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EXPLORING JUSTIFICATION IN SOLVING MATHEMATICS PROBLEMS IN A FACEBOOK GROUP

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ABSTRACT
Facebook is a popular platform that supports the development of critical thinking skills through its discussion feature. One of these potentials is its use to encourage mathematical discussions and explore justification skills in solving problems. Mathematical justification skills include providing logical reasons for the steps in solving problems. This study aims to explore the mathematical justification of Facebook users in answering questions uploaded in Facebook groups. The justification levels refer to Back, Mannila, and Wallin: assumption, vague/broad statement, rule, procedural description, and own explanation. This study used a qualitative approach with an explorative research design. The study participants were 222 members of the SMP (Solution of Mathematics Problem) Facebook forum. Data were obtained through documentation of uploaded questions, comments from forum members, and non-participatory online observation. This study analyzed answers to three geometry problems uploaded in the forum, with six people selected as research subjects based on the diversity of their justification patterns. The results showed variations in the level of mathematical justification of forum members, from assumption to own explanation. Factors influencing differences in justification levels include understanding mathematical concepts and critical thinking skills. These findings indicate that Facebook can effectively encourage mathematical discussions and improve critical thinking skills.
Keywords: Justification, Facebook Group, Mathematics

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INTRODUCTION

Facebook has become a popular platform among various groups, including students and educators. As one of the world's largest social media platforms, Facebook serves as a means of communication and entertainment and has evolved into a space for discussion and learning (Chirinda et al., 2021; Tay et al., 2021). One of the interesting aspects of using Facebook is that the platform can improve critical thinking skills (Kustijono & Zuhri, 2018; Linggu & Tasir, 2022; Putri & Aminatun, 2021). Interactions in discussion forums on Facebook encourage students to analyze, evaluate, and provide evidence-based responses to the ideas presented. In addition, discussions on Facebook often involve open-ended questions requiring deep thinking, encouraging students to develop reflective and logical thinking skills. Using Facebook in learning also encourages students to present structured arguments supported by relevant data. Kustijono et al. (2018) stated that Facebook can support students' science and critical thinking skills through group discussion forums. The threaded comments feature makes discussions more organized and creates a conducive space for developing students' mathematical abilities.

The advantage of Facebook over other social media lies in the diversity of features that support collaborative learning. Through forums or study groups on Facebook, students can share solutions to problems and discuss the steps for solving them (Anderson & Swanson, 2021; Fitri et al., 2020). Discussions in Facebook forums also allow students to receive feedback from peers and teachers (Fitri et al., 2020). Moreover, the cross-generational use of Facebook keeps it relevant as a technology-based learning medium. Sari and Purwanti (2024) state that Facebook remains relevant to all generations due to its community group features, marketplace, and ease of content sharing. This is supported by data from the Indonesian Internet Service Providers Association (APJII) in (2024), which shows that Facebook is one of internet users' most frequently accessed social media platforms. It ranks second among Generation Z users, after Instagram, and first among millennials. These findings indicate that Facebook still holds strong appeal as a digital learning platform across generations.

As one of the most widely used social media platforms across generations, Facebook has great potential for use in education, including mathematics learning (Patahuddin & Basri, 2015). This integration can include discussion activities in study groups, encouraging students to develop various mathematical abilities. One of the abilities that can be developed is mathematical justification. Through features such as discussion groups, students can refine this skill by expressing ideas and receiving feedback from others. Therefore, Facebook supports the development of critical thinking skills and fosters creativity in solving various mathematical problems.

In mathematics learning, justification is the ability to provide logical reasons for each step in solving a problem (Nafi'an, 2020). This process involves proving an opinion or argument that is correct based on previously proven knowledge (Firdausy & Rosyidi, 2020; Sukirwan et al., 2020; Supriani et al., 2019). Meanwhile, Brodie (2010) defines justification as the process by which learners create and express their mathematical arguments. Justification can be done by asking someone to present arguments or evidence for their answers and strategies (Rofiki, 2015). Justification not only helps students better understand the solution process but also trains their logical thinking, reasoning, and analytical thinking and improves students' mathematical communication skills (Glass & Maher, 2004; Hamidy & Suryaningtyas, 2016; Imaniar & Astutik, 2019; Khoirunnisak & Rizkianto, 2020; Yilmaz et al., 2019). Therefore, justification is a crucial skill in mathematics education, as it enables students to convince and reinforce the truth of a statement or reject and refute a false statement (Rofiki et al., 2017b, 2024).

In mathematical justification processes, several experts have developed different approaches to measuring students' levels of justification linked levels of justification to mathematical concept understanding (Back et al., 2009; Lo et al., 2008; Simon & Blume, 1996). Lo et al. (2008). This level consists of five levels, namely level 0, level 1, level 2, level 3, and level 4 (Lo et al., 2008; Nafi'an, 2020). Students are at level 0 if they do not provide an answer or the answer provided does not contain valid reasoning. Level 1 indicates the ability to justify with descriptive explanations without mathematical reasons. Level 2 is the ability to justify using mathematical concepts, but there are still errors. Meanwhile, justification ability at level 3 is when students use mathematical concepts, but there are still important elements in the mathematical aspects that are overlooked. Meanwhile, justification ability at level 4 is when students have used mathematical concepts comprehensively and correctly (Fatmanissa et al., 2024).

