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Enhancing Senior High School Students' Mathematical Communication Skills in Problem Solving Through Scaffolding

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Abstract

This study aims to describe the transformation of mathematical communication skills in high school students through the use of problem-solving *scaffolding*. Transformation is interpreted as a change in the way students convey mathematical ideas and solutions through writing, visuals, and symbols. The study employed a descriptive qualitative approach, utilizing data from TPMKM, think-aloud sessions, and semi-structured interviews. The analysis was carried out based on the Polya stages and source triangulation. The results showed that students in the low category before *scaffolding* only met the written *text* (Wr1) and partial *mathematical expression* (Me) indicators. After *scaffolding*, they meet Wr1, Wr2, Wr3, Dr, and Me more completely. Meanwhile, students in the medium category initially met Wr1, part of Wr2, and part of Me. After *scaffolding*, they showed significant changes: they were able to meet Wr1, Wr2, Wr3, Dr, and Me in their entirety. This transformation reflects a process of assimilation, accommodation, and equilibrium, which changes the student's categories from low to medium and from medium to high.

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Introduction

Communication is an integral part of mathematics learning, as affirmed by NCTM (2000), which lists communication as one of the five main standards of mathematics learning, along with problem-solving, reasoning and proof, connection, and representation. Communication in mathematics is not only a tool for sharing ideas but also a means of clarifying understanding, improving, discussing, and revising ideas that arise in the learning process. Purwandari et al. (2018) stated that mathematical communication is an interaction process that conveys mathematical messages in oral or written form, such as pictures, tables, diagrams, formulas, or demonstrations. Wichelt and Kearney (2009) classify communication into two types, namely oral and written. Verbal communication is often evident in group discussions, while written communication is typically presented through visual and symbolic media in the context of mathematical ideas. This ability to convey and receive mathematical ideas is referred to as mathematical communication skills.

Mathematical communication skills are an individual approach to expressing, conveying, and reflecting mathematical ideas orally or in writing. Kafrawi (2016) refers to it as the ability to communicate thoughts and ideas in one's own language, which can be visualized through images. NCTM (2000) also defines mathematical communication skills as students' ability to express mathematical ideas both verbally and in writing. Lestari (2015) emphasized that this ability includes aspects of communicating, receiving, and evaluating mathematical ideas carefully, critically, and analytically. Mathematical communication skills are essential because they demonstrate how the student solves problems and explains their thought process. Through communication, students not only present the final result but also explain how they arrived at it, whether through verbal narratives, written descriptions, images, or symbols.

Problem-solving is a crucial aspect of mathematical communication. According to Sumardiyono (in Supinah, 2010), problem-solving is the process of applying knowledge in a new context. Hudoyo (1988) stated that this is a cycle to overcome the problem until the problem is considered finished. Solso (2008) defines problem-solving as the process of organizing ideas to find solutions to problems. Meanwhile, Polya (1973) described problem-solving as an effort to achieve a goal when the path to it is not immediately apparent. Gunantara (2014) added that problem-solving is a potential area for students to apply solutions in daily life. In this process, mathematical communication plays a significant role: students need to understand the problem, strategize, execute a plan, and verify the results. The process not only strengthens critical thinking skills but also helps students convey their mathematical ideas in a more structured and transparent manner.

To help students develop mathematical communication skills, *scaffolding strategies* are indispensable. Vygotsky (in Chairani, 2015) introduced the concept *of Zone of Proximal Development* (ZPD), which underlies the importance *of scaffolding* in learning. *Scaffolding* connects students' prior knowledge with new ideas (Sidin, 2016). It is provided in the form of assistance, such as hints, warnings, encouragement, step-by-step explanations, or examples (Mardaleni et al., 2018). Kadir (2008) stated that *scaffolding* enables students to solve mathematical problems that they previously could not solve independently. Sulistyorini (2017) noted that this assistance is temporary and will be discontinued when students can complete their own work. Lestari & Andriani (2019) also emphasized that *scaffolding* helps students understand the problem thoroughly and design the right solution. In the context of math problem-solving, *scaffolding* bridges the gap between students' actual potential and development, especially for those who have difficulty communicating ideas mathematically.

