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Geometric Literacy Through the Missouri Mathematics Project Model Assisted by the Teachmint Application

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ABSTRACT

This study aims to examine the quality of the Missouri Mathematics Project (MMP) learning model assisted by the Teachmint application on students' geometric literacy. Geometric literacy is part of mathematical literacy related to understanding geometric concepts in everyday life. This study uses a mixed method with a sequential explanatory design. Quantitative data were collected through geometric literacy tests and analyzed using statistical tests, while qualitative data were obtained from observations and interviews. The experimental class in this study was Class X E-8, while the control class was Class X E-9. The results showed that the quality of learning at the planning stage obtained a very valid category with an average device validation of 88.73%. At the implementation stage, the implementation of learning showed very good results with an average teacher activity of 85.6% and student activity of 83.3%. The learning evaluation showed that the MMP model assisted by Teachmint was effective in improving geometric literacy, with the average final score of students exceeding the Learning Objective Achievement Criteria, the proportion of classical completeness reaching 90%, and an increase in students' geometric literacy by 62%. These findings confirm that the integration of structured practice-based learning models with digital technologies such as Teachmint can significantly improve the quality of students' mathematics learning and geometric literacy.

Keywords: *Geometric literacy, missouri mathematics project, teachmint application, mathematics learning, learning quality.*

Introduction

Literacy is a person's competence in formulating, applying and interpreting mathematical problems in various concepts using procedures and facts so as to understand the usefulness of mathematics in the real world (Rezky et al., 2022). Mathematics learning can improve students' competence and literacy in mathematics. Achievement of learning objectives can be assessed from students' success in understanding and utilizing mathematical understanding. The achievements of Indonesian students in the international world are not yet in line with students' mathematical literacy (Friska et al., 2024).

Mathematical literacy is divided into several dimensions, including numerical literacy, spatial literacy, and data literacy. Spatial literacy is the ability to use spatial thinking skills to visualize ideas, situations, and problems in everyday life. In this case, geometry and its measurement are included in spatial literacy. So it can be concluded that geometric literacy is part of mathematical literacy (Abidin et al., 2018).

Geometric literacy is part of mathematical literacy, which specifically involves the ability to understand geometric concepts such as shape, space, size, position, direction, and other properties related to geometric objects. In the book Adding it Up: Helping Children Learn Mathematics (2001) emphasizes the importance of understanding geometry in mathematical literacy. In general, in the book, geometry is discussed as part of the five main mathematical competencies, namely: conceptual understanding, procedural skills, reasoning, application, and engagement (productive disposition) (Kilpatrick et al., 2010).

Indonesian students have consistently demonstrated lower literacy performance compared to their counterparts from other PISA-participating countries, as evidenced by the Program for International Student Assessment (PISA) results since 2001 (Fajriah et al., 2022). Indonesia's 2022 PISA results are ranked 68th with a math score of 379, science 398, and reading 371 (OECD, 2023). PISA, run by the Organization for Economic Cooperation and Development (OECD), tests students who have completed primary education (age 15) in literacy. Indonesian students ranked 64th out of 65 participating countries (Novita & Hamimi, 2024). This happens because they are not used to solving contextual problems, as a result they find it difficult to solve problems and often make mistakes when solving context-based mathematical literacy problems (Fajriah et al., 2022).

Considering the significance of students' geometric literacy in mathematics education, the implementation of an instructional model such as the Missouri Mathematics Project (MMP) is essential. This model is specifically designed to support teachers in optimizing the use of practice exercises, thereby facilitating substantial improvements in student learning outcomes (Gunadi et al., 2020). The exercises in question are project assignment sheets, where during teaching and learning activities the teacher gives project assignments to students so that students can work on the questions with the aim of helping students more easily understand the material explained by the teacher (Ervinasari & Astuti, 2023).

The MMP learning model trains students to be able to work independently, collaborate, and have geometric literacy in solving contextual problems related to geometry (Salwah et al., 2024). MMP has five learning steps, namely: 1) Introduction (Review); 2) Development; 3) Practice and guidance with teachers; 4) Independent work; and 5) Closing (Salsabila et al., 2024).

In addition to choosing the right learning model, in every learning process the media must be considered by the teacher. One of the media that can be used in learning is Information and Communication Technology (ICT) based media (Ariyani et al., 2020).

