**Jurnal Praktik Baik Pembelajaran Sekolah dan Pesantren**
Vol. 4, No. 02, pp. 54-67
journal.iistr.org/index.php/PBSBP
DOI: 10.56741/pbpsp.v4i02.788

# The Impact of Thematic Worksheet-Assisted Meaningful Learning Implementation on Students' Mathematical Concept Understanding and Metacognitive Skills

**[1]Eni Fitriana*, [2]Deny Hadi Siswanto, [2]Akhmad Hanama**
Corresponding Author: *enifitriana93@guru.smk.belajar.id
[1] SMK Dirgantara Putra Bangsa (Vocational High School), Sleman, Indonesia
[2] Universitas Ahmad Dahlan, Yogyakarta, Indonesia

ARTICLE INFO

**Article history**
Received 14 December 2024
Revised 29 March 2025
Accepted 4 April 2025

ABSTRACT

This study aims to examine the impact of meaningful learning implementation assisted by thematic worksheets on students' mathematical concept understanding and metacognitive skills using a quantitative descriptive approach. The research employs a quantitative method with a pre-experimental design, specifically the One Shot Case Study design, and uses simple random sampling for sampling techniques. The study was conducted in class XI of Dirgantara Putra Bangsa Vocational High School in October 2024, with 30 students participating. Data collection was carried out through questionnaires on the implementation of meaningful thematic learning assisted by worksheets, metacognitive skills questionnaires, and tests on mathematical concept understanding. The results of the study indicate that: (1) Student responses to meaningful learning assisted by thematic worksheets reached 74.62%, categorized as good; (2) The implementation of meaningful learning assisted by thematic worksheets influenced students' mathematical concept understanding by 88.1%; (3) The implementation also impacted students' metacognitive skills with a contribution of 18.9%. These findings suggest that integrating thematic worksheets into meaningful learning enhances both cognitive and metacognitive outcomes. Future research should consider using more relevant or contemporary themes and exploring broader applications across subjects.

**Keywords**
Concept Understanding
Meaningful Learning
Metacognitive
Thematic Worksheets

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## Introduction

Mathematics learning is often perceived as a meaningless activity or meaningless learning. [1] explains that current mathematics instruction predominantly focuses on declarative knowledge and routine problem-solving without fostering deep learning experiences. This issue stems from limited instructional media and learning materials that fail to support meaningful learning. Consequently, students tend to view mathematics merely as a collection of formulas and rules to memorize. To address this, Thanheiser [2] highlights the importance of teachers carefully designing and preparing lessons to create learning experiences that facilitate deeper and more meaningful understanding for students.

The lack of variety in instructional media also poses a significant barrier to improving the quality of mathematics learning. Putri et al. [3] notes that many teachers still rely heavily on standard textbooks, which often overlook students' prior knowledge. As a result, the learning process becomes less effective in promoting deep conceptual understanding. According to Siswanto et al. [4], well-designed worksheets can enhance student engagement and encourage the use of more effective teaching models. With relevant worksheets, students can connect the material to familiar contexts, making the learning process more engaging and impactful.

Tejera et al. [5] emphasizes that teachers need to create learning situations that are relevant to real-world contexts, enabling students to grasp mathematical ideas more easily. Real-life scenarios allow students to see the connections between the material and their daily lives. Tall [6] further suggests that student motivation significantly improves when lessons are designed to actively and meaningfully involve students. Therefore, teachers should consider students' needs when designing engaging, effective, and contextually relevant lessons. This approach not only increases students' interest in mathematics but also fosters a balanced development of their cognitive, affective, and psychomotor skills.

A thematic approach that connects mathematics learning to students' life contexts offers a promising solution for creating meaningful learning experiences. Siswanto et al. [7] states that this approach aligns with the learning outcomes outlined in the Merdeka Curriculum. Through this method, various instructional materials can be integrated into a single theme relevant to students' lives. [8] asserts that context-based learning enables students to relate mathematical

concepts to real-life experiences. As a result, students understand that mathematics is not merely theoretical but an integral part of everyday phenomena [9].

According to Ramadhani et al. [10], meaningful learning should be the primary focus of every teaching method. Ausubel's cognitive theory posits that meaningful learning occurs when new information is assimilated with students' existing knowledge. Thus, students move beyond rote memorization to understanding and applying new concepts. Mayer adds that the goal of meaningful learning is to construct students' knowledge and experiences. In this context, a contextual approach plays a critical role by helping students build new knowledge based on real-life experiences [11].

