Mathematical communication ability viewing of self-efficacy in project-based learning assisted by performance assessment

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Abstract: This research aims to achieve two primary objectives. Firstly, it seeks to assess the effectiveness of Project-Based Learning (PjBL) by incorporating performance assessment in enhancing students' mathematical communication abilities. Secondly, the study aims to characterize students' mathematical communication abilities to their self-efficacy levels. A mixed-methods approach was employed in this study, with a population comprising 251 seventh-grade students from SMP Negeri 24 Semarang. Data were gathered through mathematical communication skill tests, self-efficacy questionnaires, and interview guidelines. The experimental group underwent PjBL facilitated by performance assessment, while the control group experienced PjBL alone. Results indicated that the experimental group demonstrated classical mastery of mathematical communication abilities, with higher average and proportional achievements than the control group. PjBL assisted by performance assessment proved to be more effective than PjBL alone. Analysis of mathematical communication abilities based on students' self-efficacy levels revealed that (1) subjects with high self-efficacy fulfilled all indicators; (2) subjects with moderate self-efficacy fulfilled indicators one and two, were less proficient in fulfilling indicators four and were unable to fulfill indicator three; and (3) subjects with low self-efficacy fulfilled indicator one but had not yet achieved indicators two, three, and four.

Keywords: Mathematical communication; Performance assessment; Project-based learning; Self-efficacy


INTRODUCTION

The improvement of the quality of human resources through the mastery, understanding, pursuit, and study of various scientific disciplines that will later be implemented in everyday life is facilitated by education. Pramono (2017) states that a crucial role in improving the education quality with the aim of producing high-quality human resources is played by mathematics. Mathematics is a science that develops according to the demands of human needs. According to Kaur & Prendergast (2022), mathematics and its teaching have developed significantly over the last few decades.

The National Council of Teacher Mathematics (2000) states that learning mathematics is the process of teaching students to have the skill to think mathematically and have basic mathematical knowledge and skills, where the process includes problem solving, reasoning and proof (reasoning and proof), communication, connection, and representation. It is important to teach students the skill of expressing their thoughts both verbally and in written form so that student can interact with others. By articulating their ideas, students will be more capable of persuading and explaining their thoughts effectively. Furthermore, this offers an opportunity
In fact, students cannot possess important mathematical communication abilities (Putri & Sundayana, 2021; Sumartini, 2019). Based on observations or the situation in the field, students’ communication skills are considered to be insufficient or low (Luritawaty, 2018; Nuraeni & Afriansyah, 2021). Students’ inskill to convey mathematical concepts throughout mathematics study is one of the reasons why they have poor mathematical communication abilities (Ariawan & Nufus, 2017). It was further explained that this was because students did not have self-confidence regarding their abilities. The self-doubt that arises is related to the affective domain (Aulia, 2018). The learning conditions in the class show that there is no student contribution in learning or students are passive (product-oriented education). According to the findings of interviews with math teachers from class VII at SMP Negeri 24 Semarang, pupils still lacked the best mathematical communication abilities since they were unable to put down what they already knew and what was being required of them while solving a problem. In addition, there are some students who have difficulty in expressing mathematical symbols so that sometimes students still have difficulty in determining concepts to solve problems. Then, there are still students who cannot make a conclusion. This corresponds to the research conducted by Maulyda et al. (2020) which claims that learners still struggle to translate word problems into mathematical form and the results of student work are still disorganized and lacks coherence. Further revelations suggested that this was caused by a lack of confidence in their own talents among students. The affective domain is connected to the self-doubt that develops (Aulia, 2018).

Another crucial element in attaining learning objectives is the affective domain. Having full faith in one's talents will help one learn at their best. This notion is associated with optimistic conduct that can encourage the achievement of the greatest possible learning results for children (Saptika et al., 2018). A student's success can be influenced by his thoughts about his abilities, and these thoughts are repetitive, prolonged, difficult to change, and become ingrained in the student. Belief in one's own abilities in the affective domain is related to self-efficacy (Saptika et al., 2018).