Based on the research results (Setyowati & Nurcahyo, 2023) Missouri Mathematics Project learning model has an influence on improving students' mathematical literacy. The results of this research are in line with (Andreyanti &

Samudra, 2023) which shows that there is an increase in students' mathematical literacy after receiving learning using the Missouri Mathematics Project learning model. In line with research conducted by (Ervinasari & Astuti, 2023) The findings indicated that students who were taught using the Missouri Mathematics Project (MMP) learning model demonstrated a higher level of conceptual understanding in mathematics compared to those who received conventional instruction. This suggests that active student engagement in the learning process positively impacts mathematical literacy. Consequently, it is important to implement the MMP model in order to assess students' geometric literacy, as this approach emphasizes direct student involvement throughout the learning proces.

21st century education requires the use of technology in its implementation because the use of technology supports success in the world of education so that it can produce quality graduates and have skills so that they can compete in the international world. The use of technology is expected to be able to increase the success of the teaching and learning process. Through technology, teaching and learning activities can be presented through various interesting applications. Learning can be delivered using audio, visual, and even audio-visual media (Saha et al., 2020). In the 21st century, technology is experiencing rapid development so that there needs to be collaboration between technology-based media in learning. The technology that can be utilized in learning is Teachmint. Teachmint is one of the latest innovations in the technology industry today which is growing rapidly (Pratiwi et al., 2024).

The purpose of using Teachmint as a learning medium is that this media is very effective, creates a learning atmosphere, is fun, interactive, and makes it easier for educators and students to access ongoing learning (Sakka et al., 2024). Teachmint media is very effective in supporting learning both face-to-face and online (Pratiwi et al., 2024). Based on research conducted (Quinto, 2023) Teachmint makes it easy to access and use to deliver instructions. Teachmint is a learning medium that can be used to present lesson content and can be used by teachers and students online.

Considering the issues presented above, this study seeks to address the following research question: How effective is the Missouri Mathematics Project (MMP) model, when supported by the Teachmint application, in enhancing students' geometric literacy? Accordingly, the aim of this research is to assess the quality of the MMP model integrated with the Teachmint platform in developing students' geometric literacy skills.

Research methods

This study employs a mixed methods approach, which integrates both qualitative and quantitative data within a single research framework. According to Creswell, mixed methods research is a methodology that combines or links quantitative and qualitative techniques to provide a comprehensive analysis

(Creswell & Creswell, 2018). The research model used is the sequential explanatory design. Sugiyono (2019) stated that the sequential explanatory research method is a combination research method that merges quantitative and qualitative data collection methods sequentially, with clear steps in the research process. Qualitative methods are primarily utilized to generate hypotheses in specific cases or with limited samples, whereas quantitative methods serve to test these hypotheses across larger populations. Therefore, the mixed methods approach is valuable both for hypothesis generation and for establishing the external validity of the findings.

In this study, the quantitative research method was employed to assess students' geometric literacy within the Missouri Mathematics Project (MMP) model supported by the Teachmint application. The validity of the research instrument was determined based on the correlation coefficient value (r_{xy}), obtained using the Pearson product-moment correlation formula developed by Karl Pearson. This coefficient served as an indicator of how well each item measured the intended construct. Meanwhile, the reliability of the instrument was assessed by calculating the internal consistency, represented by the correlation coefficient among the items within the instrument (Lestari & Yudhanegara, 2018).

The qualitative method was utilized to analyze the nature and development of students' geometric literacy in the same instructional context. Qualitative data were obtained through classroom observations and interviews. Observations were conducted during the teaching and learning process to capture real-time student behaviors and interactions, while interviews were used to explore students' perceptions and understanding related to their geometric literacy in greater depth..

Results and Discussion

The results and discussion of the research in this study are about the quality of Missouri Mathematics Project learning assisted by the Teachmint application on geometric literacy. Based on Danielson quoted from (Sunaringtyas et al., 2017) It is stated that the quality of learning consists of three stages: planning/preparation, implementation, and evaluation of the learning process. The planning stage involves the development of learning materials, student activity sheets, and instrument validation forms. Subsequently, the research instruments were validated by an expert lecturer, resulting in qualitative data regarding the quality of the learning process planning. The learning implementation stage includes mathematics learning activities with the Missouri Mathematics Project model assisted by the Teachmint application carried out by teachers and students in class by filling in the teacher's skill observation sheet and the student response sheet by the observer. The results of the observations will obtain conclusions related to the quality of learning. The learning evaluation stage includes student learning outcomes as seen from the results of the geometric literacy test.

