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The Effect of Students' Self-Efficacy on Students' Mathematical Communication Skills in Elementary School

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Abstract

The low mathematical ability of students is a major challenge that needs to be addressed in elementary school mathematics education. The goal of this study is to assess the impact of students' self-efficacy on their mathematical communication skills. The method in this study uses a quantitative approach with comparative causal types using correlation and regression analysis. The population in this study is fifth-grade students in Bandung, and the sample used is 84 fifth-grade students from one of the elementary schools in Bandung. The instruments used in this study were students' mathematical communication skills test questions, totaling 4 questions with the type of story questions on comparative material, and non-test instruments in the form of questionnaires related to students' self-efficacy. Data analysis in this study used SPSS 24 software to analyse the correlation and regression of students' self-efficacy and their mathematical communication skills. Additionally, a qualitative descriptive analysis was conducted on the students' responses regarding their mathematical communication skills. The research results indicate that, 1) there is a positive correlation between students' self-efficacy and their mathematical communication abilities with the correlation coefficient R = 0.219, which means that 4.8% of students' mathematical communication skills are determined by self-efficacy factors, 2) Students' self-efficacy has a positive effect on their mathematical communication skills with the regression equation y = 57.8 + 0.6x, which means that every time self-efficacy scores increase by 10 units, students' mathematical communication skills scores increase by 6 units. This research serves as a basis in the effort to create effective and meaningful mathematics learning by considering mathematical communication and students' self-efficacy.

Keywords: Mathematical communication, Self-efficacy, Elementary school

Abstrak

Rendahnya kemmapuan matematis siswa menjadi tantang besar yang harus dikembangkan dalam pendidikan matematika sekolah dasar. Tujuan penelitian ini adalah untuk menilai dampak efikasi diri siswa terhadap kemampuan komunikasi matematis. Metode dalam penelitian ini menggunakan pendekatan kuantitatif dengan tipe kausal komparatif dengan menggunakan analisis korelasi dan regresi. Populasi pada penelitian ini adalah siswa kelas 5 di Bandung, dan sampel yang digunakannya adalah 84 siswa kelas 5 di salah satu sekolah dasar negeri di Bandung. Instrumen yang digunakan pada penelitian ini adalah soal tes keterampilan komunikasi matematis siswa, berjumlah 4 soal dengan jenis soal cerita pada materi perbandingan, dan instrumen non tes berupa kuesioner terkait self-efficacy siswa. Analisis data dalam penelitian ini menggunakan softwere SPSS 24 untuk menganalisis korelasi dan regresi efikasi diri siswa dan keterampilan komunikasi matematisnya. Selain itu, dilakukan analisis hasil jawaban siswa berkaitan dengan komunikasi matematias. Hasil penelitian menunjukkan bahwa, 1) terdapat korelasi positif antara efikasi diri siswa dengan kemampuan komunikasi matematisnya dengan koefisien korelasi R = 0.219, yang berarti bahwa 4.8% kemampuan komunikasi matematis siswa ditentukan oleh faktor efikasi diri, dan 2) efikasi diri siswa berpengaruh positif pada kemampuan komunikasi matematisnya dengan persamaan regresi y = 57.8 + 0.6x, yang berarti setiap kali skor efikasi diri meningkat 10 unit, skor keterampilan

komunikasi matematis siswa meningkat 6 unit. Penelitian ini menjadi dasar dalam upaya menciptakan pembelajaran matematika yang efektif dan bermakna dengan memperhatikan komunikasi matematis dan self-efficacy siswa

Mathematics Clasification: Student assessment, achievement control, and rating (aspects of mathematics education)

INTRODUCTION

Mathematics is very important in the modern education system (Abu-Hiilal & Abed, 2019), so it is taught to all students at all levels of education (Jeyanthi, 2021., & Onwumere & Reid, 2014), and for students to succeed in learning, it is crucial that they continue to study mathematics. (Jackson, 2022., & Mathieson & Homer, 2022). Mathematics is closely related to various fields, such as engineering, finance, transportation, etc., and this is the primary focus of the study of mathematics in its implications for human life (Asli & Zsoldes-Marchis, 2021). In addition, mathematics is closely related to other subjects (Lingefjärd & Ahmet, 2022) and supports the advancement of knowledge and technology (Surya et al., 2017). The ability to apply mathematical concepts is a key factor in driving innovation and deeper understanding, making mathematics an essential tool for solving complex problems in modern life. Mathematics is seen as having a positive impact on students by encouraging creative and critical thinking skills so that it becomes a provision for dealing with complex lives (Markovits & Forgasz, 2017). According to Lince (2016), Math can help students gain a variety of abilities, including the capacity for analytical, systematic, critical, logical, and creative thinking. Mathematics, with its structured nature, teaches students to solve problems systematically. This provides a crucial foundation for making informed decisions. The logical thinking skills honed through proofs and mathematical reasoning enable students to identify weaknesses in arguments and avoid incorrect conclusions. Furthermore, the exploration of diverse mathematical concepts encourages creative thinking, enabling individuals to discover new relationships and formulate original solution strategies. This skills (analytical, systematic, critical, logical, and creative thinking) enables individuals to evaluate information from various sources objectively and to find innovative solutions to challenges faced both in the present and in the future.