Conceptual understanding is the foundation of mathematics learning [12]. Mathematical conceptual understanding enables students to internalize mathematical ideas and apply them in various situations [13]. Indicators of conceptual understanding include the ability to restate concepts, classify objects based on specific characteristics, provide examples and non-examples, represent concepts in different forms, and apply concepts to solve problems [14]. Thus, conceptual understanding is both a learning goal and a tool for solving real-world problems.

Teachers must also develop learning materials that foster students' metacognitive skills. According to Vlassis & Demonty [15], metacognitive learning allows students to plan, predict, and evaluate solutions to problems, particularly in mathematics. [16] explains that metacognitive skills involve two key aspects: metacognitive knowledge, or awareness of one's thinking processes, and metacognitive experiences, or the ability to control those processes. Through metacognitive learning, students not only understand the material but also develop strategies for optimizing their learning outcomes.

Relevant instructional media are vital for meaningful learning. Astiwi & Siswanto [17] highlights that students' metacognitive skills can be strengthened through instructional media that encourage them to construct, apply, and deepen mathematical concepts. Learning activities should be designed to train students in independently building their knowledge. With appropriate media, students become more actively involved in the learning process and improve their understanding of the taught concepts.

Instructional materials designed with engaging and meaningful strategies can help students understand mathematical concepts while enhancing their metacognitive abilities. One effective medium to support these objectives is thematic worksheets [18]. These worksheets are designed to actively involve students using themes relevant to their daily lives. By employing meaningful learning based on thematic worksheets, students can connect mathematical concepts to familiar contexts, thereby enhancing their understanding of the material. Overall, meaningful learning serves as an effective strategy to support students' conceptual understanding and the development of their metacognitive skills optimally.

## Literature Review

### A. Meaningful Learning

Meaningful learning is a learning process in which students connect new information with their existing knowledge, resulting in a deeper understanding. This theory, developed by Ausubel, emphasizes that learning occurs when new information is actively assimilated into students' cognitive structures. According to Barbieri et al. [19], meaningful learning involves three key elements: organizing information, integrating it with prior knowledge, and applying it in relevant contexts. This process not only enhances students' understanding but also fosters critical thinking and problem-solving skills. In contrast, rote learning tends to offer limited long-term benefits as students are unable to connect the material with real-life experiences or contexts.

The process of meaningful learning can be implemented through various strategies, one of which is the contextual approach. Haque & David [20] states that context-based learning helps students recognize the relevance of the material to real life. Additionally [21] highlights that teachers need to create learning situations that actively engage students and relate to their daily lives. Thus, meaningful learning not only aids students in comprehending the material but also increases their motivation to learn. The use of relevant instructional media is also a crucial factor in ensuring the achievement of meaningful learning.

### B. Thematic Worksheet

Thematic worksheets are instructional tools designed to integrate multiple subjects or concepts into a single, cohesive theme. According to Rahayu et al. [22], the use of thematic worksheets aligns with the principles of the Merdeka Curriculum, which emphasizes integrative learning. This approach helps students connect material from various disciplines to real-life contexts, making learning more relevant and engaging. Thematic worksheets can also enhance student participation in the learning process by encouraging them to actively explore concepts through engaging tasks. This supports the development of deeper and more holistic understanding.

The effective design of thematic worksheets requires adaptation to students' characteristics. Siswanto & Andriyani [23] states that relevant worksheets should actively involve students in activities such as group discussions, independent exploration, or simple experiments. Furthermore, Wantoro et al. [24] highlights that context-based worksheets not only improve students' understanding but also enhance their problem-solving skills. By combining interesting and relevant themes, thematic worksheets serve as a means to create meaningful and integrative learning experiences.

### C. Understanding Mathematical Concepts

Conceptual understanding is a fundamental aspect of mathematics learning. According to Siswanto & Kuswantara [25], it enables students to interpret, analyze, and apply mathematical ideas in various situations. This understanding also serves as the foundation for mastering other skills such as problem-solving and critical thinking. Oroh et al. [26] identifies several indicators of conceptual understanding, including the ability to define concepts, classify objects, provide examples and non-examples, and apply concepts in specific contexts. Therefore, fostering strong conceptual understanding helps students tackle mathematical challenges with greater confidence.