Simon & Blume (1996) explain the levels of justification based on the approach used by students in providing reasons. The levels of justification are divided into five levels: No Justification, Appeal To External Authority, Empirical Evidence, Generic Example, And Deductive Justification (Kurniawan et al., 2022; Simon & Blume, 1996). Students are at the No Justification level when they do not provide any reasons to support their justification. At the Appeal to External Authority level, students provide reasons based on external sources (such as teacher explanations, books, or peers) in their justifications. Empirical Evidence justifications involve students using empirical examples to demonstrate their justifications. Generic Examples involve students providing reasons for the validity of a statement by performing operations or transformations on a generalization of a class (not a specific example). Meanwhile, Deductive Justification is the highest form of justification, where students provide logical reasons or proofs using definitions, axioms, or proven theorems. This justification does not depend on examples but on systematic and valid deductive reasoning according to mathematical principles.

Back et al. (2009) argued that justification should be based on strong and structured arguments supported by empirical evidence. Back et al. (2009) propose five levels of justification: Assumptions, Vague/Broad Statements, Rules, Procedural Descriptions, and Own Explanations. At the Assumption level, students only provide guesses or assumptions without concrete reasons. The Vague/Broad Statement level occurs when students provide brief and unclear reasons, resulting in insufficiently informative information. At the Rule level, students provide reasons based on definitions, rules, or theorems but have not fully connected them to the context of the problem. Meanwhile, the Procedural Description level indicates that students can explain the steps of the solution sequentially but do not mention the underlying mathematical reasons. The highest level, Own Explanation, indicates that students can provide reasons using their language or symbols but still reflect a deep understanding of the concept.

Many recent studies have explored students' mathematical justification (Aziz, 2021; Melhuish et al., 2020; Nafi'an, 2020; Supriani et al., 2022). Putra (2020) researched seventh-grade students' justifications for understanding triangle concepts, which were examined based on gender. Meanwhile, Aziz (2021) researched university students' justifications for solving graph theory problems in a discrete mathematics course. However, studies that utilize Facebook as a source of discussion are still relatively rare. Facebook is one of the platforms that users can use to engage in discussions, allowing them to justify their responses.

In this study, the researchers chose to use the levels of justification proposed by Back, Mannila, and Wallin (2009). The reason for choosing mathematical justification analysis based on the levels of justification proposed by Back, Mannila, & Wallin is because this theory provides a clear framework for understanding how students construct their mathematical arguments and why they choose specific approaches. The levels of justification proposed by Back, Mannila, and Wallin emphasize that the higher the level of justification, the better a person's ability to provide reasons (Sarumaha, 2018). Therefore, this study aims to explore the justifications of Facebook users for solving mathematical problems posted on Facebook groups. The primary focus of this study is to analyze the justification abilities of Facebook forum members in response to mathematical problems posted on the forum. By understanding these levels of justification, educators can design more effective learning experiences that support the development of students' critical and creative thinking and facilitate a deeper understanding of mathematical concepts, as Facebook has the potential as a medium for sharing knowledge and engaging in interactive discussions. This research also contributes to efforts to leverage existing technology to enhance the quality of mathematics learning outside the classroom.

METHOD

This study uses a qualitative approach with an exploratory type. It aims to explore in depth the patterns of justification regarding Facebook users' ability to provide solutions to problems posted in Facebook groups. A qualitative approach was chosen because it allows researchers to understand Facebook users' justification abilities (Cresswell, 2012). The levels proposed by Back et al. (2009) are used to identify the level of justification, as shown in Table 1.

Table 1. Justification Level Indicator

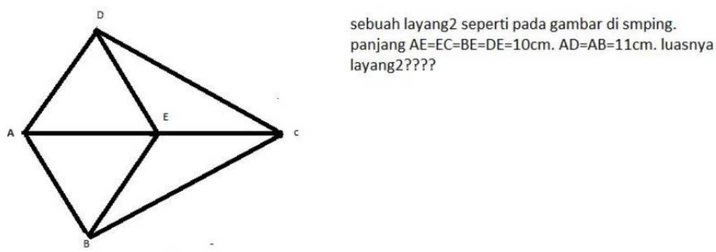
Justification Level	Indicator
Assumption	Providing an answer without clear or logical reasoning, merely based on assumptions, guesses, or statements that are not grounded in mathematical concepts
Vague/broad statement	Providing reasoning that is too general and not specific, thus insufficient to logically or mathematically support the answer
Rule	Stating a relevant definition, rule, or theorem
Procedural description	Explaining the procedure or steps of the solution in a logical sequence, including how the rules are applied to solve the problem
Own explanation	Providing reasoning or justification in one's own words, demonstrating deep understanding, logical structure, and relevance to the context of the problem

This study explores mathematical justification skills by analyzing answers to three predetermined questions. The research participants were drawn from a Facebook discussion group of 222 members, comprising mathematics education students and members of the general public interested in mathematics. The data source for this study was the comments provided by users of the SMP (Solution of Mathematics Problem) Facebook forum in answering or solving mathematical problems posted by forum members. Six individuals from the total forum members were selected as research subjects. Subject selection was conducted purposively, considering the diversity of justification answers provided for the three selected questions. This approach aimed to ensure the representation of various justification patterns emerging among forum members. Data from the six subjects were then analyzed in depth to identify the characteristics of their mathematical justification abilities.

Data were collected through documentation in the form of uploaded questions and comments from forum members and through non-participatory online observation to understand the context of the discussion. The research process was carried out in several stages, namely (1) the researcher selected mathematics questions uploaded by forum members; (2) selected comments relevant to Back, Mannila, & Wallin's level of justification; (3) analyzed the justification abilities of Facebook users and presented the research data. Data analysis was conducted using content analysis, which involved identifying justification patterns based on Back et al. (2009) levels and observing forum member interactions, such as providing arguments or clarifying answers given.

