math problems. The readiness and interest of students in learning will have a big influence on their attitude toward learning. Especially in mathematics, a subject that is considered difficult to understand, students tend to find it difficult to determine what steps to take in solving problems. The theory of self-determination holds significant importance in comprehending the underlying processes of

motivation and achievement, especially concerning mathematics, due to its profound influence on students' learning approaches. The desire for self-determination shapes how students engage with mathematical concepts, problem-solving strategies, and learning tasks. By fostering autonomy, competence, and relatedness within educational settings, educators can enhance students' intrinsic motivation to explore mathematical ideas, persist through challenges, and achieve deeper understanding. This theory underscores the critical role of internal motivation in driving academic success and fostering lifelong learning skills in mathematics. Understanding these dynamics can inform educators' efforts to create supportive learning environments that empower students to take ownership of their mathematical learning journeys effectively (Hofer et al., 2022).

Besides the differences in student readiness for learning, another difference that teachers should also pay attention to is gender (M. M. Rahman et al., 2016). stated that gender is the difference in roles, functions, characteristics, positions, responsibilities, and behavioral rights for both women and men that are formed, created, and socialized by the local community's norms, traditions, habits, and beliefs (Patricia & Zamzam, 2019). Gender differences cannot be denied by anyone. As educators, you have to be aware of these differences to make student learning successful. Gender differences affect the way students learn. Girls are stronger in verbal and emotional areas, while boys are more inclined toward kinesthetic and visual-spatial activities. What is important to girls may not be important to boys (Hofer et al., 2022). Therefore, it is necessary to study the relationship between self-determination and metacognition in junior high school students' learning of mathematics in terms of gender with the subject of junior high school students in the city of Lhokseumawe.

METHODS

This research is a correlational study that aims to analyze the relationship between self-determination and metacognition in terms of gender. The research was conducted from April to May 2022. The population in this study were students of Class VIII at SMPIT Lhokseumawe. There are four classes, consisting of VIII-1 and VIII-3 (male students) and VIII-2 and VIII-4 (female students). The students were randomly selected. Students from VIII-1 and VIII-2 classes were selected as the sample. 27 students from classes VIII-1 and VIII-2 at SMPIT Almarkazul Islami Lhokseumawe City are the sample for this study. The data collection technique used was a Likert scale questionnaire with four responses. The data collection technique employed in this study involved the use of a Likert scale questionnaire comprising four response options. A Likert scale is a commonly used method in research to measure attitudes, opinions, or perceptions of respondents towards specific statements or topics. Typically, respondents are presented with a series of statements and asked to indicate their level of agreement or disagreement on a scale, ranging from strongly agree to strongly disagree, with four response choices in this instance. Using a Likert scale questionnaire allows researchers to gather quantitative data on the preferences, beliefs, or evaluations of respondents related to the subject under investigation. Responses provided by participants are then aggregated or statistically analyzed to discern patterns or trends in their viewpoints. The research instrument is in the form of a metacognitive questionnaire and self-determination, which were validated first and then tried out. From the test results obtained, 16 valid statements out of 22 statements compiled in the metacognitive questionnaire and 20 valid statements out of 28 statements in the self-determination questionnaire were obtained. The two questionnaires were prepared based on aspects of each indicator.

Data analysis techniques were carried out descriptively and inferentially. Descriptive analysis was used to obtain a statistical picture of metacognitive variables and self-

determination. Inferential analysis aims to examine the strength of the relationship between metacognition and self-determination both as a whole and based on gender (men and women). Hypothesis testing used the Spearman rank correlation test and the correlation comparison test between male and female groups.

RESULT AND DISCUSSION

The calculation of metacognitive variables consisted of 16 (sixteen) statements made by 27 students, consisting of 10 female students and 17 male students. It is shown in the Table 1:

Table 1. Statistics Descriptive of Metacognitive Ability

	N	Minimun	Maximum	Mean	Std. Deviation
Metacognitive	27	38.00	54.00	47.3333	4.32346
Valid N (listwise)	27				

Based on table 1, it shows a standard deviation value of 4.32 with a low value (close to zero), which indicates that the data has a more aggregated dispersion level and is not too scattered. In the context of metacognitive abilities, this may indicate that individuals in the population have similar or consistent levels of metacognitive abilities.

The calculation of the self-determination variable consisted of 20 (twenty) statements made by 27 students, consisting of 10 female students and 17 male students. It is shown in the table 2:

Table 2. Statistics Descriptive of Self-Determination Ability

	N	Minimum	Maximum	Mean	Std. Deviation
Self Determination	27	42.00	70.00	58.3704	6.03291
Valid N (listwise)	27				

Based on table 2, it shows a standard deviation value of 6.03 with a low value (close to zero), which indicates that the data has a more aggregated dispersion level and is not too scattered. In the context of self-determination, this may indicate that individuals in the population have similar or consistent levels of self-determination.