Transformation is also defined as a process of fundamental change in the human body, encompassing both changes in thinking and behavior (Kartika, 2016). In mathematical communication, this transformation occurs when students change their way of thinking after being provided with *scaffolding*, either through language, symbols, or visual representations. Previous research has shown the effectiveness of *scaffolding*. Nurhayati (2017) showed its role in building learning independence, and Fatahillah et al. (2017) proved that *scaffolding* can reduce students' mistakes in solving math story problems. Initial observations in class XI MIPA 3 SMA Negeri 1 Gabus revealed that students struggled to communicate answers mathematically. Therefore, *a scaffolding approach* is necessary that can facilitate the development of students' mathematical communication skills. This study was also conducted to investigate how the transformation of mathematical communication skills in high school students, particularly in solving mathematical problems, can be achieved through *scaffolding*.

Theoretical review

Mathematical Communication

According to Purwandari, Astuti & Yuliani (2018), mathematical communication is a process of interaction or interconnection that occurs in the classroom environment, where the process of message delivery takes place. Mathematical communication is a means for students to express and interpret mathematical ideas orally or in writing, often presented in the form of visual aids such as pictures, tables, diagrams, formulas, or demonstrations. According to Paryitno et al. (2013), mathematical communication is a means for students to express and interpret mathematical ideas orally or in writing, in various forms such as pictures, tables, diagrams, formulas, or demonstrations.

Mathematical Communication Skills

Mathematical communication skills refer to an individual's approach to conveying and reflecting thoughts, as well as communicating mathematical ideas and knowledge to others in their own written language, accompanied by visual representations (Kafrawi, 2016). Mathematical communication skills encompass the ability to communicate mathematical ideas, either orally or in writing, as well as the ability to receive mathematical ideas from others carefully, analytically, and critically to hone understanding (Lestari, 2015).

Mathematical communication skills are essential for students to understand and solve mathematical problems during the learning process. Thus, the indicators of mathematical communication ability used in this study are presented in Table 1.

Table 1. Indicators of Mathematical Communication Ability

Yes	Aspects	Indicator	Description
1	*Written text*	Ability to explain ideas or solutions to a problem or image using one's own language	Students can write down mathematical model ideas from type I and II bolts using their own language.
			Students can complete many types of I and II bolts through cut-off points and maximum grades using their own language.

			Students can write solutions in their own language.
2	*Drawing*	Ability to explain ideas or solutions to mathematical problems in the form of pictures	Students can draw cut-off point graphs for each of the mathematical model types I and II.
3	*Mathematical expressions*	Ability to express everyday problems or events in mathematical model language	Students can write mathematical models of type I bolts and type II bolts in the form of symbols or functions.

Source: (Hodiyanto, 2017)

Furthermore, to assess the extent to which students master these indicators, it is necessary to group the level of ability into clear and measurable categories. This category aims to identify the initial position and development of students in the process of mathematical communication, both in written, visual, and symbolic forms. Therefore, this study categorizes the level of mathematical communication ability into three categories: low, medium, and high (Wijayanto, 2018). This classification is determined based on the total score obtained from the scoring results of each indicator, as described in the following Table 2 (Engelina, V.P., & Munandar, D.R., 2023).

Table 2. Categories of Mathematical Communication Skills

Test Scores	**Category**
$X \geq 66\%$	Tall
$33\% \leq X < 66\%$	Keep
$X < 33\%$	Low

Source: (Wijayanto, 2018)

Problem-Solving Capabilities

Robert L. Solso explains an idea that is straightforwardly coordinated to determine the answer or solution to a specific problem (Mawaddah, 2015). Polya explained that the effort to find a way out of a problem and achieve a goal that cannot be achieved quickly is referred to as problem solving (Indarwati, 2014). Problem-solving ability refers to the expertise or potential that students possess in overcoming problems and applying these skills in daily life (Gunantara et al., 2014). Kesumawati explained that mathematical problem-solving skills are the ability to recognize the components that are known, ask, and the breadth of the elements needed, the ability to make or compile mathematical models, the ability to choose and develop problem-solving strategies, and the ability to understand and examine the responses or answers that have been obtained (Mawaddah, 2015).