Mathematics is not only viewed as a collection of absolute and detailed knowledge, but also as a human activity, a social phenomenon, part of human culture that has developed historically and can be understood in a social context (Gula & Jojo, 2024), but because of the abstract nature of mathematics (Subrahmanyam, 2021), it should be taught meaningfully by considering the characteristics of children's cognitive development. Meaningful teaching focuses on contextualizing mathematical concepts, connecting them to children's real-life experiences. This helps children develop a deeper understanding and reduce anxiety towards mathematics. In addition, by considering cognitive development stages (such as Piaget's theory), teachers can ensure that the material taught is appropriate for children's ability to process information, making the learning process more effective and enjoyable. The fact is that students often receive symbolic mathematical learning without understanding its meaning (Yuliandari & Anggraeni, 2021), and it is not in accordance with the cognitive development of students who are still at the concrete operational stage. This view is also in line with the opinion of (Widodo & Kartikasari, 2017), that mathematics is still considered a complex subject by elementary school students because it is taught deductively and abstractly. In fact, elementary school students are at a stage of cognitive development that is not yet formal and still relatively concrete.This is what causes students to become bored and tend to dislike mathematics. This tendency is not without reason, but this can be proven by the many students who experience

difficulties in learning mathematics (Doğan & Sır, 2022., Harun & Manaf, 2021., & Riyanto, 2019). The problems that are frequently encountered are caused by cognitive variables, such as students lack of skill, preparedness, training, and knowledge of mathematical ideas (Szűcs & Mammarella, 2020). In addition, Mathematics learning is more oriented towards mastering lower-level cognitive processes, requiring students only to work individually and in silence. This learning activity does not stimulate students to develop a deeper understanding of mathematical concepts (Silver et al., 2009).

According to The National Council on Teacher Mathematics (2003), There are two categories of mathematics standards: material standards and process standards. Material requirements relate to what components of material students must learn (numbers, geometry and measurement, and statistics), and process standards relate to skills students must possess (problem solving, reasoning, communication, connection, and representation). For students, mathematical communication skills are crucial since they are required to communicate mathematical ideas (Uyen et al., 2021., & Yaniawati et al., 2019). Mathematical communication skills are not just about writing mathematical answers, but students should be able to articulate ideas and reasoning clearly and logically. When students can explain the steps of problem-solving or complex concepts, they are simultaneously deepening their understanding of the material being studied. When students are able to learn communication, there are numerous advantages. In general, when students communicate their thoughts to others orally or in writing, it will help improve understanding, make connections, and develop language to express mathematical ideas (Kamid et al., 2020). Mathematics is not just a series of numbers, but also has a unique language that contains words, tables, images, diagrams, graphs, and other symbols to represent complex ideas. Therefore, mathematical communication becomes an important skill for students to understand and master concepts in mathematics. The ability for mathematical communication allows individuals to articulate their thoughts with precision, transforming abstract ideas into more concrete and understandable forms. With mathematical communication, students can solve problems and explain the reasoning behind the solutions they seek, building a strong foundation for deeper understanding.

Basically, in communication, students can express, explain, describe, and listen to understand mathematics (Paridjo & Waluya, 2017). The benefit is that it enhances the understanding of concepts in depth. When students can communicate mathematical ideas, they are compelled to organize their thoughts, strengthening their understanding of the mathematical concepts being studied. Many teachers believe that the importance of the mathematics learning process and suggest that mathematical communication should be developed in mathematics classrooms (Armiati et al., 2022., & Smieskova, 2017), since communication is regarded as the key building block for comprehending mathematics, this skill must be introduced in elementary school. Understanding concepts and procedures, comprehending representations, comprehending a variety of mathematical topics, and applying them in daily life are all indications of this understanding (Chasanah et al., 2020). Students who are proficient in mathematics may therefore transform mathematical problems into mathematical models and transfer mathematical models into real-world scenarios (Hussein, 2013). Teachers must better prepare students to face real-world situations in modern life by enhancing their understanding of mathematics in their environment (Hahn, 2014), this makes mathematics a powerful tool for solving practical problems in everyday life. One key to this is through mathematical communication. As stated by The National Council on Teacher Mathematics (2000), The four standards of mathematical communication are: 1) organizing and consolidating one's mathematical thinking through communication. This is the ability to systematically organize mathematical ideas. By organizing thoughts, students can clarify complex concepts and build a stronger understanding, 2)

communicating one's mathematical thinking coherently and clearly to others. This allows students to express their mathematical thoughts coherently and clearly to others. This is important for collaboration and discussion, ensuring that ideas can be understood without confusion, 3) analyzing and evaluating one's own mathematical thinking and strategies. This allows students to evaluate their own strategies and mathematical thinking. They learn to identify mistakes, seek alternative solutions, and improve their approaches, and 4) using mathematical language to express one's mathematical ideas correctly. At this stage, students should be able to express their ideas correctly using mathematical language. This includes the proper use of symbols, terms, and representations. Mastering these skills helps students participate in more formal and accurate mathematical discussions.