This is also in line with Danielson who was quoted from (Oktriany et al., 2018) This explains that the Missouri Mathematics Project learning model assisted by the Teachmint application is considered effective in developing geometric literacy if, at stage (1) of the learning planning stage, the validation results of the learning materials used in the Missouri Mathematics Project model with Teachmint

support are deemed valid; (2) implementation of learning, the results of observations of the implementation of learning in the Missouri Mathematics Project model assisted by the Teachmint application towards geometric literacy; and (3) evaluation of learning outcomes in the Missouri Mathematics Project model assisted by the Teachmint application is said to be effective if (a) Students have successfully completed the study of geometric literacy at the class level; (b) the average geometric literacy score of students taught using the Missouri Mathematics Project model supported by the Teachmint application exceeds the established Learning Objective Achievement Criteria; and (c) the average geometric literacy score of students in the Missouri Mathematics Project model with Teachmint assistance is higher than that of students who learned mathematics through the Problem-Based Learning model.

The effectiveness of learning plays a crucial role in assessing the success of the educational process, particularly in fostering geometric literacy. This study evaluated learning quality by examining three key stages, namely planning, implementation, and evaluation. Based on the results obtained, the use of the Missouri Mathematics Project model assisted by the Teachmint application showed high learning quality and had a positive impact on improving students' geometric literacy.

1.1 Planning Stage

In the planning stage, the validity of the learning device is the main indicator in assessing the readiness and feasibility of the learning process. The devices prepared by the researcher include teaching modules, geometric literacy test questions, interview guidelines, and student worksheets that have gone through a validation process by two competent experts. The validation results show that all devices obtained high validity scores, with an overall average reaching 88.73% which falls within the highly valid category. This shows that the learning devices used have met the quality standards and feasibility to be applied in learning activities. The feasibility of these devices is a strong basis that the Missouri Mathematics Project learning design is able to facilitate students in exploring geometric literacy systematically and structured.

1.2 Implementation Stage

In the implementation stage, Missouri Mathematics Project learning was carried out four times with 30 students as subjects in the experimental class. Learning activities were observed from two aspects, namely the implementation of teacher activities and student activities. The results of the observation showed that the implementation of teacher activities had an average score of 85.6%, while student activities obtained an average of 83.3%. Both scores are in the very good category. This high score indicates that learning is going according to the plan that has been prepared and the teacher is able to implement The Missouri Mathematics Project approach successfully. The graph of the results of observations of student activities and teacher activities can be seen in the picture below.