Achieving deep conceptual understanding requires learning strategies that emphasize active student engagement. Szabo et al. [27] highlights the importance of real-world relevance in learning to help students grasp abstract concepts more easily. Additionally, using engaging instructional media such as interactive worksheets or manipulatives can assist students in connecting theory with practical applications. Lu et al. [28] asserts that conceptual understanding is the foundation of meaningful mathematics learning, making effective approaches crucial for improving student outcomes.

### D. Student Metacognition

Metacognition refers to the ability to be aware of and regulate one's own thought processes when solving problems or understanding concepts. Gonzalez-Argote & Castillo-González [29] explains that metacognitive-based learning encourages students to design, monitor, and evaluate their own learning strategies. This is particularly important in mathematics, where students often encounter tasks that require higher-order thinking. According to Abdulrahaman et al. [30], students with strong metacognitive abilities tend to be more effective in understanding material, as they can assess how well they have mastered a concept and adjust their learning strategies as needed.

Instructional approaches that support the development of metacognitive skills actively involve students in the learning process. English [31] states that activities such as group discussions, reflection, and solving open-ended problems can enhance students' awareness of their thinking processes. Additionally, learning media such as context-based worksheets can facilitate the development of metacognitive skills. Mateo-Berganza et al., [32] adds that students trained in metacognition not only achieve a better conceptual understanding but are also capable of independently and creatively applying those concepts in real-life situations.

## Materials and Methods

This study used a quantitative method with a pre-experimental design approach, specifically the One Shot Case Study design, and employs simple random sampling for the sampling technique. The research sample consists of class XI students at SMK Dirgantara Putra

Bangsa for the 2024/2025 academic year, totaling 30 students. The study analyzes student responses to the implementation of meaningful learning assisted by thematic worksheets as the independent variable (X), and examines the impact of its implementation on mathematical concept understanding ($Y_1$) and students' metacognitive abilities ($Y_2$). Data collection techniques involve four main instruments: thematic worksheets that have been tested for feasibility based on instructional material criteria by Sugiyono [33]; a test to measure mathematical concept understanding; a questionnaire on student responses to the thematic worksheets; and a questionnaire to assess students' metacognitive abilities. Data processing includes validation of the questionnaires by expert validators and a pilot test of the mathematical concept understanding instrument in class XII. The obtained data are analyzed using prerequisite tests, hypothesis testing with regression analysis, correlation testing, and coefficient of determination testing.

## Results

### A. Questionnaire Analysis of Student Responses

Table 1 shows the results of the Shapiro-Wilk normality test with a value of sig. on the use of thematic worksheets of 0.300, the sig value. the results of the ability test for understanding mathematical concepts were 0.291, as well as the sig. in the questionnaire results related to student metacognition, it was 0.165, all three were greater than 0.05. Therefore, it can be said that the three data are normally distributed. Next, homogeneity will be tested regarding the use of thematic worksheets to test the ability to understand mathematical concepts and worksheets to students' meta-cognitive abilities.

**Table 1.** Normality Test Results

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Worksheets | .138 | 30 | .148 | .959 | 30 | .300 |
| Test | .143 | 30 | .120 | .959 | 30 | .291 |
| Metacognitive | .126 | 30 | .200* | .950 | 30 | .165 |

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Table 2 shows the homogeneity test results of the sig. between the use of thematic worksheets on conceptual understanding ability tests, namely 0.538 and thematic worksheets on students' metacognition, 0.264, where the sig value is both greater than 0.05, meaning the data has a homogeneous distribution. Interpreting the responses of 30 students as a whole from the application of thematic worksheets in class XI matrix learning, the researcher summarized the percentages in the form of an average for each aspect.

**Table 2.** Homogeneity Test Results

| | | Levene Statistic | df1 | df2 | Sig. |
|---|---|---|---|---|---|
| Concept understanding test | Based on Mean | .836 | 5 | 23 | .538 |
| | Based on Median | .643 | 5 | 23 | .669 |
| | Based on Median and with adjusted df | .643 | 5 | 18.177 | .670 |
| | Based on trimmed mean | .827 | 5 | 23 | .543 |
| Metacognitive | Based on Mean | 1.393 | 5 | 23 | .264 |
| | Based on Median | .914 | 5 | 23 | .489 |
| | Based on Median and with adjusted df | .914 | 5 | 15.228 | .498 |
| | Based on Trimmed mean | 1.368 | 5 | 23 | .273 |

The questionnaire consists of 12 statements collected in 6 aspects of the ability to understand mathematical concepts (see Table 3).