Transformation

Transformation is also defined as a process of fundamental change in the human body, encompassing both changes in thinking and behavior (Kartika, 2016). Ability transformation is the process of changing or developing a person's capacity or skills in a particular field. Through this transformation, it is hoped that mathematical communication skills will improve. To stimulate the transformation of students' mathematical communication skills, the right approach or method is needed so that students can utilize all their communication skills in solving problems. Piaget (1959) stated that the development of mathematical communication skills occurs through three processes: assimilation, accommodation, and equilibrium.

Scaffolding

Vygotsky has a level of knowledge or tiered knowledge called *scaffolding*, which is giving a certain amount of help to students during the learning process and then allowing students to be responsible for it when the teacher reduces the help provided, so that it can create an excellent opportunity for students to be able to do it on their own (Chairani, 2015). Guidance, encouragement, as well as warnings and problem-solving, are forms of help that teachers can provide to students, enabling them to become independent (Nabila & Gani, 2017). Alibali (2006) suggested that students develop through assignments, and teachers can use *scaffolding variations* to accommodate differences in students' knowledge levels. The complexity of the content or concept in a lesson will require several *scaffolds at* different times. The following table outlines the types of scaffolding and their usage (Syafrudin, 2018).

Table 3. Types of Scaffolding

Jenis *Scaffolding*	**Scaffolding *Uses***
Example	Illustrate a problem used to present another concept.
Explanation	Verbally explain how the process of a job is
Question	Provide questions related to previous concepts.
Scaffolding Visual	Assist in the form of gestures, images, or other visually acceptable means.

Method

This study employs a qualitative descriptive approach to describe the transformation of mathematical communication skills in low- and medium-high school students as they solve mathematical problems through scaffolding. Transformations are analyzed based on indicators of mathematical communication ability: expressing ideas, interpreting and evaluating ideas, and using mathematical terms and notation. The research was conducted at SMA Negeri 6, Malang City, in the even semester of the 2024/2025 school year, with the subject of grade XI students who had studied linear program material.

Subjects were selected using *purposive sampling techniques*, based on the criteria of initial mathematical communication ability determined through initial tests and interviews. The researchers assigned four subjects, two each from the low and medium categories. The main instruments in this study include mathematical communication problem-solving tests (TPMKM), *think-aloud protocols, and semi-structured interviews, all of which have* been validated by experts.

Data collection was conducted through three primary techniques: written tests, think-aloud protocols, and interviews. The data analysis process involves data reduction, presenting data in the form of narratives and tables with a coding system, and concluding to illustrate the transformation of students' mathematical communication skills. The validity of the data was established through the triangulation of sources, which involved comparing test results, think-alouds, and interviews.

The research procedure is divided into three stages: preparation (initial observation and instrument preparation), implementation (initial test, *scaffolding*, follow-up test, *think-aloud*, and interview), and data analysis. The entire process is carried out within 1-2 months. This research is expected to provide an in-depth understanding of how scaffolding can facilitate gradual improvements in students' mathematical communication skills.

Results

Based on the research results related to transforming students' mathematical communication skills in the low category for solving mathematical problems through scaffolding, it was found that the subjects categorized as low in this study, represented by S1R and S2R, were identified. The results before *scaffolding* revealed difficulties in several stages of problem-solving, according to Polya, particularly in strategizing and executing plans. After being given *scaffolding*, there was an improvement in the mathematical communication abilities of S1R and S2R. S1R showed progress in compiling mathematical models and began to carry out systematic completion steps, although they were not yet perfect. This is reflected in the indicators of mathematical communication skills, written *text* (Wr1, Wr2), *drawing* (Dr), and *mathematical expressions* (Me1). Meanwhile, S2R demonstrated a more comprehensive ability, as evidenced by the fulfillment of *the written text* (Wr1, Wr2) and *mathematical expression* (Me1) indicators. S2R is not only able to form mathematical models from various factors in the problem, but also able to conclude and re-examine the results of the solution. This indicates that scaffolding plays a crucial role in helping students reflect on and refine the problem-solving strategies they use, as well as in enhancing the achievement of mathematical communication skills indicators more comprehensively.