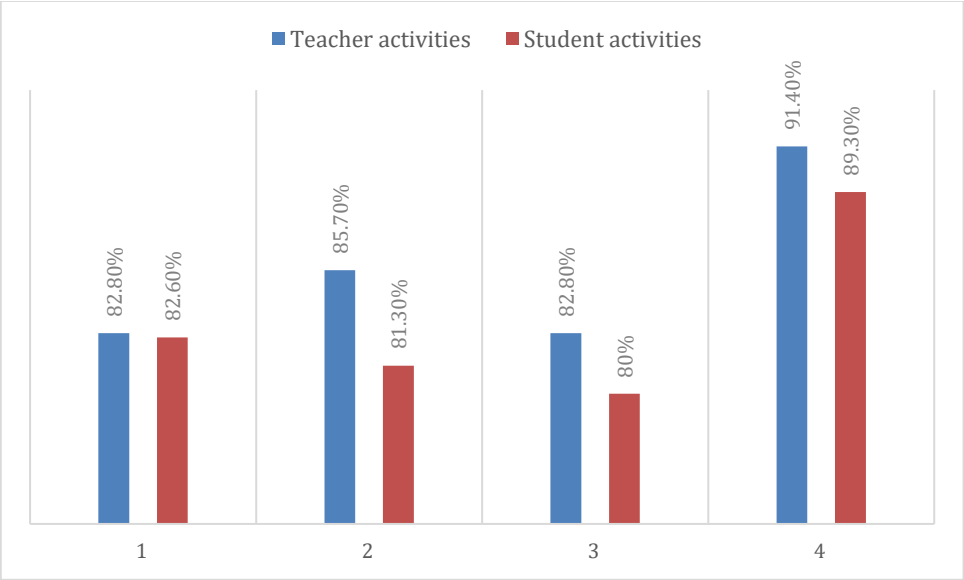

Figure 1. Graph of the results of observations of student and teacher activities

Student activeness in learning is also very visible, especially during group activities and student worksheets, which are the characteristics of this model. Collaborative learning allows students to discuss, exchange ideas, and develop conceptual understanding together. In this case, the integration of the Missouri Mathematics Project learning strategy with the use of Teachmint application features, such as online assignments and monitoring the learning process, plays a major role in creating an active, interactive, and meaningful learning atmosphere.

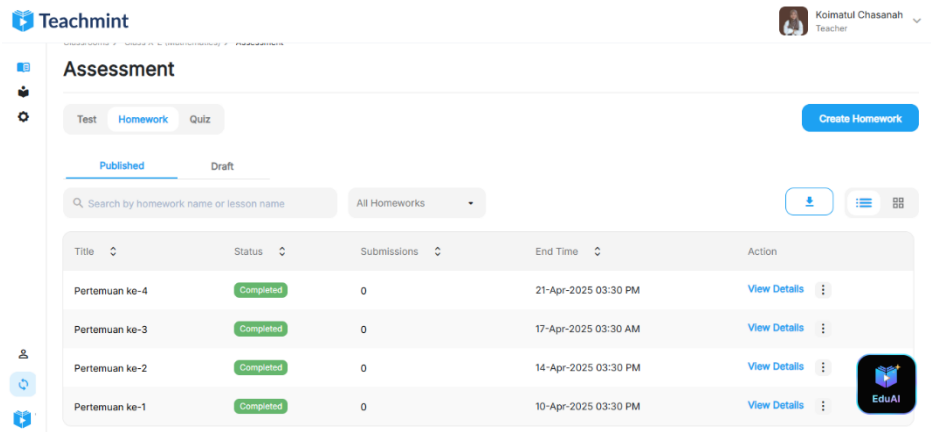

Figure 2. Teachmint Application View

1.3 Evaluation Stage

At the learning evaluation stage, the assessment is carried out by looking at the effectiveness of the Missouri Mathematics Project model learning. The Missouri Mathematics Project learning model is deemed effective if the following conditions are met: (a) the average geometric literacy of students using the Missouri Mathematics Project model, facilitated by the Teachmint application, exceeds the Mathematics Learning Achievement Criteria; (b) geometric literacy under the Missouri Mathematics Project model with Teachmint support achieves at least 75%

of the Learning Achievement Criteria; (c) the average geometric literacy of students in the Missouri Mathematics Project model surpasses that of students in the Problem-Based Learning model; (d) the completion rate of students engaged in the Missouri Mathematics Project model assisted by the Teachmint application is higher than that observed in the Problem-Based Learning model; and (e) there is an improvement in students' geometric literacy skills. Prior to conducting hypothesis testing, initial data analysis is necessary to verify that the sample is drawn from a population that is normally distributed and homogeneous, and that the two groups (classes) selected have comparable means. The following section details the results of the initial data analysis performed in this study.

Table 1. Summary of Geometric Literacy Test Results

	Maximum Value	**Minimum Value**	**Average**
Experimental Class	100	64	82,27
Control Class	88	50	67,8

1.3.1 Initial Data of Geometric Literacy

1) Initial data normality test

The initial data normality test was conducted with the aim of finding out whether the sample studied came from a normally distributed population. The initial data normality test in this study used the Shapiro-Wilk test with the help of SPSS. Based on the results of the SPSS calculation, the following results were obtained.

Table 2. Initial Data Normality Test

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Experiment Pretest	.097	30	.200*	.959	30	.299
Pretest Control	.142	30	.129	.945	30	.122

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on the Test of Normality table with Shapiro-Wilk, the significance value of the experimental class pretest results is $Sig = 0{,}299 > 0{,}05$ and the significance results of the pretest results of the control class is $Sig = 0{,}122 > 0{,}05$. Based on the testing criteria, then H_0 accepted. Therefore, the initial data originates from a population that is normally distributed.