Success in completing assignments and solving problems well is significantly influenced by self-efficacy among students. (Liu & Koirala, 2009). Self-efficacy is the conviction that one can accomplish particular goals, while Bandura (1997) suggests that self-efficacy is defined as an attitude of assessing or considering one's own abilities in completing specific tasks. Students’ low self-efficacy in math suggests that many of them are unwilling to put extra effort into solving arithmetic issues, they often choose to quickly abandon tasks perceived as difficult without attempting to complete them thoroughly (Novferma, 2016). Students with low self-efficacy frequently quit up when faced with challenging issues because they alternate between wanting and avoiding doing their schoolwork and feeling hopeless (Martalyna et al., 2018).

Students’ self-efficacy can influence how well they handle and solve mathematical problems (Mufida et al., 2018). Another issue with math instruction is that pupils often lack the skills necessary to solve complicated issues that require deduction, calculations, or the skill to understand graphs or diagrams (Adlim et al., 2017). Mathematics learning is regarded as an essential symbolic language to master. By acquiring mathematical communication abilities, students can be more effective in conveying, understanding, and solving mathematical problems using symbols and mathematical language. Therefore, the mastery of mathematical communication abilities is considered a highly crucial aspect in the process of mathematics learning. This indicates that mathematical communication abilities are a key element required by students to understand and master mathematical content.

According to Bandura (2006), the measurement of student self-efficacy refers to three dimensions, namely (1) difficulty (level), (2) strength or resilience (strength), (3) generality (generality). The magnitude factor is related to how challenging the work is perceived by the individual. The confidence a person has in their skill to do a job well is related to the strength
component. A person’s confidence in their skill to finish similar jobs in general constitutes the
generality feature (Rapsanjani & Sritresna, 2021).

According to the findings of interviews with mathematics instructors and a number of class VII students at SMP Negeri 24 Semarang, pupils' level of self-efficacy was still deficient. This is shown when students solve math problems, students are not sure they can solve math problems because of failures in the past such as often getting low scores, this shows the level or level of difficulty of the task. When individuals are able to solve them, they are still at a moderate or low level. Students think that math problems are difficult to do before students try to do them, this shows that the dimensions of strength that students have or the level of strength students have in doing assignments are still at moderate or low strength. The generality dimension is also at a moderate or low level, this is indicated by the presence of students who often submit assignments at the end of the collection deadline or even pass the submission deadline. Thus, it may be said that pupils' self-efficacy is still below par.

Presenting challenging problems that are relevant to students’ real-life experiences and can be solved using the mathematical skills they have acquired can enhance students' low mathematical communication skill (Kumalaretna & Mulyono, 2017). Enhancing students' mathematical communication abilities can be achieved through engaging activities and the use of materials that resonate with their innate interests. So student activities in the form of projects can be key in developing mathematical communication abilities (Nani & Kusumah, 2015).

Models, tactics, media, and learning resources play a crucial role in shaping an optimal learning environment, not only enhancing learning outcomes but also stimulating the development of students' mathematical communication skills. The success of instructional methods is measured not only in terms of effectiveness but also in creativity and the level of enthusiasm that can motivate students. This creates opportunities for students to express their views more effectively and broadly. Research by (Sari, 2017) emphasizes the importance of innovative teaching methods in creating an efficient and productive environment, providing profound understanding, and fostering critical thinking skills. Therefore, the implementation of effective instructional models, tactics, supportive media, and high-quality learning resources is a crucial step in enhancing students' mathematical communication skills comprehensively and sustanably.

A learning paradigm such as PjBL can enhance the development of mathematical communication abilities, boost student activity, and increase their engagement, thereby fostering greater enthusiasm for learning mathematics (Paruntu et al., 2018). This statement is supported by Rahmazatullaili et al. (2019) assertion that learning, which provides students with opportunities to discover solutions to problems through various methods, can be facilitated through the PjBL learning model. At the junior high school level, learning is directed to maximize project-based learning. In the Merdeka Curriculum, project-based learning (PjBL) takes center stage (Ministry of Education, Culture 2022). The Merdeka Curriculum is designed as a competency-based curriculum with the aim of supporting the recovery of the learning process after the more than 2-year impact of the COVID-19 pandemic. To achieve this goal, Project-Based Learning (PjBL) is implemented in the classroom to facilitate the advancement of the Pancasila Student Profile. The learning model that focuses on creating products and directly involves students in the learning process is itself centered around by PjBL (Durohman et al., 2018). Trianto (2014) explains that PjBL, which stands for student-centered innovative learning, uses the teacher as a motivator and facilitator while allowing students to design their own learning on their own.