To better understand how S1R and S2R evolve in problem-solving, it is essential to review the cognitive transformation process that is experienced. According to Piaget's theory, this process consists of three primary forms: assimilation, accommodation, and equilibrium. All three describe how students adjust and build new knowledge structures in response to unfamiliar situations or problems. By observing the behavior of S1R and S2R in the problem-solving process, it can be identified which forms of transformation dominate, as well as the role of *scaffolding* in encouraging the move from one form of transformation to another more adaptively and reflectively. The explanation is presented in Table 3 below.

Table 4. S1R and S2R Transformation Tendential Process

Aspects	**Encoding**	**Transformation Tendency Process**	
		S1R	**S2R**
Written text	*Wr*	Before *scaffolding*, S1R demonstrated assimilation because it only utilized known methods by creating x and y equations for the given problem. After *scaffolding*, there is a tendency to **accommodate**, characterized by the emergence of the ability to formulate solutions that find the cutoff points on the x and y axes of both the mathematical models of materials A and material B, as well as to find the maximum value of the objective function.	S2R shows **assimilation** before *scaffolding*, as evident from the attempt to create x and y equations for the given problem. After *scaffolding*, accommodation occurs, characterized by the emergence of the ability to formulate solutions and shows **equilibrium**, i.e., adjustment and balance between the old scheme and the new information.

Aspects	Encoding	Transformation Tendency Process	
		S1R	**S2R**
Drawing	*Dr*	In the early stages, S1R does not provide a complete picture, indicating assimilation, where it utilizes prior knowledge but is not yet able to adapt to the problem's context. After *scaffolding*, there was a shift towards **accommodation**, as evident in his efforts to draw graphics, even though he did not specify the area of the finishing set.	There was no **accommodation**, as there were no changes or adjustments to the scheme. Not achieving **equilibrium**, because there is no balance between new information and old schemas
Mathematical expression	*Me*	Before *scaffolding*, written mathematical models were limited to explicit information (e.g., materials A and B), indicating a lack of **assimilation**. After being given *scaffolding* in the form of questions and examples, S1R began to build a model of additional factors, indicating **accommodation**. However, because it has not been completed in the final stage (such as re-checking), **the equilibrium** process has not been fully achieved.	From the beginning, S2R was able to develop a mathematical model that incorporated material A, material B, and additional factors, although not all of them were accurate. It shows **accommodation**. After *scaffolding*, the ability is significantly improved; S2R can determine the cut-off points between the lines and conclude, indicating that it has reached **equilibrium.**

To clarify the transformation tendency of S1R and S2R in mathematical communication skills through scaffolding for solving mathematical problems, the following transformation process scheme is presented, which shows that significant changes occur at the stages of strategizing and executing the plan, as illustrated in Figures 1 and 2 below.

Figure 1. The Process of Transforming Students' Mathematical Communication Skills in the Low-Category Stage of Developing Strategies

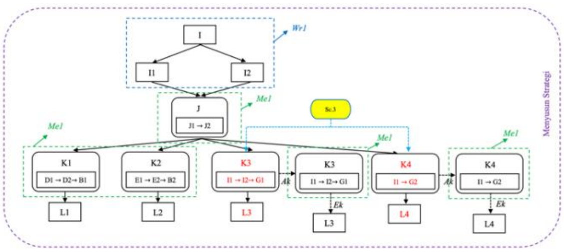
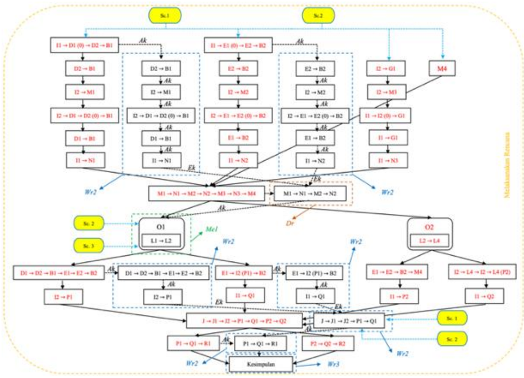