The results demonstrate that students are rarely taught mathematical communication skills in the curriculum, which results in students' mathematical communication abilities being generally subpar. This also has an effect on students' inadequate understanding (Stoffelsma & Spooren, 2019). The main impact of this condition is the lack of deep mathematical understanding among students. When students cannot communicate what they understand in mathematics, it indicates their understanding has not fully formed. Furthermore, the lack of mathematical communication skills can lower students' confidence. Students may feel frustrated or anxious when asked to present or discuss solutions to given problems, which can ultimately hinder their classroom participation and engagement in mathematics. According to Wardono & Kurniasih (2015), the ability of Indonesian students to learn, reason, communicate, solve, and comprehend problems in diverse settings is still comparatively low. The 2018 PISA findings also show that students' mathematical communication skills yield low results (Avvisati et al., 2019). Indonesian students' average mathematical literacy score is 379, which is far lower than the 489 average score for all PISA participants (Kimsiantini et al., 2021). Even in the latest PISA results in 2022, the average mathematics literacy score of students dropped by 13 points, scoring 366 (Fauzi et al., 2025).

Students must possess this mathematical communication skill in order to completely comprehend a mathematical idea. Self-efficacy can play an important role in developing mathematical communication because students who believe in their abilities will be more willing to participate, ask questions, and try to explain their ideas, which is at the core of effective mathematical communication. The term "self-efficacy" was initially used by Bandura (1977), This refers to a person's confidence in his ability to carry out and finish a specific assignment. Self-efficacy is viewed as a belief in one's own talents that has a variety of effects on human action (Davidovitch & Yavich, 2022; Bandura, 1986). Bandura (1977) noted that four separate types of information—job performance, vicarious experience, verbal persuasion, and physiological state—are used to determine efficacy. A study explain that self-efficacy significantly affects students' mathematical communication (Sirad et al, 2023). Even so, both influence each other and have a significant relationship (Suparman & Juandi, 2022). The relationship between the two is reciprocal. When students have high self-efficacy, they tend to be more willing to participate, discuss, and explain their thoughts, which in turn enhances their mathematical communication skills. Conversely, when students successfully communicate mathematical ideas well and receive positive feedback, this success will boost their self-efficacy in the future.

Efficacy is the main capital needed to achieve certain goals. Self-efficacy is a strong belief in one's ability to succeed in specific situations. This belief is not mere optimism but a strong predictor that influences motivation, perseverance, and the amount of effort one exerts when facing challenges. According to Ushers & Pajares (2009), beliefs and expectations are often very positively related. The results that most people expect depend on their judgement and beliefs about what they

can achieve. Self-efficacy is a crucial aspect of the self, and this research study is always interesting to investigate (Zhou et al., 2019). This is because self-efficacy is a strong predictor that affects almost every aspect of a person's life, from academic performance (learning) to career success and mental health. The best strategy to deal with it is to engage in various high-intensity brain exercises that target motivational brain regions, as math-related issues are also inextricably linked to students' fear and anxiety about the study (Akin & Kurbanoglu, 2011), and one of them is self-efficacy.

Various studies consistently show that self-efficacy plays a central role in mathematics learning. This is because self-efficacy mediates the positive relationship between interest in mathematics and mathematics achievement (Zhang & Wang, 2020). Self-efficacy show positive results in learning, especially in mathematics (Ozkal, 2019), who explains that there is a connection between students' ability in studying mathematics and their level of self-efficacy, Additionally, self-efficacy is crucial for lowering students' anxiety in math classes (Yurt, 2022; & Rozgonjuk et al., 2020), increasing mathematical problem solving abilities (Lavenia et al., 2019; Simamora et al., 2019), and having a positive effect on mathematical communication skills (Hendriana & Kadarisma, 2019). The results of the study indicate that overall self-efficacy serves as an important foundation that allows students to be more successful, more resilient, and more confident in every aspect of mathematics learning.

Mathematical communication skills in children significantly impact their lives, making the level of self-confidence, including self-efficacy, a primary focus for researchers. Therefore, further research is urgently needed to thoroughly examine the reciprocal relationship between students' self-efficacy and mathematical communication skills. The investigation should focus on how students' confidence or self-efficacy in their mathematical abilities directly influences their ability to convey mathematical ideas clearly, both orally and in writing. A deeper understanding of this influencing mechanism will provide a solid foundation for educators and researchers to design effective interventions to enhance both crucial aspects of mathematics learning (students' self-efficacy and mathematical communication skills).