In order for assessments to be in line with the planned learning objectives, they should be used in conjunction with the usage of relevant learning models in the learning process. Masrukan (2017) states that a systematic process called assessment is used to learn more about a person or an object's attributes. However, in reality the teacher only uses assessment solely to be used as a measuring tool for how smart the student is. In order for students to
demonstrate and apply their knowledge in diverse circumstances in accordance with the intended criteria, one alternative evaluation that can be employed is in the form of a performance assessment. This is also supported by Tejeda & Gallardo (2017) who reveal to evaluate students' skill to solve a problem in real-world situations with their knowledge, performance assessments can be utilized. Moreover, employing performance assessment as an approach can be more effective as it distinctly identifies students' strengths and weaknesses.

According to Anintya et al. (2017) study on communication skills in relation to learning styles, the study suggested that students with visual and auditory learning styles achieved an accomplishment level of 4, whereas kinesthetic learner achieved an accomplishment level of 3. It is crucial to conduct a more in-depth investigation to understand in detail how various mathematical communication abilities are acquired by students with different learning styles. Additionally, within this context, each participant is also engaged in the process of understanding how to evaluate their own level of self-efficacy to determine the extent of their mathematical communication abilities.

**METHOD**

**General Organization of the Paper**

In this research, a mixed-methods approach using a sequential explanatory design was employed. The study design effectively integrates both quantitative and qualitative research methods, with the initial phase utilizing quantitative approaches and the subsequent phase incorporating qualitative methods. Quantitative methods were applied to assess the extent of students' mathematical communication abilities within the PjBL learning model assisted by performance assessment. Meanwhile, qualitative methods were employed to investigate and address how students' mathematical communication abilities are perceived in relation to self-efficacy within the PjBL learning model assisted by performance assessment.

The study focused on seventh-grade students at SMP Negeri 24 Semarang, with the entire population considered. A simple random sampling technique was used to select two classes, specifically class VII A and VII B, each consisting of 30 students. Class VII A served as the control group, while class VII B was designated as the experimental group. The intervention involved implementing the PjBL model for mathematics instruction in the experimental class, while the control class followed traditional mathematics teaching. Among the students in class VII B, six were selected as subjects, with two each from the high, medium, and low self-efficacy categories.

The study encompasses two variables: students' mathematical communication abilities and self-efficacy. Validated, reliable, and appropriately calibrated data were obtained from self-efficacy questionnaires, interviews, and tests assessing mathematical communication abilities. Prior to the study, these instruments underwent validation, distinction, and difficulty level checks in trial classes. The quantitative data derived from mathematical communication abilities tests underwent various analyses, including normality tests, homogeneity tests, traditional completeness tests, average difference tests, and proportion difference tests, to examine hypotheses.

Subjects were selected based on their self-efficacy levels, including two high self-efficacy, two moderate self-efficacy, and two low self-efficacy subjects. The selection process involved purposive sampling for interviews, considering specific criteria for subject inclusion. Interviews were conducted to enhance the quantitative data related to students' mathematical communication abilities. The results of assessments and topic-focused interviews were used to characterize students' mathematical communication abilities within the context of PjBL assisted by performance assessment.
RESULTS AND DISCUSSION

Results

The Analysis of Mathematical Initial Skill Data

To ensure that the experimental class and control class really had similar baseline conditions before undergoing the intervention, an analysis of the initial mathematical skill data was undertaken. The data under examination pertains to the scores of the Middle Semester Assessment (PTS) for class VII. The analysis of the initial mathematical skill data encompassed conducting normality tests, homogeneity tests, and average difference tests.