2) Initial data homogeneity test

The initial data homogeneity test was performed to determine whether the samples under study were drawn from a homogeneous population. In this study, the Levene's test was employed for the homogeneity assessment, using SPSS software. Based on the SPSS output results, the following results were obtained.

Table 3. Initial Data Homogeneity Test

Test of Homogeneity of Variances

Pretest Results

Levene Statistic	df1	df2	Sig.
3.178	1	58	.080

Based on the results, the sig value is obtained $sig = 0{,}080$. The fact is obtained $0{,}080 > 0{,}05$. Based on the results, it can be concluded that the initial data were drawn from a homogeneous population. So, the sample comes from a homogeneous population.

3) Test of equality of initial data averages

The initial data average similarity test was conducted with the aim of finding out whether the samples studied had the same average. The initial test for the similarity of averages in this study was conducted using the Independent Samples Test with the assistance of SPSS. Based on the SPSS analysis results, the following results were obtained.

Table 4. Mean Equality Test

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Pretest Results	Equal variances assumed	3.178	.080	-.038	58	.970	-.133	3.529	-7.198	6.931
	Equal variances not assumed			-.038	55.328	.970	-.133	3.529	-7.205	6.939

Based on these results, the value obtained $sig = 0{,}97$. Obtained facts $0{,}97 > 0{,}05$. Based on these results, it can be stated that the initial data has the same average. So, the samples studied have the same average.

Following the analysis of the initial data, the researcher designated the experimental and control groups as outlined in the previous section. Subsequently, a hypothesis test was conducted on the final data to evaluate the effectiveness of the Missouri Mathematics Project in mathematics learning. The results of the final hypothesis test are presented below.

1.3.2 Geometric Literacy Final Data

1) Final data normality test

The final normality test was conducted with the aim of finding out that the samples studied came from a normally distributed population. The normality test for the final data in this study was conducted using the Shapiro-Wilk test, assisted by SPSS software. The following results were obtained based on the SPSS analysis.

Table 5. Final Data Normality Test

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Posttest Experiment	.088	30	.200*	.985	30	.930
Posttest Control	.089	30	.200*	.980	30	.813

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on these results, the significance value of the pretest results for the experimental class is $Sig = 0{,}930 > 0{,}05$ and the significance results of the pretest results of the control class is $Sig = 0{,}813 > 0{,}05$. Based on the testing criteria, then H_0 accepted. So, the final data comes from a normally distributed population.

2) Final data homogeneity test

The final data homogeneity test was carried out to determine whether the samples analyzed originated from a homogeneous population. In this study, the Levene's test was utilized for assessing homogeneity, with assistance from SPSS software. Based on the SPSS output results, the following results were obtained.

Table 6. Final Data Homogeneity Test

Test of Homogeneity of Variances

Posttest Results

Levene Statistic	df1	df2	Sig.
.115	1	58	.736

Based on these results, the value obtained $sig = 0{,}736$. Obtained facts $0{,}736 > 0{,}05$. Based on these results, it can be concluded that the initial data originated from a homogeneous population. Therefore, the sample is considered to come from a homogeneous population.

At the evaluation stage, a series of statistical tests were conducted to assess the effectiveness of learning on students' geometric literacy. Learning effectiveness was determined through five main indicators. First, the average geometric literacy results of students in the experimental class reached 82.27, which means that it has

exceeded the Learning Objective Achievement Criteria for Mathematics, which is 70. Second, as many as 90% of students in the experimental class completed classically, which also exceeded the minimum classical completion limit of 75%. Third, the results of the mean difference test indicated that students in the experimental group demonstrated a higher average geometric literacy score compared to those in the control group, with scores of 82.27 and 67.8, respectively. Additionally, the proportion test revealed that the completion rate in the experimental group was significantly greater than that of the control group, which employed the Problem-Based Learning model.