**Table 3.** Recapitulation of Student Response Questionnaires

| No | Aspect | Percentage |
|---|---|---|
| 1 | Thematic worksheets make it easier for students to understand | 68.33% |
| 2 | Thematic worksheets are fun during learning | 76.66% |
| 3 | Thematic worksheets are meaningful during learning | 78.33% |
| 4 | Thematic worksheets make students active and interested in writing notes | 71.66% |
| 5 | Thematic worksheets motivate students | 68.33% |
| 6 | Thematic worksheets make students have a greater desire to learn mathematics | 85.00% |
| | Mean | 74.62% |
| | Category | Good |

Based on Table 3, the average value of the meaningful learning response questionnaire assisted by thematic worksheets for class XI students at Dirgantara Putra Bangsa Vocational High School is 74.62%. This score is included in the good category, meaning that some students responded well to the statements given regarding the use of thematic worksheets. These results are in line with research from Zhao et al. [34] that the application of meaningful learning can significantly demonstrate its efficacy and effectiveness as a learning model.

**B. Analysis of the influence of student responses**

The indicators of mathematical concept understanding in this study are developed based on expert opinions, with a focus on the topics of ratios and scales. These indicators include the ability to restate a concept, classify objects based on specific properties related to the concept, provide examples and non-examples of the concept, use and select appropriate procedures or operations, and apply concepts or algorithms in problem-solving [35]. These indicators are designed to comprehensively assess students' understanding of the mathematical concepts being taught.

The test used consists of five essay questions that cover various aspects of mathematical concept understanding. Each student's response is scored on a scale of 1 to 5 for each question, while students who do not answer a question are given a score of 0, resulting in a maximum score of 150 per question. To obtain an overview of the percentage of mathematical concept

understanding among students at Dirgantara Putra Bangsa Vocational High School, the analysis is conducted based on each of the predetermined indicators.

**Table 4.** Recapitulation of the Percentage of Students' Understanding

| No | Aspect | Percentage |
|---|---|---|
| 1 | Restate the concept | 86.67% |
| 2 | Classifying objects according to certain properties | 80.67% |
| 3 | Provide examples and non-examples of the concept | 77.33% |
| 4 | Using, utilizing and selecting certain procedures | 76.67% |
| 5 | Apply concepts to problem solving | 78.00% |
| | Mean | 79.87% |
| | Category | Good |

The highest percentage in this study was found in the indicator of the ability to provide examples and non-examples related to the concept of comparison and scale, with 79.87% of students showing good results. On the other hand, the lowest percentage was in the indicator of the ability to use, utilize, and choose certain procedures or operations, which only reached 76.67%, indicating weakness in this domain.

**Table 5.** ANOVA test results between variables X and $Y_1$

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 12112028.857 | 1 | 12112028.857 | 208.106 | .000[b] |
| | Residual | 1629637.809 | 28 | 58201.350 | | |
| | Total | 13741666.667 | 29 | | | |

a. Dependent Variable: $Y_1$
b. Predictors: (Constant), X

Based on the image above, the relationship between variable X (implementation of meaningful learning assisted by thematic worksheets) and variable Y1 (mathematical concept understanding) is analyzed through correlation testing, with a significance value of 0.000 < 0.05, indicating a significant relationship. The correlation coefficient can be observed in the following image.

**Table 6.** The magnitude of the influence between variables X and $Y_1$

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .939[a] | .881 | .877 | 241.24956 |

a. Predictors: (Constant), X

Based on the picture above, it can be seen that the R Square value is 0.881. This value comes from squaring the correlation coefficient value R $(0.939)^2$. The R Square figure is equal to 88.1%, which means that the thematic worksheets have an influence on the ability test to understand mathematical concepts. Meanwhile, the remaining 11.9% was influenced by other variables besides the thematic worksheets. These findings are consistent with previous research, such as by Aprili et al. [36], which shows that meaningful learning can increase understanding of mathematical concepts, as well as the use of thematic worksheets as an alternative medium that

supports learning outcomes. Fig. 1 to Fig. 3 present a thematic student worksheet with core matrix material.