The subsequent results reveal that the initial data on mathematical proficiency adheres to a normal distribution and demonstrates homogenous variance, allowing for the application of a t-test to evaluate the mean difference. IBM SPSS Statistics 21 was employed for the Levene and Kolmogorov-Smirnov tests. The Independent-Samples T Test conducted using IBM SPSS Statistics 21 indicated no significant average difference between the initial mathematical skill data values of the experimental class and the control class.

Analysis of Mathematical Communication Skill Data

Quantitative statistics regarding mathematical communication skill originate from written tests administered to both the experimental and control classes. Utilizing IBM SPSS Statistics 21, calculations for the homogeneity test were conducted on the Levene test results, indicating that the variance in mathematical communication skill data was consistent between the two classes. SPSS calculations, specifically the Shapiro-Wilk test, demonstrated that the data for each class were normally distributed, ensuring the regular distribution of data. This conclusion was derived from the normality test conducted with SPSS on the combined test results of both the experimental and control classes.

If the following conditions are met, PJBL assisted by performance assessment is considered effective for enhancing the mathematical communication abilities of seventh-grade students at SMP Negeri 24 Semarang: (1) Students’ mathematical communication abilities in PJBL assisted by performance assessment exceed classical mastery; (2) The average mathematical communication proficiency of students in PJBL assisted by performance assessment is higher than the average achievement of students’ mathematical communication abilities in traditional PJBL; and (3) The proportion of students who master mathematical communication abilities in PJBL assisted by performance assessment surpasses the proportion of students’ mastery in traditional PJBL.

Test hypothesis 1 related to the performance-assisted classical mastery test for PJBL class, with the following hypothesis.

\[ H_0 : \pi \leq 0.75 \] (percentage of students in performance-assisted PJBL classes who score < 75 have not exceeded classical mastery).

\[ H_1 : \pi > 0.75 \] (percentage of students in performance-assisted PJBL classes who score ≥ 75 have exceeded classical mastery).

The test criterion is that \( H_0 \) is accepted if \( Z_{count} < Z_{(0.5-\alpha)} \) with \( Z_{(0.5-\alpha)} \) obtained from the standard normal distribution list with probskill (0.5–\( \alpha \)). Based on excel calculations, we get \( Z_{count} = 1.948 \) and \( Z_{table} = 1.64 \), so \( Z_{count} > Z_{table} \). As a result, \( H_0 \) was rejected, meaning that the percentage of students in the experimental class who scored ≥ 75 had exceeded classical completeness. Thus, PJBL is assisted by an effective performance assessment on the mathematical communication abilities of class VII students of SMP Negeri 24 Semarang.

Test hypothesis 2 related to the test of differences in the average mathematical communication skill of PJBL class students assisted by performance assessment and PJBL class students, with the following hypothesis.

\[ H_0 : \mu_1 \leq \mu_2 \] (the average mathematical communication skill of PJBL class students assisted by performance assessment is not higher than PJBL).
$H_1 : \mu_1 > \mu_2$ (the average mathematical communication skill of PJBL class students assisted by performance assessment is higher than PJBL class).

Test criteria $H_0$ is accepted if $-t_{table} < t_{count} < t_{table}$ and rejects $H_0$ if $t$ has another value. Degrees of freedom $(df) = (n_1 + n_2 - 2)$ and degrees of opportunity $(1 - \alpha)$ (Hendikawati, 2015). Based on these calculations, it is obtained $t_{count} = 4.49$ and $t_{table} = 1.67$, so that $t_{count} > t_{table}$, as a result $H_0$ is rejected. It means that the average mathematical communication skill of PJBL class students assisted by performance assessment is higher than that of PJBL class.

Test hypothesis 3 related to the test of differences in the proportion of mathematical communication abilities of PJBL class students assisted by performance assessment and PJBL class students, with the following hypothesis.

$H_0 : \pi_1 \leq \pi_2$ (the proportion of the mathematical communication skill mastery of the PJBL class students assisted by performance assessment is not higher than the proportion of the PJBL class students’ mathematical communication mastery).