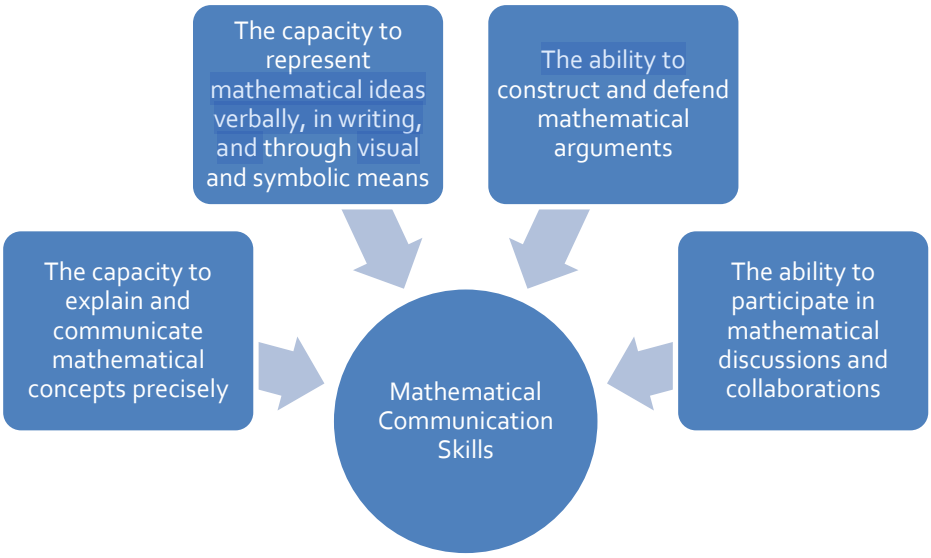
Research on the connection between students' mathematics communication abilities and self-efficacy in elementary schools is still hard to come by. Another reason is that the latest PISA test results for Indonesia show that students' mathematical literacy is low, and one of the factors is the ability to communicate mathematically. Therefore, it is very important to investigate the influence of self-efficacy on mathematical communication skills, as it is useful for identifying how students' self-beliefs affect the way they express their understanding of mathematics. This will serve as a basis for developing interventions that enhance students' confidence, enabling them to be more effective in solving mathematical problems with mathematical communication. The goal of this study is to thoroughly examine and gain a general understanding of how elementary school students' self-efficacy and mathematical communication skills relate to one another. This study is seen as having a positive impact on students' understanding of mathematics, overcoming barriers to learning mathematics such as anxiety, fear, boredom, and difficulty, and more specifically, how to enhance students' mathematical communication skills through self-efficacy.

METHOD

This research uses a positivist paradigm. The positivist paradigm in research adheres to the belief that reality is objective and singular, so scientific knowledge must be based on things that can be verified through sensory experience. This means that all observations in research must be converted into concrete and measurable facts or entities, usually in the form of quantitative data (numbers) or clearly defined variables, to reach conclusions considered value-free and objective

(Fadhel, 2002). One of the research approaches that falls within the positivist paradigm is quantitative research. Quantitative research is a formal, objective, rigorous, deductive approach that uses systematic strategies to generate and refine knowledge through problem-solving (Burns & Grove et al., 2005). It is a scientific study that examines phenomena by collecting numerical data, which is then analyzed using statistical methods, both descriptively and inferentially (Aliaga & Gunderson et al., 2002). This study employs correlation and regression analysis in a quantitative manner with causal comparative types. The link between two or more variables, including whether they have an influence on one another or not, is examined using correlational research methodologies (Büyüköztürk et al., 2012). The analysis of the relationship between student self-efficacy and communication skills, as well as the impact of student self-efficacy on students' mathematical communication abilities, makes this method particularly appropriate for usage.

The population of this research is all fifth-grade elementary school students in Bandung. The sampling technique used is purposive sampling. The purposive sampling technique is a method that deliberately selects participants based on the qualities they possess. It is a non-random technique that does not require a fundamental theory or a specific number of participants. In short, the researcher determines what needs to be known and attempts to find individuals who can and are willing to provide information based on their knowledge or experience (Bernard, 2002). The selection of research samples was carried out with consideration of several factors, namely 1) students at the school entered through an admission system determined by the local government based on a zoning system and age selection, 2) the samples also have diverse social backgrounds in accordance with the characteristics present in Bandung, and 3) the similarity of facilities, learning systems, and educational curricula used in schools in Bandung. Based on these criteria, the samples are deemed to have characteristics similar to the student population in Bandung. The sample used is 84 fifth-grade students from one of the elementary schools in Bandung. The data collection technique in this research uses tests, questionnaires.The research instrument was a test of mathematics communication skills that included a self-efficacy questionnaire and four comparative tale questions. The indicators of mathematical communication skills are explained in Figure 1.



Fugure 1. The indicators of mathematical communication skills
(Elliot & Kenny, 1996)

Based on Figure 1, mathematical communication skills are not just about talking mathematics, but are an integral process that involves representing ideas/concepts, providing accurate explanations,

logical reasoning (argumentation), and social interaction (discussion/collaboration). While the self-efficacy instrument was taken based on Bandura's theory (2012), namely 1) magnitude, 2) strength, and 3) generality.

The validity and dependability of the instrument are examined before to administration. Content validity and empirical validity (internal validity) are two different types of validity for the instrument. The validation process, which aims to see the complete content of the knowledge content arranged in the instrument, is carried out by practitioners of material content experts in mathematics to check the validity of the content. While SPSS and the Pearson Correlation Test are used for empirical validity. Cronbach's alpha and alignment reliability were employed to assess the instrument's dependability. Based on the test results of 30 students, the validity score ranges from 0.495 to 0.667 (valid) with a reliability score of 0.930 (reliable).