RESULT AND DISCUSSION

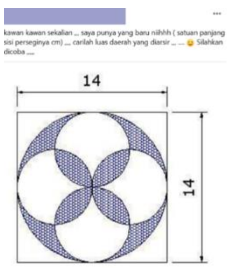
Based on the research findings, the researcher selected three geometry problems from the Facebook discussion forum SMP (Solution of Mathematics Problem). The selected problems are presented in Figures 1, 2, and 3.



Translate:
The adjacent figure shows that a kite has $AE = EC = BE = DE = 10\ cm$. AD = 11 cm and $AD = AB = 11\ cm$. What is the area of the kite?

Figure 1. Question 1

The first question was chosen for analysis because it was one of the most interesting topics in the forum, as evidenced by the 22 comments from members. In this first question, forum members were asked to determine the area of a kite based on the image and information provided.



Translate:
Dear friends, I have something new (the unit of length is cm). Please find the shaded region area. Feel free to try it out.

Figure 2. Question 2

To complement the analysis and obtain a more diverse picture of the mathematical justification abilities of forum members, the researcher analyzed two other questions, namely question 2, shown in Figure 2, and question 3, shown in Figure 3. The second question received 19 comments related to the area of a circle, while the third question received 16 comments and discussed the concept of the volume of a solid figure. These two questions were also selected because they represent different topics in mathematics and demonstrate active interaction within the forum, making them relevant for further analysis based on justification levels.

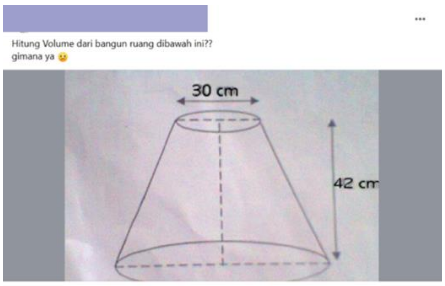


Figure 3. Question 3

Translate:
Calculate the volume of the following solid figure. How do you do it?

Question 1:

Based on the analysis of the solution to Question 1, members of the SMP (Solution of Mathematics Problem) Facebook forum showed active involvement in the discussion, as evidenced by 22 comments. These comments reflect the members' participation in providing answers and show various levels of justification used. In addition, several comments served as scaffolding in the form of guidance or support provided by other members regarding the proposed solution. The results of the analysis of the justification levels of the forum members are presented in Table 2.

Table 2. Distribution of Comments on Question 1

Type of Comment		Quantity
Level of Justification	*Assumption*	1
	Vague/broad statement	1
	Rule	-
	Procedural description	1
	Own explanation	-
Scaffolding		15
Other comments not related to the solution of the question		4

The solutions provided by forum members were then selected, with three comments representing the justification level and one scaffolding comment for further analysis. The first comment came from S1, shown in Figure 4. This comment was categorized at the assumption level because S1 only provided an answer without giving clear reasons or evidence. The statement assumes that the lengths of diagonals BD and AC can be directly used in the calculation without explaining how these two values are utilized in calculating the kite's area. Additionally, although the lengths of sides AD and AB are known in the problem, S1 explains how these values are used in calculating the area or connecting them to other parts of the figure, such as the triangle or kite formed. Therefore, the answer provided does not provide a sufficient basis for reasoning and lacks support for a deep mathematical understanding.

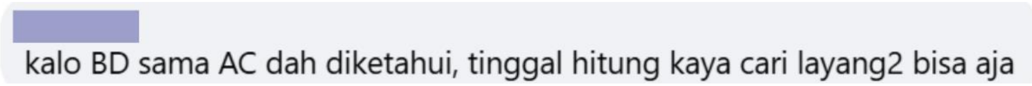

kalo BD sama AC dah diketahui, tinggal hitung kaya cari layang2 bisa aja

Figure 4. S1's answer to question 1

Translate: If BD and AC are known, just calculate it like you would for a regular kite.

Unlike the S1 approach, which lacks reasoning, S2 shows a more comprehensive and structured justification process. S2 provides three alternative solutions in stages, which develop through interaction with other forum members. Figure 5 shows that S2 begins by explaining that triangle ADE is an isosceles triangle. Next, S2 draws a height line from point E to side AD, resulting in $AP = \frac{11}{2}$. Based on the triangle configuration formed, S2 uses the basic definition of trigonometric functions to determine the values of $\cos \angle DAE = \frac{\frac{11}{2}}{10} = \frac{11}{20}$ and $\sin \angle DAE = \frac{\sqrt{279}}{20}$. The sine value is then used in the triangle area formula to calculate the area of ΔACD, resulting in the area of the kite, where $Area\ ABCD = 2\,[\Delta ACD] = 2 \times \frac{1}{2} AC\ AD \sin \angle DAE = 20 \times 11 \times \frac{\sqrt{279}}{20} = 11\sqrt{279}$.