$H_1 : \pi_1 > \pi_2$ (the proportion of the mathematical communication skill mastery of the PJBL class students assisted by performance assessment is higher than the proportion of the PJBL class students’ mathematical communication skill completeness).

The test criterion $H_0$ is rejected if $Z_{count} \geq Z_{0.5-\alpha}$ (Hendikawati, 2015). Based on Microsoft Excel’s calculations, $Z_{count} = 2.79$ and $Z_{table} = 1.645$, so $Z_{count} > Z_{table}$, as a result $H_0$ is rejected. This indicates that a greater percentage of PJBL class students have completed their mathematical communication abilities, as determined by performance evaluation, than a greater percentage of PJBL class students have completed their mathematical communication abilities.

According to the results of data analysis on tests of students’ mathematical communication abilities using PJBL learning assisted by performance assessment, they have achieved learning mastery based on KKM, namely 75 for mathematics. The percentage of students who achieve learning mastery is 90% which has exceeded 75% classical learning mastery. This shows that the implementation of the PJBL model combined by performance assessment can help students achieve learning mastery both individually and classically. This is in line with the research of Rahmadhani & Mariani (2021); Chalim et al. (2019); and Usman et al. (2022) stated that PJBL achieved the classical completeness criteria. Anisa et al. (2017) and Arivina & Prabowo (2017), also stated that performance assessment-assisted learning achieves classical mastery. The results of the mathematical communication skill test indicate that the average class score for PJBL learning assisted by performance assessment is 85. This implies that, overall, the class achieved an average score of 85 in testing their mathematical communication abilities using the PJBL learning approach assisted by performance assessment. The test results for students’ mathematical communication abilities in PJBL learning assisted by performance assessment reached 75, which aligns with the Minimum Mastery Criteria (KKM) for the subject of mathematics.

Moreover, the test for differences in proportions revealed that the proportion of proficiency in mathematical communication abilities among students in the PJBL class assisted by performance assessment is greater than the percentage of proficiency in mathematical communication abilities among students in the PJBL class without performance assessment assistance. In other words, incorporating performance assessment in PJBL learning can increase the proportion of students mastering mathematical communication abilities compared to the PJBL class without performance assessment assistance. Considering the outcomes of the performance assessment-assisted PJBL class test whose score was less than the KKM of 3 people, it was obtained that 90% of students in the performance assessment-assisted PJBL class scored ≥75, so students in the performance assessment-assisted PJBL class had exceeded classical mastery. It is proven that PJBL assisted by performance assessment provides a chance for students to improve their mathematical communication skills. This is supported by the statement of Chalim et al. (2019); Maudi (2016), that PJBL can enhance students’ mathematical
communication abilities because teachers can involve students more in projects while managing classroom learning.

The use of performance assessments benefits students’ comprehension as well as their skill to communicate mathematically. Based on research results, the use of performance assessment can be an alternative assessment for project activities in accordance with the use of the current curriculum, namely the Merdeka curriculum. Performance assessment in learning makes students more motivated to give their best in every project assignment they work on. Afifnas et al. (2018) in his research also stated that with a performance assessment Students will become more engaged and motivated to give their best in learning because assessment will be carried out on every activity students carry out. This has a positive impact on students’ courage to try new things and reduces fear if they do something wrong, because the score they will get at each step of the project is not just the final result. With the performance assessment students can also get used to completing the completion with steps that are in accordance with the indicators of students' mathematical communication abilities. By using a performance assessment, the development of students' abilities can be monitored clearly and in detail.

Isa aand Burhanuddin (2016) in their research stated that students engaged in learning with the assistance of performance assessments tend to achieve good mathematical communication abilities, both verbally and in writing, and fall into the good category. In the topic of this research, the learning is centered around the topic of quadrilaterals. The use of performance assessment on quadrilateral material aids students in solving problems with the correct procedures, allowing them to understand the necessary steps to address issues related to quadrilateral material. Masrukan (2017) states that performance assessment has basic characteristics, namely: (1) students are asked to demonstrate their skill to create a procedure or be involved in an activity (action), and (2) the accuracy of the procedure is more important than the result.