The data analysis strategy employed in this study employs quantitative techniques before drawing a conclusion on the overall investigation. The methods in question are 1) descriptive statistics, used to see the average, maximum, and minimum scores of the scores obtained by students; the tools used to calculate descriptive statistics are Microsoft Excel applications; and 2) inferential statistics, used to see the relationship and influence of each variable. The tool used to calculate inferential statistics is SPSS software version 24. The students' math test results also became the subject of in-depth analysis regarding their mathematical communication skills in relation to self-efficacy. This analysis was conducted using qualitative descriptive methods, which involved explaining the meaning of the phenomena that emerged. The results of the analysis of this data serve as a basis for interpreting the research by relating it to several relevant theories or sources and become the foundation for drawing comprehensive conclusions from the research.

RESULTS AND DISCUSSION

Results

The SPSS regression software is used to look for a significant correlation between the level of self-efficacy and students' mathematical communication skills under the premise that the two populations are equally distributed and that the normal and variance are the same in order to test the hypothesis, which claims that there is a significant positive correlation between the level of self-efficacy and students' mathematical communication skills. To test the research hypothesis above, a descriptive statistical table is presented below.

Table 1. Descriptive Statistics of Self-Efficacy and Mathematical Communication Skill

	N	Min	Max	Mean	SD	Var
SE	84	41,00	64,00	53,15	5,14	26,45
MC	84	50,00	100,00	87,86	13,29	176,68

Based on the Table 1, the minimum score obtained from self-efficacy is 41, and the maximum score is 64. Meanwhile, the average is 53.15. While the minimum score for mathematical communication skills is 50 and the maximum score is 100, While the average is 87.86.

The outcomes of using SPSS software for regression to evaluate the two research hypotheses about the connection between self-efficacy and mathematical communication abilities are as follows.

Table 2. Correlation Score

Model	R	R Square	Adjusted Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.219[a]	.048	.036	13.048	.048	4.134	1	82	.045

Based on the Table 2, the sig score is 0.045 or less than 0.05, indicating a connection between mathematical communication skills and self-efficacy. The correlation coefficient score is 0.219, which indicates that both have a poor relationship when assessed from the perspective of relationships. The above-mentioned data also reveal that the coefficient of determination is 0.48, indicating that self-efficacy has a 4.8% effect on mathematical communication ability and that the remaining 95.2% is influenced by other factors.

An ANOVA test was used to determine the impact of self-efficacy on mathematical communication abilities. The outcomes are as follows.

Table 3. ANOVA Score

Model	Sum of Squares	df	Mean Square	F	Sig.
Reression	703.737	1	703.737		
Residual	13960.549	82	170.251	4.134	.045[b]
Total	14664.286	82			

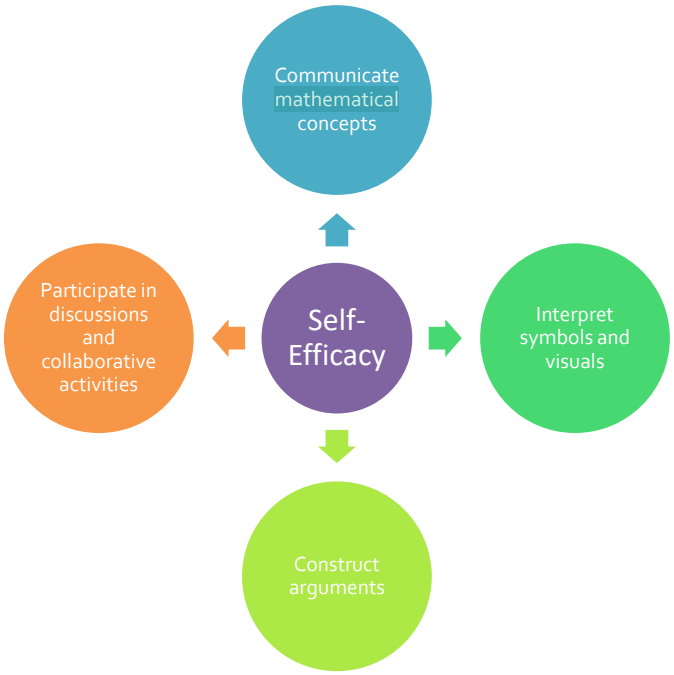
Based on the Table 3, the sig score is equal to 0.045 or less than 0.05, this suggests that self-efficacy has a considerable impact on mathematical communication abilities.

Table 4. Coefficients Score

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	57.760	14.872		3.884	.000
Score_X	.566	.279	.219	2.033	.045

Based on the Table 4, students' self-efficacy has a positive effect on their mathematical communication skills with the regression equation $Y = 57.8 + 0.6x$. The regression coefficient equation is 0.6 (positive), meaning that students' mathematical communication abilities are positively correlated with students' levels of self-efficacy. This means that for every 10 units an individual student's self-efficacy score increases, their mathematical communication ability rises by 6 units. Even though the link is classified as low, it is favorable and shows that self-efficacy positively affects learning mathematics, especially mathematical communication skills.