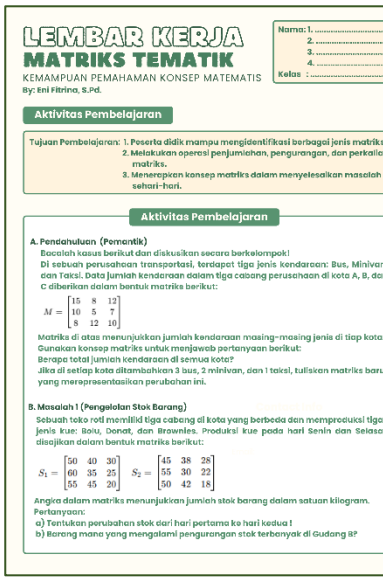



**Fig. 1.** Worksheet Identity

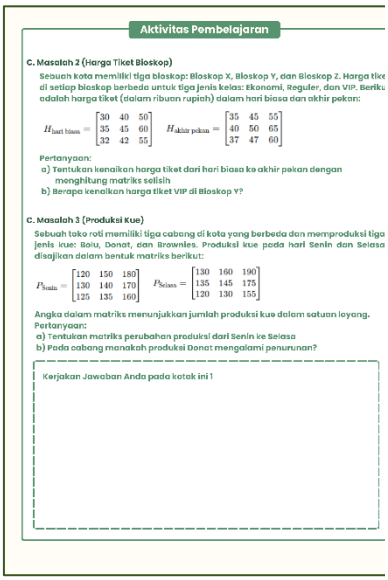



**Fig. 2.** Problems that Students Solve

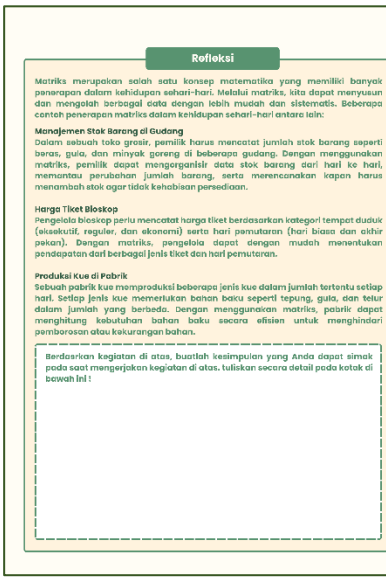



**Fig. 3.** Reflection

From Fig. 1 to Fig. 3, the worksheet completed by students is designed with the trigger of students' mathematical concept understanding and metacognitive abilities. where on the worksheet there are several points such as the identity of the worksheet, the remaining problems to be solved, and reflections and conclusions which will later be used to find out the extent of students' conceptual understanding.

## C. Analysis of the influence of student responses

The metacognitive ability questionnaire was obtained from student responses after the implementation of meaningful learning assisted by thematic worksheets. The data collection instrument consists of a questionnaire with 16 statements developed from the indicators listed in the instrument matrix, addressed to 30 students from the experimental class, namely class XI at Dirgantara Putra Bangsa Vocational High School.

The first aspect of metacognitive ability is cognitive awareness, which involves how students reflect on, recognize, regulate, and become aware of their cognitive processes as well as their self-awareness. The second aspect is metacognitive skills, which involve how students predict, plan, monitor, and evaluate the results of their actions. The results of the student response questionnaire regarding metacognitive abilities, based on each indicator, are explained using Excel calculations.

The metacognitive ability of class XI students at Dirgantara Putra Bangsa Vocational High School, after the implementation of meaningful learning assisted by thematic worksheets, showed the highest score on the connection indicator at 79.44%, followed by the strategy indicator at 74.67%, and the lowest score on the understanding indicator at 72.67%.

**Table 7.** Recapitulation of student metacognitive ability

| No | Aspect | Percentage |
|---|---|---|
| 1 | Understanding | 72.67% |
| 2 | Strategy | 74.67% |
| 3 | Connection | 79.44% |
| | Mean | 75.59% |
| | Category | Moderate |

These results align with the research by Ramdani et al. [37], which showed an improvement in metacognitive ability along with students' understanding. The study found that 65% of students were categorized as having moderate metacognitive abilities. Based on these findings, it can be concluded that in this study, students were more capable of organizing and planning their cognitive processes when completing tasks but were still lacking in structuring their cognition during the learning process.