**Discussion**

**The Description of Mathematical Communication Skill in View of Students’ Self-Efficacy**

Following the implementation of Project-Based Learning (PJBL) assisted by performance assessment, experimental group students underwent a self-efficacy questionnaire to classify their self-efficacy as either high, moderate, or low. The rules for categorizing self-efficacy were applied during the calculation and grouping of data after the collection of self-efficacy data. Table 1 lists the students who were chosen to participate in this study as the study’s subjects.

<table>
<thead>
<tr>
<th>No.</th>
<th>Subject</th>
<th>Subject Code</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>S-1</td>
<td>E-02</td>
<td>High self-efficacy</td>
</tr>
<tr>
<td>2</td>
<td>S-2</td>
<td>E-11</td>
<td>High self-efficacy</td>
</tr>
<tr>
<td>3</td>
<td>S-3</td>
<td>E-10</td>
<td>Moderate self-efficacy</td>
</tr>
<tr>
<td>4</td>
<td>S-4</td>
<td>E-28</td>
<td>Moderate self-efficacy</td>
</tr>
<tr>
<td>5</td>
<td>S-5</td>
<td>E-16</td>
<td>Low self-efficacy</td>
</tr>
<tr>
<td>6</td>
<td>S-6</td>
<td>E-20</td>
<td>Low self-efficacy</td>
</tr>
</tbody>
</table>

Table 2 contains the findings of the analysis of mathematical communication abilities in terms of student self-efficacy using PJBL with performance assessment.

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Self-Efficacy Level</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High</td>
<td>Moderate</td>
</tr>
<tr>
<td>(1)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>(2)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>(3)</td>
<td>✓</td>
<td>–</td>
</tr>
<tr>
<td>(4)</td>
<td>✓</td>
<td>✓(-)</td>
</tr>
</tbody>
</table>
1. Mathematical Communication Skill of Subjects with High Self-Efficacy

According to the study's findings, it can be observed that participants with high levels of self-efficacy are capable of fulfilling every need for mathematical communication abilities. This aligns with Bandura's statement (1997) asserting that individuals with high self-efficacy have confidence in their own abilities and can tackle problems diligently and accurately. Research by Permana et al. (2016) also notes that characteristics of high self-efficacy involve perseverance in completing tasks despite difficulties and a belief in one's abilities. Figure 1 displays the outcomes of the test results on mathematical communication abilities for students with high levels of self-efficacy.

Based on the illustration in Figure 1, subjects can accurately convey information about the question, as seen in their written communication skills. Furthermore, subjects are also capable of formulate a mathematical model from the question to determine the required amount of ceramics. Their skill to draw relevant conclusions is also evident. Additionally, subjects can depict the problem situation through a square image sketch that is pertinent to the issue. Moreover, subjects can solve the problem by calculating the costs incurred to purchase ceramics using mathematical language or symbols accurately.

Subject with high self-efficacy levels have the skill to describe their situations in various ways, such as through images, spoken language, written language, and algebra. They are also capable of creating and solving mathematical models, allowing them to meet all the indicators of mathematical communication abilities. This includes capacity to construct a model from situations or problems using diverse forms of expression, including verbal, written, concrete, graphic, and algebraic representations (written text), alongside the skill to formulate arguments and generalizations (written text), translate real objects, images, and diagrams into mathematical ideas (drawing), and articulate mathematical concepts by describing daily activities in language or mathematical symbols (mathematical expression).

This is compliant with Juhrani et al. (2017), who assert that students exhibiting a heightened level of self-efficacy demonstrate a proficient fulfillment of all facets pertaining to mathematical communication proficiency. These students display the skill to articulate mathematical concepts effectively through mathematical communication, thereby adeptly resolving mathematical problems. Despite the potential existence of errors, such deviations are considered inconsequential. Furthermore, Bandura (1997) theorizes that individuals endowed with elevated self-efficacy tend to perceive formidable tasks as opportunities for surmounting challenges. In essence, a heightened sense of self-confidence serves as a facilitator for students when approaching arduous tasks, fostering a positive mindset and fortitude in overcoming impediments.