Figure 2. The Process of Transforming Students' Mathematical Communication Skills in the Rendag Category at the Stage of Implementing the Plan



Based on the exposure of data related to the transformation of students' mathematical communication skills in the medium category when solving mathematical problems through scaffolding, it was found that the subjects categorized as medium in this study, represented by S1S and S2S. The results before *scaffolding* revealed difficulties in several stages of problem-solving, according to Polya, particularly in strategizing and executing plans. After being given *scaffolding*, there was a change in the mathematical communication skills of S1S and S2S. S1S demonstrates complete progress, specifically by determining the cutoff points along the x and y axes, drawing graphs, identifying the cutoff points between inequalities, and determining the maximum value, ultimately drawing conclusions. This is reflected in the indicators of mathematical communication ability of *written text (Wr1, Wr2, Wr3), drawing (Dr),* and *mathematical expressions (Me1).* Meanwhile, S2S demonstrated its ability with solutions that are still imperfect, as evidenced by the fulfillment of *the written text (Wr1, Wr2, Wr3)* and *mathematical expression (Me1)* indicators. S2S is not perfect in finding the cutoff points against the x- and y-axes (not paying attention to additional factors), drawing graphs, and finding cutoff points between the inequalities of material B and the second additive factor. This indicates that scaffolding plays a crucial role in helping students reflect on and refine the problem-solving strategies they use, as well as in enhancing the achievement of mathematical communication skills indicators more comprehensively.

To better understand how S1S and S2S evolve in problem-solving, it is essential to review the cognitive transformation process that is experienced. Based on Piaget's theory, this process comprises three primary forms: assimilation, accommodation, and equilibrium. All three describe how students adjust and build new knowledge structures in response to unfamiliar situations or problems. By observing the behavior of S1S and S2S in the problem-solving process, it can be identified which forms of transformation dominate, as well as the role of *scaffolding* in encouraging the transition from one form of transformation to another more adaptively and reflectively. The explanation is presented in Table 5 as follows.

Table 5. S1R and S2R Transformation Tendential Process

Aspects	**Encoding**	**Transformation Tendency Process**	
		S1S	**S2S**
1	**2**	**3**	**4**
Written text	*Wr*	Before *scaffolding*, S1S demonstrates the assimilation process by scaling x and y and identifying the cutoff points of materials A and B. After *scaffolding*, there is accommodation and then equilibrium, because S1S can devise a solution to find the cutoff points against the *x* and *y* axes of all mathematical models, looking for the cut-off point between inequality, and determining the maximum value precisely	Before *scaffolding*, S2S demonstrated assimilation because it employed the known method, namely by making x and y separations and searching for the cutting point between the inequalities. After *scaffolding*, there is a tendency to accommodate, characterized by the emergence of the ability to formulate solutions from the cutoff points to the x- and y-axes, as well as determining the maximum value, even though the completion step is not yet thorough.
Drawing	*Dr*	Before *scaffolding*, S1S did not draw graphs of inequality, indicating a limited assimilation process. After *scaffolding*, accommodation occurs and develops in the direction of equilibrium because it can draw diagrams, determine the area of the set of finishes, and precisely indicate the corner points.	Before *scaffolding*, S2S did not display a visual representation or graph of completion. This indicates the absence of integration of visual communication forms. After *scaffolding*, there was a tendency for accommodation as S2S began to depict graphics, even though it was not yet entirely accurate.
Mathematical expression	*Me*	Before *scaffolding*, S1S demonstrated assimilation by constructing mathematical models of information (material A, material B, objective functions, and additional factors). After *scaffolding*, there is a transformation towards accommodation and equilibrium because the mathematical model is compiled in its entirety, and the process of completion and interpretation is continued appropriately.	Before *scaffolding*, S2S only compiled a model from a portion of the information, showing the assimilation process. After *scaffolding*, accommodation occurred as S2S began to incorporate additional factors into the model, although completion was not yet fully achieved.