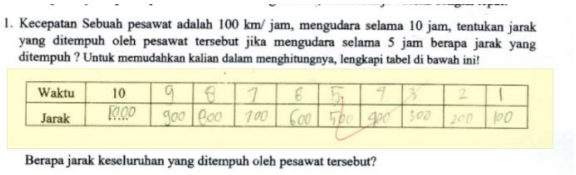
Students who possess high self-efficacy tend to have high mathematical communication skills, as evidenced by indicators of their mathematical communication abilities, including the ability to communicate mathematical concepts, interpret symbols and visuals, construct arguments, and participate in discussions and collaborative activities. The relationship is illustrated below.



Students who possess high self-efficacy tend to have strong mathematical communication skills. This is shown by their ability to explain and communicate mathematical concepts, represent mathematical information symbolically and visually, construct and maintain arguments, and participate in mathematical discussions and collaborations.

Figure 2. The relationship between self-efficacy and students' mathematical communication skills

Students can communicate mathematical concepts. This is shown in Figure 3.


1. Kecepatan Sebuah pesawat adalah 100 km/ jam, mengudara selama 10 jam, tentukan jarak yang ditempuh oleh pesawat tersebut jika mengudara selama 5 jam berapa jarak yang ditempuh ? Untuk memudahkan kalian dalam menghitungnya, lengkapi tabel di bawah ini!

Waktu	10	9	8	7	6	5	4	3	2	1
Jarak	1000	900	800	700	600	500	400	300	200	100

Berapa jarak keseluruhan yang ditempuh oleh pesawat tersebut?

Figure 3. Students' answer about communicating mathematical concepts

The problem above requires students to determine the distance travelled. Students are asked to justify the distance travelled by communicating mathematical concepts. Written arguments are needed regarding the concept of distance travelled in the topic of ratios.

The initial step taken by students is to observe the story problem related to the distance travelled. In the answer above, students are already able to communicate the concept. The student's answer shows that when the plane's time is 9, the distance is 900; when the time is 8, the distance is 800, and so on until at time 1, the distance travelled by the plane is 100. This is based on the concept of ratio. Overall, students can communicate the concept of ratio. Students with a high level of mathematical self-efficacy are more likely to communicate mathematical concepts effectively.

Students can communicate symbols and visuals. This is shown in Figure 4.

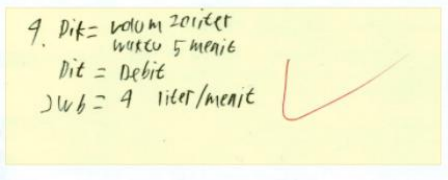


Figure 4. Students' answers about communicating symbols and visuals

The question above measures the ability to communicate symbols and visuals; students are asked to represent the given problem effectively. In answering the question, students are already able to solve it well, as indicated by their visualization and representation skills. Students with a high level of mathematical self-efficacy are more likely to communicate symbols and visuals effectively.

Students can build arguments. This is shown in Figure 5.

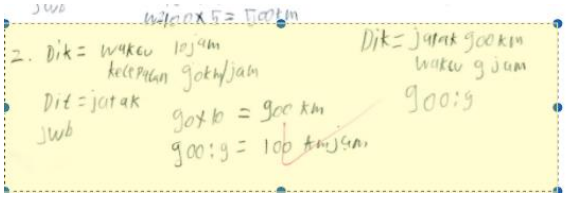


Figure 5. Students' answers about building arguments

The question above requires students to build arguments in answering questions about the average speed of trains in the context of comparison, the problems given are still related to simple comparison concepts suitable for elementary school students. Students can solve the given problems and construct strong arguments. Students with a high level of mathematical self-efficacy are more likely to build compelling arguments.

Students can demonstrate mathematical discussion and collaboration. This can be seen in Figure 6.

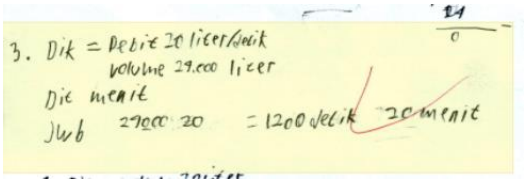


Figure 6. Students' answers about discussion and collaboration

The question above requires students to solve problems related to flow rate. Overall, students can solve the given problems. Students with high mathematical self-efficacy can engage in discussions, listen to their peers' arguments, and collaborate effectively.