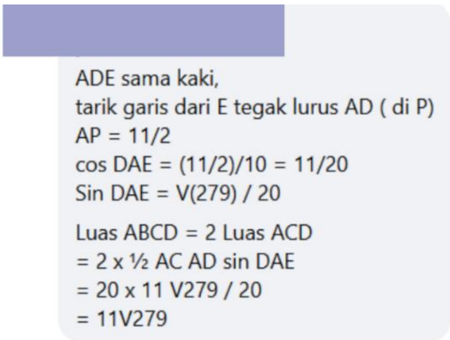

ADE sama kaki,
tarik garis dari E tegak lurus AD (di P)
AP = 11/2
cos DAE = (11/2)/10 = 11/20
Sin DAE = V(279) / 20
Luas ABCD = 2 Luas ACD
= 2 x ½ AC AD sin DAE
= 20 x 11 V279 / 20
= 11V279

Figure 5. S2's answer to question 1

Translate:
ADE isosceles
Draw a line from E perpendicular to AD (at P)
$AP = 11/2$
$cos\ DAE = \frac{\frac{11}{2}}{10} = \frac{11}{20}$
$sin\ DAE = \frac{\sqrt{279}}{20}$
$Area\ ABCD = 2\ Area\ ACD$
$= 2 \times \frac{1}{2} AC\ AD\ sin\ DAE$
$= 20 \times \frac{11\sqrt{279}}{20}$
$= 11\sqrt{279}$

Based on the provided solution process, S2's response, as shown in Figure 5, can be categorized under the procedural description level. This is because S2 uses a structured and detailed approach to solving the problem. S2 begins solving the problem by identifying the type of triangle, then utilizes the type of triangle to determine the length of the altitude, and uses trigonometry rules to obtain the area of the plane figure. Accordingly, S2 exhibited the capacity to systematically and sequentially elaborate the steps involved in the problem-solving process. This justification is at a higher level than the rule because the student not only mentions definitions or formulas but applies them systematically in the context of the problem. However, the explanation provided has not reached the own explanation level because it has not been fully conveyed in their own words or accompanied by in-depth conceptual arguments. Mefiana et al. (2023) mention that there are types of students who can solve problems using procedures or rules but cannot provide reasons for using those procedures. Students can describe the solution in detail and step by step, but sometimes, they do not provide in-depth reasons why those steps are relevant in the broader context of the problem.

The answer provided by S2 allowed other forum members to provide scaffolding for the solution. The question creator provided one example of scaffolding, as shown in Figure 6. The scaffolding provided consisted of different strategies for calculating the area of the kite. The assistance provided guided the forum members in solving the problem using the concept of circles. The forum member who created the question only explained the initial steps of the approach without completing the calculations in full. It shows that the assistance provided guides and encourages independent thinking among forum participants, consistent with scaffolding characteristics.

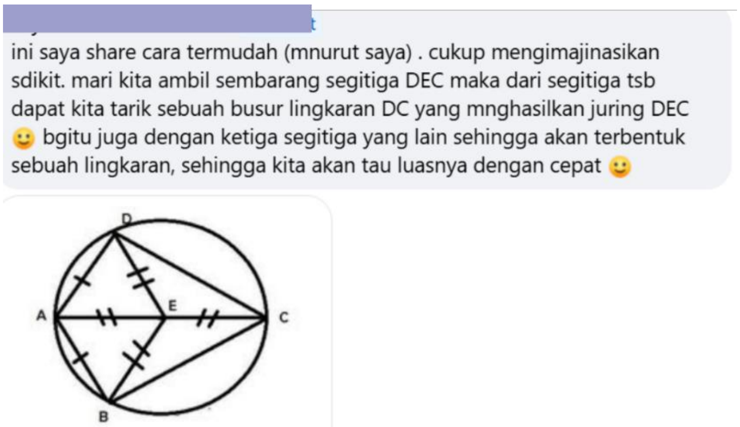


Figure 6. *Scaffolding* Question 1

Translate: Here is the easiest method (in my opinion). Just imagine a little. Let us take any triangle DEC. We can draw a circle arc DC from that triangle, which produces a sector DEC. Similarly, a circle will form with the other three triangles, allowing us to determine its area quickly.

From the scaffolding given in Figure 6, S2 answered using the steps directed by the scaffolding. In the third method shown in Figure 7, S2 showed a vague/broad statement level of justification. The vague/board statement level of justification can be seen from the last steps, where S2 did not write down why $Area\ ABCD = 2\ Area\ ADC$. Although the scaffolding provided can be considered a basis or clue to understanding the concepts used in the calculation, the answers submitted by S2 are still very concise and less detailed. The steps to complete the calculation, such as the relationship between the sides of the triangle and the application of the formula to calculate the length of the DC side, were not explained clearly enough. It causes the justification process to be less informative and does not support overall understanding.

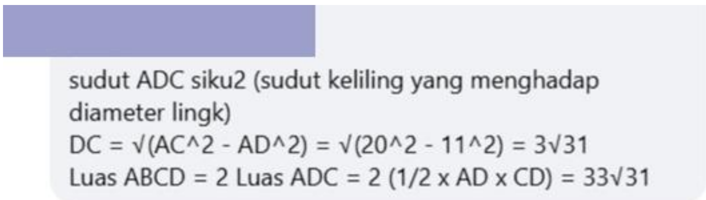


Figure 7. S2's answer to Question 1 in a different way

Translate: ADC is a right angle (the angle around the circumference facing the diameter of the circle)

$DC = \sqrt{AC^2 - AD^2} = \sqrt{20^2 - 11^2} = 3\sqrt{31}$

Luas ABCD = 2 Luas ADC $= 2\left(\frac{1}{2} \times AD \times CD\right) = 33\sqrt{31}$

Question 2:

The second question was chosen to be analyzed because it attracted the attention of forum members, which can be seen from the number of comments entered. Based on the analysis of the discussion on the problem, members of the Facebook Solution of Mathematics Problem forum were actively involved in submitting solutions and responding to other members' answers. Nineteen comments reflected a high level of interaction among forum participants. The comments show variations in the level of justification used by forum members in solving the question and scaffolding comments that provide direction on how to solve the question. The results of the analysis of the level of justification shown by forum members are shown in Table 3.