Lastly, the improvement test using N-Gain showed that the experimental group experienced a 62% increase in geometric literacy, classified as fairly effective, whereas the control group exhibited only a 38% increase, which was deemed ineffective. This notable improvement in the experimental group can be attributed to the implementation of the Missouri Mathematics Project (MMP) learning model assisted by the Teachmint application. The MMP model emphasizes structured and repetitive practice through individual and group exercises, enabling students to develop problem-solving habits in mathematical and geometric contexts. By consistently engaging in problem solving activities, students became more familiar with interpreting geometric information, identifying relevant strategies, and applying geometric concepts to real world situations key aspects of geometric literacy. Furthermore, the use of the Teachmint application facilitated better classroom management and communication, supporting more efficient delivery and monitoring of learning activities.

This finding strengthens the opinion (Pratiwi et al., 2024; Setyowati & Nurcahyo, 2023) which states that learning with structured, periodic and collaborative practice patterns can strengthen students' understanding and prevent repeated errors. In addition, these results are also in line with the views of (Das, 2019; Dubinina et al., 2022) which emphasizes the importance of integrating learning technology in supporting the effectiveness of mathematics learning. The Teachmint application has been proven to function not only as a communication medium for teachers and students, but also as a means of flexible and efficient learning management. The use of features such as online assignments and learning evaluations can facilitate Missouri Mathematics Project learning more optimally, especially in this digital era.

Overall, it can be concluded that the Missouri Mathematics Project learning model assisted by the Teachmint application has very good quality and is effective in improving students' geometric literacy. The combination of intensive practice-based pedagogical approaches and application-based learning technology is an adaptive and relevant strategy to the needs of today's education. With good learning quality from the planning stage to the evaluation, this model is recommended for use in the context of mathematics learning that emphasizes strengthening conceptual literacy, especially in geometry topics.

Closing

Based on the analysis of the research findings conducted at SMA Negeri 2 Bae, Kudus City, regarding geometric literacy development through the Missouri Mathematics Project model supported by the Teachmint Application, focusing on trigonometric ratios in right triangles, the following results were obtained.

1) Planning stage, at the learning planning stage, the Missouri Mathematics Project learning device is valid for geometric literacy. These results are proven by the validation results for the teaching module, geometric literacy test, interview guideline, and student worksheet, with a very valid category.
2) At the learning implementation stage, the implementation of Missouri Mathematics Project learning for geometric literacy obtained very good results. These results are supported by the teacher and student activity outcomes during the implementation of Missouri Mathematics Project learning, which demonstrated very positive performance.
3) At the learning evaluation stage, students' geometric literacy in the Missouri Mathematics Project model supported by the Teachmint application exceeds the Mathematics Learning Achievement Criteria. The proportion of students achieving classical completeness surpassed 75%. Furthermore, students' geometric literacy in the Missouri Mathematics Project model with Teachmint assistance was superior to that of students who received instruction through the Problem-Based Learning model. The completion rate of students in the Missouri Mathematics Project model with Teachmint support was also higher than that of the Problem-Based Learning group. Additionally, the improvement in students' geometric literacy within the Missouri Mathematics Project model assisted by the Teachmint application was greater compared to those who experienced Problem-Based Learning.

Suggestion

1. The use of the Missouri Mathematics Project model supported by the Teachmint application requires the readiness of digital devices such as smartphones, laptops, or tablets connected to the internet network. Therefore, students are encouraged to bring these devices every time they take a learning session.
2. Before implementing learning with the Missouri Mathematics Project model assisted by the Teachmint application, teachers should first provide an explanation to students regarding the stages that will be carried out during the learning process.
3. In addition, the results of this study can also be used as a source of information for further researchers in exploring other variables that have the potential to make a greater contribution to improving students' geometric literacy.

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Dr. Iwan Junaedi, M.Pd. is a lecturer in the Mathematics Education Study Program at Universitas Negeri Semarang (UNNES) who is active in developing mathematics learning and improving the quality of education. He currently serves as the Director of Principals, School Supervisors, and Education Personnel at the Ministry of Primary and Secondary Education of the Republic of Indonesia (Kemendikdasmen RI). In his role, Dr. Iwan contributes to the formulation of national education policies, especially related to strengthening the role of principals and supervisors as learning leaders. In addition to teaching and researching, he is also active as a resource person in seminars, training, and writing scientific articles that focus on educational innovation and the development of the teaching profession. His dedication to bridging the academic world and educational practice is very evident in every step he takes.