Discussion

Self-efficacy has become a very important part of achieving student mathematics achievement (Schöber et al., 2018). Self-efficacy refers to an individual's belief in their ability to successfully carry out a specific task. Students with high self-efficacy tend to feel more competent when they perform well and highly value their tasks (Zientek et al., 2019). Various studies consistently show that a high level of self-confidence is a strong indicator of success in mathematics subjects (Liu et al., 2024., Ulpah, 2019., & Cleary & Kitsantas, 2017), and self-efficacy not only affects performance in exams but also has a significant positive impact on mathematical communication skills. According to Falco (2019), students with strong self-efficacy are more likely to set goals and create an adaptive learning environment for themselves.In addition, students with high self-efficacy tend to be more willing to participate in discussions, ask questions, and articulate mathematical ideas. This creates a positive cycle. Increased self-efficacy encourages better communication, and success in communication, in turn, reinforces self-confidence.

In self-efficacy, students believe that difficulties can be overcome. In fact, when students face difficulties, it will definitely lead to confusion. In Piaget's theory, this is explained as a disequilibrium because students are unable to understand the context of the problem presented or the problem is not familiar (Lovatt & Hedges, 2014). This will encourage cognitive reorganization to restore balance (Cavicchi, 2018., & Bormanaki & Khoshhal, 2017). Disequilibrium can occur when students are confronted with new concepts or problems that do not align with their existing understanding. This situation arises when students cannot apply familiar knowledge schemas to solve the issues. So the main capital that must be possessed is that students have a high interest in overcoming these problems; this interest is closely related to the magnitude indicator of self-efficacy. Self-efficacy becomes a crucial initial capital for students in facing and overcoming the problems presented,

especially in mathematics. Confidence in one's abilities is a driving force that influences how much effort students will put in and how resilient they will be in the face of difficulties. Students with high self-efficacy do not view challenges as insurmountable obstacles, but rather as opportunities to learn and grow. Self-efficacy will change from disequilibrium to equilibrium. This equilibration process serves as the unifying factor and sufficient condition for cognitive development, enabling adaptation to environmental demands (Bormanaki & Khoshhal, 2017).

Students must also have a strong commitment to solving the problem, this commitment must also be supported by high motivation. Commitment represents the perseverance to stay focused on goals, even when facing challenges and problems. On the other hand, motivation is the internal drive that triggers and directs students' behavior, making them eager to start and continue striving in solve mathematical problems. According to Brophy (2010), An explanation for behavior's commencement, direction, intensity, persistence, and quality, particularly behaviour that is goal-directed, is provided by the theoretical concept of motivation. What we learn, how we learn, and when we choose to learn can all be impacted by motivation (Schunk & Usher, 2012). This commitment and motivation are part of the strengths in self-efficacy indicators, so from these two things, a persistent effort should emerge, high self-confidence should emerge, and in the end, positive goals should emerge in doing various things, including solving problems encountered.

In addition, students must have the courage to try various things, and they must have an unyielding spirit. This enthusiasm is obtained by highly motivated students (Laila, 2022). Commitment represents perseverance to stay focused on goals, even when facing challenges and problems. In addition, motivation is the internal drive that sparks and directs student behavior, which makes students enthusiastic to start and continue trying to solve math problems. So from this capital, students can look for various alternative solutions to the problems they are facing. This ability is closely related to generality indicators in self-efficacy. The generality indicator in self-efficacy allows students to apply their beliefs in their abilities across various situations and tasks, even those they are not familiar with. This means that the confidence they develop in one area (such as mathematics) can extend to other areas (such as science or real-life problem-solving).

Students with high self-confidence usually have faith in their ability to complete tasks and finish them. Students with strong self-efficacy tend to work harder and show more resilience when facing challenges (Sakiz et al., 2012). This attitude allows them to view difficulties not as obstacles, but as opportunities for growth, which makes them less likely to give up, It means exhibit more endurance (Bandura, 1986). Furthermore, they are more effective in using metacognitive techniques, which involve the ability to monitor and regulate their thinking processes (Fast et al., 2010). This means they are more skilled at evaluating learning strategies, identifying mistakes, and adjusting their approach to improve performance, ultimately leading to better mastery of mathematical content. So, self-efficacy is the main capital and is very important for students to have when solving various problems in learning mathematics. As for what students can do in solving problems, namely, describe these problems using appropriate mathematical terms, using language that is easy to understand, and using concrete examples or relevant illustrations, In Piaget's theory, elementary school-age children are at the concrete operational stage, so their learning must be directed at things that are real and can also be imagined by students (Arisetyawan et al., 2020), so that concrete and real properties will make it easier for students to construct knowledge. In terms of explaining grammar, these things are connected to students mathematical communication abilities.

Students must also be proficient in using appropriate notation, symbols, and diagrams to effectively communicate mathematical concepts. The use of standard symbols and notation ensures

that mathematical ideas can be understood universally. Furthermore, students need to utilize practical tools to visualize data and complex mathematical relationships. This ability, which encompasses the mastery of mathematical representation skills, enables students to present problems and solutions in various formats, such as graphs, tables, equations, and physical models, thereby deepening their understanding and facilitating comprehensive communication of their ideas. Mathematical representation is a fundamental skill in problem-solving. According to Khairunnisak et al (2021), mathematical representation is crucial because it helps visualize abstract ideas into a more concrete and understandable form. Without representation, mathematical concepts remain in the realm of ideas, making them difficult to analyze or apply. Mathematical representations, such as graphs, tables, diagrams, or symbols, serve as resources to realize mathematical ideas (Hatisaru, 2022). For example, when faced with word problems, students who can represent them in equations or diagrams will find it easier to see the relationships between variables and formulate appropriate solutions.This is closely related to indicators of discourse ability in mathematical communication.