Table 3. Distribution of Comments on Question 2

Type of Comment		Quantity
Level of Justification	*Assumption*	3
	Vague/broad statement	-
	Rule	1
	Procedural description	-
	Own explanation	2
Scaffolding		5
Other comments not related to the solution of the question		8

Three comments were selected from the comments the forum members gave, which showed the members' level of justification. S3 became one of the forum members who gave an answer to question number 2. The answer given by S3, shown in Figure 8, indicates that S3 assumes the work must involve auxiliary lines and provides only the calculation $154 - 77 - 24.5 = 52.5$ without further explanation. This answer shows that S3 does not provide a clear and logical explanation to support the results of his calculations. Although S3 wrote down the math operations, S3 did not describe the thought process from which the results were obtained. In fact, an explanation of the meaning of the numbers written down and related to the information in the problem is needed to get a complete understanding. This shows that S3 only guessed the final answer without accompanying systematic steps or in-depth understanding, so it is classified at the assumption level. This finding aligns with Vebrian et al. (2021) that in solving problems, students often do not show structured mathematical justification in solving problems but are more subjective or based on conjecture.

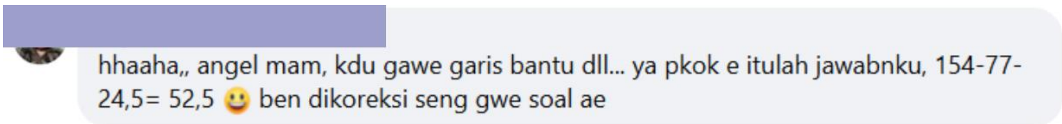


Figure 8. S3's Answer to Question 2

Translate: Hahaha. It is not easy, Mam. You have to make auxiliary lines, etc. Yes, anyway, that is my answer, $154 - 77 - 24.5 = 52.5$. *Let us correct the one who made the problem.*

Based on the answer given by S4 in Figure 9, it can be seen that S4 solved the problem by using systematic steps and accompanied by clear mathematical explanations. In solving the problem, S4 wrote down the calculation results and provided visualizations and symbols that made it easier to solve the problem. This shows that S4 understands the mathematical concepts and can coherently communicate his thought process. S4 started the solution by identifying the large circle area as $154\ cm^2$. Then, S4 calculated the area of the unshaded part of the small circle. In this process, S4 explained that the unshaded area is calculated from four similar shapes with a total area of $98\ cm^2$. Therefore, the shaded area is the area of the large circle minus the area of the small circle, which is $154 - 98 = 56\ cm^2$. In addition, S4 also uploaded the handwritten picture shown in Figure 9. S4 rewrote the circle area formulas and described the parts of the shape to clarify conceptual understanding and relationships between geometry elements. S4 used narration, symbols, and pictures to explain the calculation steps. This shows that S4 tried to explain the reasoning in a language that is easy to understand.

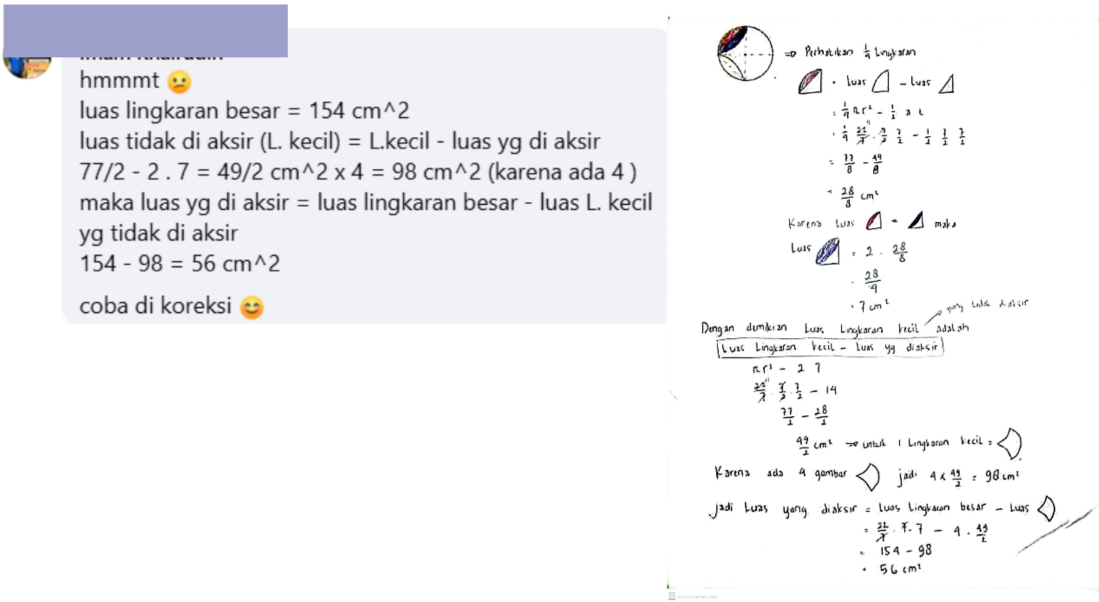


Figure 9. S4's Answer to Question 2

Translate:

Left side figure
hmm.
area of the large circle = $154\ cm^2$
area not emphasized (small A) =small A. - emphasized area $\frac{77}{2} - 2.7 = \frac{49}{2}\ cm^2 \times 4 = 98\ cm^2$ *(because there are 4)*
then the accentuated area = area of the large circle - area of the unaccented small A. $154 - 98 = 56\ cm^2$
try to correct it

Right side figure
Consider the $\frac{1}{4}$ *circle*
 *= Area*  *- Area* 

$$= \frac{1}{4}\pi r^2 - \frac{1}{2}at$$
$$= \frac{1}{4}.\frac{22}{7}.\frac{7}{2}.\frac{7}{2} - \frac{1}{2}.\frac{7}{2}.\frac{7}{2}$$
$$= \frac{77}{8} - \frac{49}{8}$$
$$= \frac{28}{8}cm^2$$