Given:
Room side: 6 meters = 600 cm
Tile side = 30 cm
Tile price = Rp50,000/box
Asked:
How many tiles are needed?
The cost incurred to buy the tiles?
Answered:
So, the number of tiles needed is 400 tiles.
So, the cost required to buy the tiles is Rp2,000,000.
2. Mathematical Communication Skill Subjects with Moderate Self-Efficacy

Based on the subject's work on question number 2, it can be detailed that the indicator of written communication skill (written text) shows that the subject has successfully conveyed information about the question accurately in written form. However, the subject has not been able to formulate a mathematical model of the problem to determine the required number of rhombuses, resulting in an incorrect final conclusion. In terms of drawing communication skills, the subject appears to struggle in creating a problem situation through a sketch, particularly in the form of a rectangular flat shape, as the drawn shape resembles more of a rectangle (See Figure 2). Furthermore, in the indicator of mathematical expression skill, the subject has not been able to solve the problem, namely calculating the length of wood needed to trim each rhombus using mathematical language or symbols accurately.

![Figure 2. The results of students with moderate self-efficacy](image)

In light of the study's findings, it is deduced that respondents with a moderate level of self-efficacy exhibit noteworthy proficiency in fulfilling two pivotal indicators pertaining to mathematical communication. Firstly, they display the capacity to model situations or problems through speech, writing, tangible objects, graphics, and algebra. This underscores their adeptness in conveying mathematical concepts across diverse mediums, thereby manifesting adaptability in communication methodologies. Secondly, these respondents can adeptly formulate arguments and generalizations, signifying their competence in articulating mathematical ideas with clarity and logical coherence. These findings yield deeper insights into the correlation between self-efficacy levels and mathematical communication abilities. Consequently, the research underscores the significance of psychological elements in the cultivation of students' proficiency in mathematical communication.

The research conducted by Berliana & Sholihah (2022) indicates that students with moderate self-efficacy levels are capable of conveying mathematical ideas in writing. This finding aligns with Bandura (1997), which explains that students with moderate self-efficacy tend to exhibit high interest and commitment towards easy tasks but are inclined to avoid challenging ones. The results of Desmawati et al. (2015) study provide information that when students' self-efficacy is at a moderate level, their mathematical communication abilities also tend to be moderate. In other words, a moderate level of self-efficacy can influence how students express mathematical ideas, and this is also reflected in their mathematical communication abilities.

Participants that have low self-efficacy also perform indicator tasks less well of (4) expressing mathematical concepts by stating everyday events in language or mathematical symbols. Subjects with moderate self-efficacy are sometimes less thorough in planning and make mistakes in calculations, so that the final results obtained are not correct. Calculation...
errors are caused by a lack of self-efficacy in their skill to solve problems. Self-efficacy that is not high tends to be less serious in completing tasks and easily becomes discouraged when faced with difficulties (Fatmasari et al., 2022). This is in accordance with the opinion of Putrisari et al. (2017) that students with a moderate level of self-efficacy have the confidence to do the task seriously, but on the other hand they also have anxiety about the obstacles that arise whether these obstacles can succeed in achieving the expected goals or fail to achieve the goals.

Furthermore, subjects with moderate self-efficacy have not been able to fulfill indicator (3) reflecting real objects, images and diagrams into mathematical ideas (drawing). In line with the statement of Juhrani et al. (2017) and Ghofur et al. (2022) that students with moderate self-efficacy are less than optimal in using several mathematical communication indicators. According to Ariawan & Nufus (2017) this is because students are less able to communicate mathematical ideas in learning mathematics.

3. Mathematical Communication Skill Subjects with Low Self-Efficacy

Based on the Figure 3, it can be seen that in the written communication skill indicator (written text) the subject is able to write the information in the question correctly. The subject has failed to create a mathematical model of the issue to ascertain the necessary number of rhombuses. In the image communication skill (drawing) indicator, the subject has not been able to create a problem situation in the form of a flat, rectangular sketch, it appears that the subject has composed the sketch that was made. Furthermore, in the mathematical expression skill indicator, the subject is able to solve the problem, namely calculating the length of wood needed to trim each rhombus using mathematical language or symbols.