**Table 8.** ANOVA test results between variable X and $Y_2$

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 6858160.336 | 1 | 6858160.336 | 6.542 | .016[b] |
| | Residual | 29352777.164 | 28 | 1048313.470 | | |
| | Total | 36210937.500 | 29 | | | |

a. Dependent Variable: Y2
b. Predictors: (Constant), X

Based on the image above, the relationship between variable X (implementation of meaningful learning assisted by thematic worksheets) and variable $Y_2$ (students' metacognitive skills) is analyzed through correlation testing, with a significance value of 0.016 < 0.05, indicating a significant relationship. The correlation coefficient can be observed in the following image.

**Table 9.** The magnitude of the influence between variables X and $Y_2$

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .435[a] | .189 | .160 | 1023.87180 |

a. Predictors: (Constant), X

Based on the image above, it is shown that the R Square value is 0.189. This value is derived from squaring the correlation coefficient R $(0.435)^2$. The R Square value of 18.9% indicates that thematic worksheets have an influence on students' metacognitive skills. The remaining 81.1% is influenced by other variables besides the thematic worksheets. This finding is consistent with previous studies, such as by Sadykova et al. [38], which showed that meaningful learning can enhance students' metacognitive abilities. Fig. 4 to Fig. 6 show learning activities using thematic worksheets.



**Fig. 4.** Group Discussion



**Fig. 5.** Group Presentation



**Fig. 6.** Conducting Questionnaires and Tests

The image above shows student activities in learning using thematic worksheets which include discussion activities, presentations that direct students to improve their metacognition, as well as completing tests and questionnaires given by the teacher.

## Conclusion

The implementation of meaningful learning assisted by thematic worksheets proved to be an effective strategy in enhancing students' learning experiences. The students responded positively to the approach, indicating increased engagement and motivation during the learning process. Beyond student perceptions, the use of thematic worksheets also significantly contributed to the improvement of students' mathematical concept understanding and the development of their metacognitive skills. These findings suggest that integrating contextual and theme-based learning materials can support deeper comprehension and promote self-regulated learning. While the results of this study are promising, there is still room for refinement and further exploration. One limitation identified was the relevance of the themes chosen in the worksheets. In future research, it is recommended that the themes incorporated into the worksheets be more closely aligned with students' real-life experiences, current events, or culturally relevant contexts to further increase relatability and engagement. Additionally, future studies could investigate the long-term effects of thematic worksheets on student learning outcomes across different subjects and educational levels. It would also be beneficial to explore the integration of digital or interactive versions of these worksheets to cater to diverse learning styles and to take advantage of evolving educational technology. By continuing to refine and adapt this instructional approach, educators and researchers can better support the development of essential cognitive and metacognitive skills that are crucial for students' academic success and lifelong learning.

## Conflict of Interest

The authors declare that there is no conflict of interest.

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## Authors



**Eni Fitriana** is a dedicated mathematics teacher at Dirgantara Putra Bangsa Vocational High School, where she is actively involved in efforts to enhance the quality and effectiveness of mathematics education. With a passion for teaching and a strong commitment to student success, Eni has developed numerous innovative teaching approaches that make mathematics more engaging and accessible to her students. Her instructional methods often integrate real-life contexts and problem-solving scenarios, helping students connect mathematical concepts with everyday experiences. (email: enifitriana93@guru.smk.belajar.id).



**Deny Hadi Siswanto** is currently pursuing a Master's degree in Mathematics Education at the Faculty of Teacher Training and Education, Universitas Ahmad Dahlan, Yogyakarta. His academic and professional interests center around the development of innovative, student-centered teaching strategies designed to foster deeper understanding and engagement in mathematics learning. Deny is particularly focused on assessing and monitoring individual student progress to tailor instruction to diverse learning needs. In addition to his studies, he actively participates in educational forums and collaborative research projects aimed at improving mathematics pedagogy at various educational levels. (email: 2207050007@webmail.uad.ac.id).



**Akhmad Hanama** is a graduate student in the Master of Education Management program at the Faculty of Teacher Training and Education, Universitas Ahmad Dahlan, Yogyakarta. With a strong interest in leadership and educational innovation, Akhmad is dedicated to enhancing teaching and learning processes through the development of effective instructional methods and collaborative learning environments. His work emphasizes the importance of teamwork, communication, and reflective practice among students and educators. Akhmad's academic journey is also marked by his active involvement in research and community engagement initiatives that aim to improve educational outcomes at the institutional level. (email: akhmad2107046016@webmail.uad.ac.id).