To clarify the transformation tendency of S1S and S2S mathematical communication skills in solving mathematical problems through *scaffolding*, the following transformation process scheme is presented, which shows that significant changes occur at the stages of strategizing and executing plans, as illustrated in Figures 3 and 4 below.

Figure 3. The Process of Transforming Students' Mathematical Communication Skills in the Medium Category at the Strategy Stage

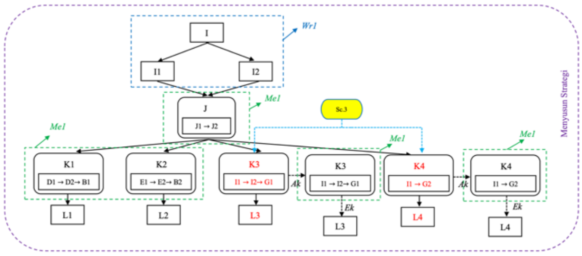
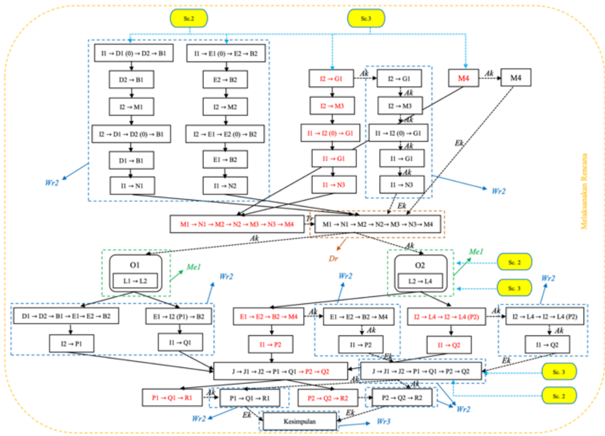


Figure 4. The Process of Transforming Students' Mathematical Communication Skills in the Medium Category at the Stage of Implementing the Plan



Discussion

The transformation of the mathematical communication skills of low-category students demonstrated that, at the stage of understanding the problem, students consistently identified important information in the issue. This finding aligns with the observations of Rahma (2023) and Fatahillah (2017), who noted that students in the low category can meet the indicators at this stage without requiring intervention. Therefore, at the stage of understanding the problem, *scaffolding* is not provided because students have demonstrated an initial understanding of the problem's context independently.

In contrast, at the stage of developing a strategy, students are unable to choose the correct completion step and write a complete mathematical model. The *written text indicator* is starting to be fulfilled, but *the mathematical expressions* are not yet fully formed. After being given *scaffolding* in the form of structured questions, students' ability to choose a solution strategy and write mathematical models increases. These findings align with those of Rahma (2023) and Fatahillah (2017), who emphasized the importance of *scaffolding* at the strategy development stage.

Furthermore, at the stage of implementing the plan, students in the low category were initially unable to solve the problems systematically. After the *scaffolding intervention*, students showed improvement in compiling the completion steps, presenting the final results, and began to write calculations in an orderly manner. Mathematical communication skills, such as the use of images and symbolic expressions, are beginning to emerge, although they are not yet entirely perfected. This finding aligns with the research of Hodiyanto (2017) and Nurhayati (2017), which emphasizes the effectiveness of *scaffolding* in improving problem-solving skills.

At the re-examination stage, students who had previously not evaluated their answers began to make corrections to calculation errors or model arrangements. This change occurs because *scaffolding* enables students to continue the problem-solving process until the final stage of completion. Rahma (2023) noted that low-category students require a special approach to solve questions and reach the final evaluation stage. With *scaffolding*, evaluating answers becomes an integral part of the student's thinking process.

Overall, the transformation of mathematical communication skills in low-category students was influenced by *the gradual scaffolding provided*. Transformation occurs through processes of assimilation, accommodation, and equilibrium (Bormanaki, 2017), in which students form new understandings that are more complex than ever before. This research reinforces previous findings that *scaffolding* is not just a momentary tool, but an effective pedagogical strategy to form reflective, communicative, and mathematically independent problem solvers (Nurhayati, 2017; Hodiyanto, 2017).