Because the area  = *, then*
Area  $=2.\frac{28}{8}$
$$= \frac{28}{4}$$
$$= 7\ cm^2$$

Therefore, the area of the small circle that is not shaded is
The area of the small circle - the area of the shaded one

$$\pi r^2 - 2.7$$
$$\frac{22}{7} \cdot \frac{7}{2} \cdot \frac{7}{2} - 14$$
$$\frac{77}{2} - \frac{28}{2}$$

$\frac{49}{2}$ *for one small circle =* 

Because there are four images  *so,* $4 \times \frac{49}{2} = 98cm^2$

So the shaded area = the area of the large circle -  *area*

$$= \frac{22}{7}.7.7 - 4.49.2$$
$$= 154 - 98$$
$$= 56\ cm^2$$

The solution provided by S4 indicates that the student operates at the justification level of *own explanation.* This is because S4 used mathematical formulas and supported them by justifying his language. S4 wrote down the procedural steps and communicated the reasons behind each stage of the solution in a way that was in accordance with his own understanding, which was still based on mathematical principles and concepts. This finding is in line with the research of Back et al. (2009), which states that students at their own explanation level often show a good understanding of the basic concepts of mathematics. Students apply rules or formulas and try to explain the reasons behind using these steps in a way that is based on their understanding.

The findings of the solution of question number 2, by forum member S5, shown in Figure 10, show that S5 has justification ability at the rule level. In the comment, S5 provided a relevant mathematical rule, namely using the Area of a circle and Area of square formulas to calculate the Area of the shaded Area. In addition, S5 also explained that the shading that was originally in the center of the circle was moved to the edge so that the area of the shaded area could be calculated as the difference between the area of the circle and the area of the square. However, the explanation did not include a detailed description of the process or mathematical reasoning used at each step, such as why the length of the side of the square was expressed as $7\sqrt{2}$ and how the visual form of the area of the circle was valid. Therefore, this comment reflects justification at the rule level, focusing on applying relevant rules and formulas without providing detailed reasoning/explanation.

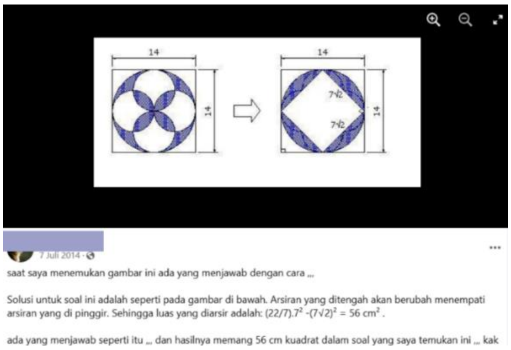


Figure 10. S5's answer to Question 2

Translate:
The solution to this problem is shown below. The shading in the middle will change to occupy the shading on the edge. So the shaded area is: (22/7).72 - (7/2)² = 56 cm².
Some people answer like that, and the result is indeed 56 cm squared in this problem that I found.

Question 3:

In solving question number 3, there were 16 comments. Some of these 16 comments are included in scaffolding and justification skills at the assumption and procedural description levels. Meanwhile, other comments were not included in the justification or scaffolding categories. The details of the distribution of comments are shown in Table 4. In question 3, the researchers analyzed two answers from forum members, namely the answers from S1 and S6.

Table 4. Distribution of Comments on Question 3

Type of Comment		Quantity
Level of Justification	*Assumption*	1
	Vague/broad statement	-
	Rule	-
	Procedural description	2
	Own explanation	-
Scaffolding		10
Other comments not related to the solution of the question		3

Based on the analysis, the justification used by S1 was at the assumption level. In his comments (Figure 11), S1 started the solution by assuming that the shape was a cylinder with a radius of 20 cm, so the cylinder volume was calculated using the formula $\pi r^2 t$. In addition, S1 also assumed that the remaining part had a radius of 5 cm and a height of 42 cm, thus forming two cones, which were calculated using the cone volume formula $\frac{2}{3}\pi r^2 t$. However, these assumptions were made without supporting mathematical proof or reasoning. S1 did not explain why the shapes were interpreted as cylinders and cones and the reason for obtaining the radius and height of the cones. Because no conceptual justification or reasoning supports these assumptions, this answer is included in the assumption justification level, which is justification in the form of conjectures or initial thoughts without a strong mathematical foundation.

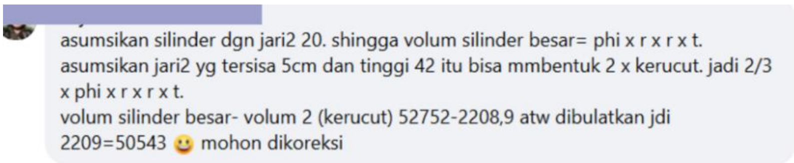

asumsikan silinder dgn jari2 20. shingga volum silinder besar= phi x r x r x t.
asumsikan jari2 yg tersisa 5cm dan tinggi 42 itu bisa mmbentuk 2 x kerucut. jadi 2/3 x phi x r x r x t.
volum silinder besar- volum 2 (kerucut) 52752-2208,9 atw dibulatkan jdi 2209=50543 mohon dikoreksi

Figure 11. S1's answer to Question 3

Translate: Assume a cylinder with a radius of 20. so that the volume of a large cylinder $= phi \times r \times r \times t$. *Assume the remaining radius of 5cm and a height of 42 that can form 2* $\times$ *cones. So,* $\frac{2}{3} \times phi \times r \times r \times t$. *The volume of large cylinder – The volume of 2 (cones)* $52752 - 2208.9$ *or rounded up to* $2209 = 50543$. *Please correct.*

The deficiency in validating the assumptions shown by S1 opens up space for scaffolding in forum discussions, as seen in the comments in Figure 12. The scaffolding provided includes not only cognitive aspects but also affective scaffolding. Cognitive scaffolding is seen from conceptual directions, such as the use of the concept of congruence to calculate the height of a pointed cone. This is in line with Hermkes et al. (2018), who stated that cognitive scaffolding could strengthen students' concept understanding. Affective scaffolding appears through positive reinforcement, such as "Good thinking," which increases motivation and reduces student anxiety in completing tasks (Brower et al., 2018).