Calculating the correlation value of Metacognitive and Self-Determination variables with the Spearman correlation formula. Based on the analysis with SPSS, the output is that the relationship between gender and students' metacognitive abilities and self-determination was analyzed using Spearman's correlation analysis, as shown in Table 3.

Table 3. Correlation of Students' Metacognitive Ability and Self-Determination

			Metacognitive	DD
Spearman's rho	**Metacognitive**	Correlation Coefficient	1.000	.716**
		Sig. (2-tailed)	.	.000
	DD	Correlation Coefficient	.716**	1.000

		Sig. (2-tailed)	.000	.

Based on the SPSS output of the Spearman correlation test, a significant value of 0.000 was obtained, which indicated sig< 0,05 so, H_0 was rejected (there is a correlation between metacognitive variables and self-determination).

Calculating the correlation value of Metacognitive and Self-Determination variables in male students with the Spearman correlation formula, if the significance value is more than 0.05, then. H_0 is accepted.

Table 4. The Relationship Between Metacognitive Ability and Self-Determination in Male Students

			MT_LK	**DD_LK**
Spearman's rho	**MT_LK**	Correlation Coefficient	1.000	.759**
		Sig. (2-tailed)	.	.000
		N	17	17
	DD_LK	Correlation Coefficient	.759**	1.000
		Sig. (2-tailed)	.000	.
		N	17	17

Based on the SPSS output of the Spearman correlation test, a significant value of 0.000 was obtained, indicating sig < 0,05 thus, H_0 rejected (there is a correlation between metacognitive variables and self-determination in male students). Male students with high metacognitive abilities will also have high self-determination abilities.

Calculating the correlation value of Metacognitive and Self-Determination variables in female students with the Spearman correlation formula.

Table 4. The Relationship Between Metacognitive Ability and Self-Determination in Man Students

			MT_PR	**DD_PR**
Spearman's rho	**MT_ PR**	Correlation Coefficient	1.000	.584
		Sig. (2-tailed)	.	.076
		N	10	10
	DD_ PR	Correlation Coefficient	.584	1.000
		Sig. (2-tailed)	.076	.
		N	10	10

Based on the SPSS output of the Spearman correlation test, a significant value of 0.076 was obtained, indicating sig > 0,05 so H_0 is accepted (there is no correlation between metacognitive variables and self-determination in female students). Female students with high metacognitive abilities will not have high self-determination abilities either. This was also influenced by the small sample value (10 students). As in the test of two different variables, we must develop a null hypothesis and its alternatives. The arrangement of the alternative hypothesis is similar to the mean difference test. It can be directional or non-directional. This is following the theoretical studies conducted by researchers. Accordingly, the hypothesis being tested is as follows:

$H_0 : \rho_1 - \rho_2 = 0$
$H_0 : \rho_1 - \rho_2 \neq 0 (< or >)$
To test it, the z statistic is used, by:

$$z = \frac{(z'_1 - z'_2) - 0}{\sigma_{z'_1 - z'_2}} \quad (1)$$

z' value using the formula below:

$$z' = 0{,}5 \ln \left(\frac{1+\rho}{1-\rho}\right) = \frac{1}{2}\{ln(1+r) - \ln(1-r)\} \quad (2)$$

The standard deviation is calculated as follows:

$$\sigma_{z'_1 - z'_2} = \sqrt{\frac{1}{n_1 - 3} + \frac{1}{n_2 - 3}} \quad (3)$$

The critical point for rejecting the hypothesis can be determined using the standard normal table, with decisions adjusted to the hypothesis being tested.
As an example for the case above, the hypothesis being tested is as follows:
$H_0 : \rho_1 - \rho_2 = 0$
$H_1 : \rho_1 - \rho_2 \neq 0$
Example $r_1 = +0{,}759 and\ r_2 = +0{,}584, with\ n_1 = 17\ and\ n_2 = 10$. Then obtained:

$$z'_1 = 0{,}5 \ln \left(\frac{1+\rho}{1-\rho}\right) = \frac{1}{2}\{ln(1+r_1) - \ln(1-r_2)\}$$
$$z'_1 = \ln \frac{1}{2}\{ln(1+0{,}759) - \ln(1-0{,}759)\}$$
$$z'_1 = \ln \frac{1}{2}\{0{,}567 - (-1{,}423)\}$$
$$z'_1 = \ln \frac{1}{2}(1{,}99)$$
$$z'_1 = -0{,}005$$