The transformation of the mathematical communication skills of middle category students indicates that, at the stage of understanding the problem, students consistently identify essential information in the issue. This ability demonstrates that students already understand the context of the situation without requiring additional intervention. This finding is supported by Rahma (2023) and Fatahillah (2017), who stated that middle category students have generally met the indicators at this stage without the need for *scaffolding*. Therefore, at the stage of understanding the problem, *scaffolding* is not given because students are already able to carry out the initial process independently.

However, at the stage of developing a strategy, students are unable to choose the proper solution steps. They are unable to write mathematical models in full, using symbols or functions. Although *the written text* indicator is visible, *the mathematical expressions* are still not fully formed. After being given *scaffolding* in the form of questions, students demonstrated an improvement in their ability to choose effective strategies and formulate mathematical models that accurately fit the problem. This finding aligns with the observations of Rahma (2023) and Fatahillah (2017), who emphasize the importance of scaffolding at this stage for students in the medium category.

Furthermore, at the stage of implementing the plan, students in the medium category, before being given scaffolding, were not able to prepare a solution with systematic steps and present the final result appropriately. *Scaffolding* in the form of examples, explanations, and questions helps students solve problems by identifying cut-off points, recording maximum results, and creating mathematical model graphs. After the intervention, the ability to write *text*, *mathematical expressions*, and *drawings began to appear*, although not entirely perfect. These findings align with those of Hodiyanto (2017) and Nurhayati (2017), who emphasized the effectiveness of scaffolding in supporting mathematical problem-solving.

At the re-examination stage, students who previously did not show evaluation of the answer results began to be able to check the graph errors and formulate the maximum value solution. *The scaffolding* provided in the previous stages encourages students to evaluate the results and correct any mistakes they find. This reflective activity aligns with Rahma's (2023) research, which suggests that students in the medium category will evaluate whether they are equipped with the right learning aid. This indicates that the process of re-examination is a crucial component in students' development of mathematical communication skills.

Overall, the transformation of the mathematical communication skills of the target students is underway through the learning stages, supported by *structured scaffolding*. This change occurs through the process of assimilation, when students integrate new information into their existing knowledge; accommodation, when students adjust their cognitive structures to understand more complex concepts; and finally, equilibrium, when a new understanding is achieved and becomes more stable

(Bormanaki, 2017). This process demonstrates that scaffolding is not only a technical aid but also a learning strategy that encourages thinking restructuring, enabling students to solve problems with a reflective, logical, and communicative approach (Nurhayati, 2017; Hodiyanto, 2017).

Conclusion

The transformation of the mathematical communication ability of low-category students showed that before *scaffolding*, students had met the *written text* indicator (Wr1) by making x and y spelling, and began to fulfill mathematical expression (Me), even though it was not yet complete. After being given scaffolding in the form of examples, explanations, and questions, there is an improvement through the process of assimilation, accommodation, and equilibrium. Students can better meet the indicators (Wr2) by determining the cut-off point and maximizing the value of the objective function, as well as meeting (Wr3) by drawing the correct conclusions. The ability to draw graphics (Dr) is also starting to appear, although it is not perfect. Overall, the Me indicator was achieved more fully after *scaffolding*, and students' abilities improved from the low to the medium category.

The transformation of the mathematical communication skills of students in the medium category showed that, before scaffolding, students had fulfilled the written text indicator (Wr1) through x and y reasoning, and began to fulfill Wr2 and mathematical expressions (Me), although they were not yet perfect. After being given *scaffolding* in the form of examples, explanations, and questions, there was a significant improvement through the process of assimilation, accommodation, and equilibrium. Students retain their ability to (Wr1) and refine (Wr2) by formulating cut-off points and maximum values from the mathematical model of material A, material B, and additional factors. The students' ability also develops in (Wr3), i.e., correctly deducing the solution, and in the drawing indicator (Dr), by drawing graphs from cut-off points. Additionally, the indicator (Me) is fully fulfilled by a systematic mathematical model. Overall, this transformation demonstrates an increase from the medium to the high category, reinforcing the effectiveness of scaffolding in fostering reflective and intact mathematical communication.

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