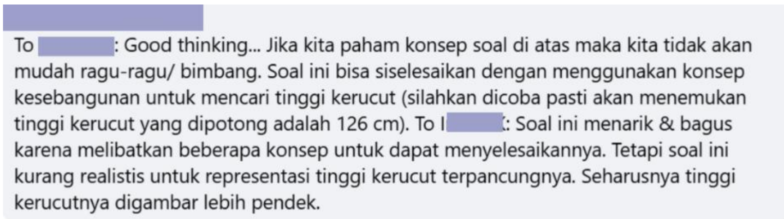

[redacted]
To [redacted]: Good thinking... Jika kita paham konsep soal di atas maka kita tidak akan mudah ragu-ragu/ bimbang. Soal ini bisa siselesaikan dengan menggunakan konsep kesebangunan untuk mencari tinggi kerucut (silahkan dicoba pasti akan menemukan tinggi kerucut yang dipotong adalah 126 cm). To I[redacted]: Soal ini menarik & bagus karena melibatkan beberapa konsep untuk dapat menyelesaikannya. Tetapi soal ini kurang realistis untuk representasi tinggi kerucut terpancungnya. Seharusnya tinggi kerucutnya digambar lebih pendek.

Figure 12. *Scaffolding* Question 3

Translate: To: Good thinking. If we understand the concept of the problem above, we will not hesitate easily. This problem can be solved by using the concept of congruence to find the height of the cone (please try to find the height of the cut cone is 126 cm). To I: This problem is interesting and good because it involves several concepts to solve it. However, this problem is not realistic enough to represent the height of the truncated cone. The height of the cone should be drawn shorter.

Scaffolding in the forum discussion proved effective in encouraging forum members to produce more systematic and valid solutions. An example is the solution given by S6 in problem number 3, shown in Figure 13. S6 shows the justification level of the procedural description. This can be seen from how S6 utilized the concept of congruence to calculate the height of the full cone by comparing the side lengths of the whole cone and the truncated cone. The steps taken by S6 began by determining the height of the full cone (T) by comparing the similarity. After obtaining the height, S6 continued calculating the whole cone's volume using the formula $\frac{1}{3}\pi r^2 t$. Furthermore, the volume of the smaller cone was calculated step by step and then subtracted from the volume of the larger cone to obtain the volume of the truncated cone. This solution reflects a good procedural understanding of the concepts of congruence and volume. Although the explanation given has not yet reached an in-depth conceptual description, S6 could convey the calculation stages coherently and clearly. Therefore, this answer is classified at the procedural description level by the classification by Back et al. (2009), where students can mention the correct steps but have not fully explained the reasons or principles behind each step.

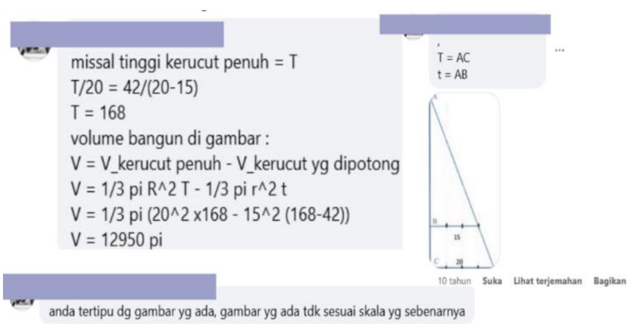


Figure 13. S6's answer to Question 3

Translate:
Height of a full cone = T
$$\frac{T}{20} = \frac{42}{20-15}$$
$$T = 168$$
The Volume of the shape in the picture:
V = V_full cone - V_cut cone
$$V = \frac{1}{3} pi\ R^2\ T - \frac{1}{3}\ pi\ R^2 t$$
$$V = \frac{1}{3}\ pi\ (20^2 \times 168 - 15^2\ (168 - 42))$$
$$V = 12950\ pi$$
The picture fools you; the picture is not to scale

Research on students' mathematical justification ability has become important in mathematics education, especially in understanding how students solve geometry problems. In this study, the researcher explored students' mathematical justification through problems uploaded on the SMP (Solution of Mathematics Problem) Facebook forum. The results showed that forum members could provide correct answers and reasons, especially after being given scaffolding by the problem creator. Scaffolding is given in the form of explaining the purpose and objectives of the problem or providing basic ideas for working on the problem. This is in line with Ihechukwu (2020), who stated that scaffolding can improve students' achievement and ability in mathematics. In addition, scaffolding helps students solve complex math tasks because students gain direction, a clearer understanding of concepts, and confidence to continue problem-solving (Puntambekar, 2022; Saputra et al., 2024).