When students find alternative answers, they must be able to include relevant evidence, logical reasons, and strong arguments to support the solution to the given problem. This demonstrates a deep understanding of the material and reflects the students' ability to organize their thoughts in a structured manner. Furthermore, students should be open to various perspectives from others (their peers), listen to different arguments, and be willing to reflect on their own thinking. This ability is directly related to the indicators of sociolinguistic competence in mathematical communication, which emphasizes the importance of interacting, negotiating, and effectively using mathematical language in a social context.

Having an open attitude toward others' viewpoints is key in learning mathematics. This attitude allows for productive discussions about mathematical concepts, where students can share their understanding, ask questions, and constructively critique ideas. This discussion activity creates social interaction with various parties. In Piaget's view, students' cognitive development is influenced by social interaction (Müller et al., 2015). Piaget viewed social and intellectual development as interrelated, proposing that logical thinking arises through cooperation in free social interactions, which contrasts with pre-logical thinking limited by authority figures (Jahoda, 2000). A contemporary study shows that social interactions play a fundamental role in children's understanding of thoughts through triadic interactions involving the child, others, and shared experiences (Carpendale & Lewis, 2004). Social interaction activities will greatly support the formation of knowledge because students can argue arguments proving problem solving, and this will create cognitive conflict where students are aware of every difference in the cognitive structure of each individual. In order to solve difficulties, debates also take place, and here is where learning takes place, of course (Fauzi & Arini, 2021). This is closely related to signs of mathematical communication strategy.

The research findings show that strong self-efficacy is an important foundation for student success in mathematics. This self-efficacy not only affects students' ability to understand concepts but also has a close relationship with mathematical communication skills. Both aspects are crucial for students to solve various mathematical problems effectively. Therefore, fostering self-efficacy in students becomes a strategic step to enhance their mathematical understanding and their ability to communicate effectively, which is key to solving complex problems in mathematics. This is also in accordance with the opinion of Rakoczy et al (2019) that teachers can help students develop self-efficacy in learning mathematics, thereby improving student learning outcomes, even though the most important source of self-efficacy is the students' own performance.

Implication of Research

The results of this study clearly show a significant positive correlation between self-efficacy and students' mathematical communication skills at the elementary school level. This finding confirms that students' confidence in their abilities is a key factor in how effectively they convey mathematical ideas. Therefore, in a collective effort to substantially improve the quality of mathematics learning, teachers need to take proactive steps, including: 1) creating and maintaining a positive and supportive learning environment to enhance students' self-efficacy, ensuring they feel safe to try and fail in the learning context, 2) teachers also need to actively develop students' mathematical communication skills through the use of various enjoyable and meaningful learning strategies, consistently involving students in active communication, such as through group discussions, structured social interactions, and collaborative project work, and 3) teachers must holistically integrate mathematical communication skills and the enhancement of students' self-efficacy in all aspects of learning, ensuring that the ability to explain and present mathematical ideas becomes an integral part of every teaching session, not just an additional activity.

Limitation

Although the findings of this study provide valuable insights, it is essential to acknowledge that the results have several significant limitations that need to be addressed in future research. These limitations primarily include the study's relatively simple scope and the limited number of participants, which may affect the generalizability of the findings. Additionally, the data collection techniques employed were also restricted, relying solely on instruments such as tests and questionnaires, which may not fully capture the complexity of the variables being studied. Therefore, there is a strong hope that this research can be further developed and expanded to address these methodological weaknesses. Specifically, future studies should focus on practical ways to address the affective issues that students often experience when learning mathematics, such as fear, anxiety, difficulty, and various other learning obstacles. This development should also include a more in-depth examination of how self-efficacy and mathematical communication skills interact and influence the overall mathematics learning context, particularly at critical stages in elementary school.

CONCLUSION

Based on the research findings, there is a positive relationship between self-efficacy and mathematical communication skills. 4.8% of students' mathematical communication skills are influenced by self-efficacy. Regression analysis also reinforces this finding, where an increase in self-efficacy scores correlates with an increase in mathematical communication skills scores. The results of the ANOVA test also indicate that both self-efficacy and mathematical communication skills have a significant impact on students. Therefore, it can be concluded that self-efficacy is very important to tackle mathematical challenges, especially those involving mathematical communication. Students with high self-efficacy tend to influence their mathematical performance, including their ability to communicate effectively in mathematics. This is indicated by the emergence of various student abilities, such as communicating mathematical concepts, interpreting symbols and visuals, constructing arguments, and participating in discussions and collaborative activities. Strong self-efficacy among students is a key component for success in mathematics learning. In the school context, teachers need to create a positive environment to foster students' self-efficacy, developing mathematical communication skills through active strategies such as discussions and project work,

and integrating the improvement of self-efficacy and mathematical communication into mathematics learning.

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