![Figure 3. The results of students with low self-efficacy](image-url)

Students characterized by low self-efficacy can represent a situation or problem through verbal expression, written communication, concrete means, graphics, and algebra. Consequently, it can be inferred that individuals with low self-efficacy levels possess the capskill to understand a problem thoroughly, as demonstrated by their proficiency in precisely documenting known information and grasping the questions presented within the problem. This is in accordance with Bandura’s social cognitive theory (1997) which says that individuals with low self-efficacy tend to concentrate on tasks they feel capable of and believe can be completed and avoid tasks they cannot do.

Subjects with low self-efficacy exhibit difficulties in formulating arguments and generalizations in written text. They encounter challenges in translating real-world objects, images, and diagrams into mathematical concepts through drawing. Moreover, articulating mathematical ideas by describing everyday events using language or mathematical symbols (mathematical expressions) proves to be a persistent challenge for them. Out of the four
indicators employed to assess mathematical communication abilities, students only demonstrated proficiency in one indicator. The indicator is modeling situations or problems using spoken, written, concrete, graphic, and algebraic representations. This is in line with the statement that students with low self-efficacy tend to be inefficient in utilizing several mathematical communication indicators. They still face difficulties in expressing their mathematical ideas adequately or effectively. In other words, a low level of self-confidence can impact students' skill to communicate in a mathematical context (Hasanah et al., 2021; Juhrani et al., 2017). According to Ariawan & Nufus (2017), the reason behind these challenges is that students are less capable of conveying mathematical ideas during mathematics learning. The findings of this study are consistent with the research conducted by Andrianingsih & Waluya (2021), which asserts that students with low self-efficacy encounter difficulties across all indicators. Students have not yet demonstrated the skill to articulate and solve mathematical models, whether presented in the form of images or in formulating questions based on given problems. In other words, a low level of self-efficacy can be considered a factor influencing students' challenges in various aspects of mathematical learning.

CONCLUSION

The researcher’s discussion led to the following conclusions. The results suggest that within the framework of Project-Based Learning (PjBL) in mathematics supported by Performance Assessment, students surpass the classical mastery level in their mathematical communication abilities. Moreover, the average mathematical communication abilities of students in PjBL assisted by Performance Assessment are higher compared to those in PjBL without assistance. Additionally, the proportion of completeness in students' mathematical communication abilities in PjBL assisted by Performance Assessment exceeds the proportion in PjBL without assistance. Therefore, it can be inferred that PjBL assisted by Performance Assessment is more effective in improving mathematical communication abilities than PjBL without assistance.

The analysis of students' mathematical communication abilities based on their Self-Efficacy yields the following insights: (a) Students with high self-efficacy can fulfill indicators of mathematical communication abilities, such as create the model of problems or conditions using verbal, written, concrete, graphical, and algebraic (written text); composing arguments and generalizations (written text); reflecting real objects, images, and diagrams into mathematical ideas (drawing); and expressing mathematical concepts through the language of daily activities or expressing mathematical symbols (mathematical expression); (b) Students with moderate self-efficacy can meet indicators of mathematical communication abilities, such as modeling situations or problems using verbal, written, concrete, graphical, and algebraic (written text); composing arguments and generalizations (written text); showing less proficiency in indicators like expressing mathematical concepts by stating everyday events in language or mathematical symbols (mathematical expression); and not being able to meet indicators such as reflecting real objects, images, and diagrams into mathematical ideas (drawing); (c) Students with low self-efficacy can fulfill indicators of mathematical communication abilities, such as modeling situations or problems using verbal, written, concrete, graphical, and algebraic (written text); and have not been able to meet indicators such as composing arguments and generalizations (written text); reflecting real objects, images, and diagrams into mathematical ideas (drawing); and expressing mathematical concepts by stating everyday events in language or by expressing mathematical symbols (mathematical expression).

Declaration

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