This study uses geometry problems to measure students' justification skills because forum members most often discuss the topic. In addition, geometry is considered adequate for measuring justification ability because solving geometry problems requires students to connect various abstract concepts, develop logical arguments, and draw conclusions based on visual observations and geometric constructions (Masfingatin et al., 2020). The results showed variations in the level of justification shown by forum members, ranging from the assumption level to own explanation. The difference in justification levels is closely related to variations in each individual's level of mathematical understanding. Individuals with high mathematical understanding tend to provide logical and thorough justifications, while individuals with low understanding ability tend to provide less clear and wrong justifications (Prameswari & Ismail, 2023).

As one of the most widely used social media, Facebook has the potential to be an effective online learning medium (Ulla & Perales, 2021). Discussion forums on Facebook allow active interaction and encourage users to build mathematical understanding through discussion. In this study, junior high school forum members could solve problems using various methods. In addition, forum members could also submit answers after getting a stimulus from the problem creator. This shows that social media-based learning can positively impact improving mathematics problem-solving and justification skills.

In particular, this study also found that cognitive and affective scaffolding contributed to improving individuals' justification skills. Cognitive scaffolding provides support in understanding mathematical concepts and relating them to problem-solving steps. This support enabled students to develop a deeper understanding and provide more structured reasoning. This is in line with the opinion of Kim et al. (2022), who states that assistance in questions or additional explanations can facilitate students' critical thinking in justifying. Additionally, scaffolding affective, which focuses on emotional support and student motivation, plays a crucial role in boosting students' self-confidence, enabling individuals to become more active in providing arguments and justifications without fear of being wrong. Rasyid et al. (2024) emphasize that positive interactions and active discussions between teachers and students can enhance students' critical thinking and justification skills. Therefore, integrating both forms of scaffolding can improve students' ability to provide more in-depth and structured justifications for the solutions they use.

Based on the analysis results, the justification level of forum members is mostly at the assumption level, as shown in Table 5. This is because, in mathematics learning, assumptions are often used to construct theories or formulate hypotheses that are then tested or examined.

Although assumptions can be a starting point in constructing arguments, in the context of mathematics learning, each assumption should ideally be supported by clear definitions, rules, or theorems. However, students tend to make assumptions without providing strong reasons. This is in line with the opinion of Hamidy and Suryaningtyas (2016), who state that students describe results more than they explain the process or why they chose specific steps. As a result, the answers given often do not fully demonstrate deep understanding or structured mathematical thinking.

Table 5. Facebook Forum Members' Justification

Justification Level	Question 1	Question 2	Question 3	Total
Assumption	1	3	1	5
Vague/broad statement	1	-	-	1
Rule	-	1	-	1
Procedural description	1	-	2	3
Own explanation	-	2	-	2

At the assumption justification level, the Facebook SMP forum members only gave answers without giving reasons/arguments why the answers were correct. In addition, forum members only provide conjectures on the steps to solve the problem. This happens because of the lack of understanding of the concept of forum members in solving problems. Hwang et al. (2020) stated that individuals often have difficulty building deep conceptual understanding, especially in geometry, which requires spatial and formal understanding. Meanwhile, Permana et al. (2020) stated that individuals cannot provide reasons for problem-solving due to low mathematical reasoning skills.

The vague/broad statement level shows that forum members only provide problem-solving with brief and less in-depth reasons. In fact, in solving problems, individuals should be able to think deeply to solve problems. The factor that causes students' justification ability to be at the vague/broad statement level is the lack of students' critical thinking skills in solving problems. Low critical thinking can cause students to fail to provide relevant justifications for problem-solving (Chusni et al., 2021; Septiany et al., 2024). Facebook forum members have also shown the rule level. In this study, forum members used the circle area and square area formulas to calculate the shaded area. However, the forum members did not provide reasons behind the formulas or detailed explanations in each stage of the solution. This aligns with previous research findings that individuals only know the rules, properties, or theorems without providing an in-depth understanding (Khoerunnisa & Sari, 2021; Rofiki et al., 2017a).

Facebook forum members have also shown justification skills at the procedural description level, where forum members show good understanding skills. Forum members have been able to apply coherent steps in solving a problem but have not understood deeply why the steps are correct. This is in line with Setiana et al. (2021), who said that generally, individuals only understand the application of a rule or definition in solving problems but do not know the logical reason why the concept is correct and can be used to solve problems.

The results showed that forum members have justification skills at the level of own explanation. This shows that forum members have a deep understanding of the basic concepts of mathematics and have high critical thinking skills. This aligns with Setiana et al. (2020)

statement that individuals with high critical thinking ability can provide clear and valid reasons for solving problems using their language. Individuals who can own explanations are not only able to present a complete solution but also to include logical reasons for each step. This shows that individuals understand the procedure and the relationship between the mathematical concepts used. Thus, justification is relational because it is based on a thorough understanding, not just memorizing or applying rules.

CONCLUSION

The mathematical justification ability of Facebook SMP (Solution of Mathematics Problem) members in solving problems uploaded on the forum is very diverse, with dominance at the assumption level, where many members only provide answers without logical reasons or proof. However, Facebook forum members also showed the justification level of vague/broad statements, rules, procedural descriptions, and explanations. This study also shows that interactive discussions in Facebook forums can function as an effective learning medium through scaffolding, which is support in the form of additional explanations or basic ideas that help forum members understand and solve problems. Scaffolding improves forum members' mathematical skills, especially in solving complex problems. However, this research is still limited to exploring justification in solving math problems. Therefore, future research is expected to explore forum members' critical thinking, creative thinking, and mathematical communication skills in solving mathematical problems. In addition, future researchers are expected to expand the research object by involving other social media platforms, such as Instagram and TikTok, to obtain a more comprehensive insight into the utilization of social media in mathematics learning.

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