Next, determine the value z'_2 with the following calculations:

$$z'_2 = 0{,}5 \ln \left(\frac{1+\rho}{1-\rho}\right) = \frac{1}{2}\{ln(1+r_2) - \ln(1-r_2)\}$$

$$z'_2 = \ln \frac{1}{2}\{ln(1+0{,}584) - \ln(1-0{,}584)\}$$
$$z'_2 = \ln \frac{1}{2}\{0{,}459 - (-0{,}877)\}$$
$$z'_2 = \ln \frac{1}{2}(1{,}336)$$
$$z'_2 = -0{,}4035$$

and the standard deviation value:

$$\sigma_{z'_1 - z'_2} = \sqrt{\frac{1}{17-3} + \frac{1}{10-3}} = 0{,}46$$

Thus, the results obtained:

$$z = \frac{(-0{,}005 - (-0{,}4035)) - 0}{0{,}46}$$
$$z = \frac{(0{,}3985) - 0}{0{,}46}$$
$$z = 0{,}866$$

If we choose the significance level 0,05 then the critical point is $z \leq -1{,}96\ atau\ z \geq 1{,}96$. Because the z count is between -1,96 and 1,96, then we accept H_0. This means that there is no difference in correlation between the two groups.

Based on the results of the hypothesis testing that has been done, there is a relationship between metacognitive abilities and students' self-determination abilities in mathematics. Likewise, in the analysis of the relationship between metacognitive abilities and self-termination in male students, it also shows that there is a relationship between the two variables, which indicates that if the metacognitive abilities of male students are high, the ability to self-terminate will also be high. The value of the correlation coefficient on the relationship between metacognitive abilities and self-determination in male students shows a value of 0.759, this means that about 70% of metacognitive abilities and self-determination abilities correlate above the median value of the two data groups. The value of the correlation coefficient on the relationship between metacognitive abilities and self-determination in female students was obtained at 0.584, this means that 58% of metacognitive abilities and self-determination abilities correlated above the median value of the two data groups. The difference in the value of the correlation coefficient between the relationship between metacognitive ability and self-determination in male students and the relationship between metacognitive ability and self-determination in female students shows that the correlation coefficient in the relationship between metacognitive ability and self-determination in male students is higher, this can be influenced by motivation better instruction in men than women (Hakan & Münire, 2014).

Furthermore, from the analysis of two independent different tests, namely the correlation group of metacognitive ability with self-determination ability in male students and the correlation group of metacognitive ability with self-termination ability in female students, the results showed that there was no difference in the correlation of metacognitive ability and self-termination ability between groups of students. male and female students. These results follow the hypothesis that there is no correlation between students' metacognitive abilities and self-determination when viewed based on gender. So the results of this study support previous research that gender does not influence metacognitive skills, even cognitive processes by modeling students' mathematical representations are also not influenced by gender (Darmawan et al., 2018; Siswati et al., 2016; Kurniadi et al., 2021 Kurniadi et al., 2021).

CONCLUSION

Metacognitive abilities and self-determination abilities are essential skills that are developed through personal experiences and shaped by the environment. Metacognitive abilities play a critical role in regulating and controlling cognitive processes involved in learning and thinking. These abilities encompass self-awareness and self-regulation skills, such as planning, monitoring, and evaluating one's understanding and performance. For example, a student with strong metacognitive skills might be adept at identifying effective study strategies, recognizing when they do not comprehend a topic, and adjusting their learning methods accordingly.

Self-determination, on the other hand, manifests as intrinsic motivation, reflecting a person's internal desire to seek new knowledge and discover new things. This form of motivation is driven by internal rewards like personal satisfaction and the joy of learning, rather than external incentives such as grades or social approval. For instance, a student-driven by intrinsic motivation may pursue learning opportunities out of a genuine passion for the subject matter, not just to fulfill requirements or gain recognition.

Although metacognitive abilities and self-determination abilities are distinct in their definitions and indicators, they are interconnected. Research indicates that students with high metacognitive abilities also tend to exhibit high self-determination abilities. This relationship can be attributed to the fact that metacognitive skills, such as self-regulation and self-reflection, enhance a student's capacity to set personal goals and pursue them with determination. Additionally, intrinsically motivated students are more likely to engage in reflective practices that foster their metacognitive development. Interestingly, the correlation between metacognitive abilities and self-determination abilities does not show significant differences based on gender. Studies suggest that both male and female students can equally develop and benefit from these abilities. This indicates that educational interventions aimed at enhancing metacognitive skills and self-determination should be equally effective for all students, regardless of gender.

In conclusion, metacognitive abilities and self-determination abilities are interlinked and mutually reinforcing. By fostering an environment that supports the development of these skills, educators can help students become more effective, motivated, and autonomous learners. This holistic approach to education not only improves academic performance but also prepares students for lifelong learning and personal growth.

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