

The Effectiveness of the Missouri Mathematics Project (MMP) Model on Students' Understanding of Mathematical Concepts

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Abstract

This study aims to determine the effectiveness of the Missouri Mathematics Project (MMP) learning model on students' understanding of mathematical concepts in class X at SMA Negeri 1 Tambelang. This research is a quantitative study of the quasi-experimental type. The sample in this study consisted of 66 students. The sampling technique used in this study was cluster random sampling. The instrument for this research was a test of mathematical concept understanding, which underwent validity and reliability testing before being used to collect data. Data analysis was conducted using statistical testing, specifically the t-test. Based on the research results, the average score for the experimental class was 81.32, while the control class had an average of 67.45. The average for the treatment with the Missouri Mathematics Project (MMP) model in the experimental class X IPS 1 was higher than that of the direct learning model in the control class X IPS 2. Therefore, it can be concluded that the Missouri Mathematics Project (MMP) learning model is more effective than the direct learning model in improving students' understanding of mathematical concepts related to quadratic equations and functions in class X at SMA Negeri 1 Tambelang.

Keywords: Understanding of mathematical concepts, Missouri Mathematics Project.

1 INTRODUCTION

Learning and education are expected to be able to provide students with qualified learning outcomes to live in the 21st century (Mardhiyah et al., 2021). The development of the era is increasingly advanced and must be followed by the development of human resources (Nasrika, 2019). One of the many ways for humans to develop is by studying mathematics, because by studying mathematics, the ability to think systematically, logically, and critically that humans have can be improved (Rachmantika & Wardono, 2019; Rahmadhani, F. (2023). The development of mathematics has been rapidly increasing year by year in response to the demands of the times. One of the developments in question is the issue of mathematics learning. Mathematics is a field of study present at all levels of education, from elementary school to higher education, and even in daily life. Based on the demands of the 2013 curriculum, there are several mathematical literacy skills that students need to achieve, one of which is the ability to understand concepts. Mulyati states that learning should be directed towards understanding mathematical concepts and principles, which are necessary for solving mathematical problems, problems in other disciplines, and issues in daily life.

Based on interviews with a student from class X at SMA Negeri 1 Tambelang, it was found that most students often struggle to understand the mathematics material explained by the teacher. The researcher observed that during the learning process, it became evident that the teacher conveyed information from the textbook to the students, resulting in a tendency for students to be passive rather than active. Students only listened to the teacher's explanations, copied examples, and completed exercises by following the patterns provided by the teacher. As a result, the students' reasoning processes could not be stimulated, leading to their inability to solve problems that differed from the examples

given by the teacher. The low understanding of concepts among students is related to the material that has been taught. This is reflected in students not knowing how to study effectively and efficiently, as they only try to memorize formulas without fully understanding them. Consequently, when given practice problems, most students are unable to solve questions that differ from the examples provided.

Mastery of mathematical concept understanding is crucial in mathematics education, as this understanding facilitates students in learning mathematics and solving existing problems. Therefore, teachers should employ appropriate approaches and teaching methods to enable students to grasp the material being taught (Sopiyah., et.al, 2024; Utami et.al., 2024). In the process of mathematics learning, conceptual understanding serves as a fundamental basis for reasoning when solving mathematical problems as well as everyday issues. A concept itself is an idea based on experience related to an event that remains abstract and is explained in one's own words. Mathematical concept understanding refers to a student's ability to master the material and their capability to comprehend, absorb, master, and apply it in mathematics learning. A student can be said to possess conceptual understanding in mathematics if the indicators of conceptual understanding are met.

The indicators used in this research are based on the regulations of the Ministry of Education and Culture, Dpdinkas number 506/c/Kep/PP/2004, which include: 1) Restating a concept, 2) Classifying objects according to specific properties (aligned with the concept), 3) Providing examples and non-examples of a concept, meaning the student's ability to give both examples and non-examples of material that has been studied, 4) Presenting concepts in various forms of mathematical representation, 5) Developing necessary or sufficient conditions for a concept, and 6) Using, utilizing, and selecting specific procedures or operations. In addition to the learning model, students' tendencies to learn are also important to consider. For example, some students find it easier to express their thoughts in writing because they have time to remember, think, and organize their thoughts. Meanwhile, there are also students who find it easier to convey their thoughts by expressing them verbally to the other person. Of course, it is a consideration for educators to be able to vary the learning models that will be used in the classroom (Rahmat Akbar, 2022).

Low conceptual understanding can be improved by using an appropriate learning model aligned with the material being taught. One such model that can enhance students' conceptual understanding is the Missouri Mathematics Project (MMP) model. The MMP model is a structured learning approach that uses exercises to help students achieve remarkable improvement, providing opportunities for students to work in groups, engage in controlled practice, and apply their understanding independently through seatwork. The project task consists of a series of questions or instructions designed to develop a systematic idea or concept. It is expected that this will enhance students' understanding. The project can be completed individually (during the seatwork phase) or in groups (during the controlled practice phase), making it a task that asks students to produce something (a new concept) from their own efforts. The Missouri Mathematics Project (MMP) learning model and the Think Talk Write (TTW) learning model are cooperative learning models that are considered capable of developing the mathematics outcomes of grade VIII students. The TTW learning model was chosen based on its advantages, including: 1) Can create a pleasant learning environment and atmosphere, and impressive learning (Dewi et al., 2016); 2) improve student skills; 3) improve thinking and writing skills; 4) form a thinking process; 5) improve understanding through interaction; and 6) help teachers know how far the level of student understanding is (Repelita, 2019; Wulan, 2024; Evi., et.al, 2024). Meanwhile, the selection of the MMP learning model is based on the ability to improve students' conceptual understanding, problem solving, and mathematical problem solving (Rahmat, 2016).

Based on previous research conducted by Anita Rahman titled "Missouri Mathematics Project (MMP): A Learning Model to Influence Students' Mathematical Understanding in Vocational Schools," the observations made during the learning activities in the

experimental class generally reflected student engagement consistent with the characteristics and steps of the MMP model, where students were more active in understanding and solving problems. The student activity in the experimental class was better compared to that of the control class, which used conventional teaching methods

Additionally, previous research by Tri Melinia titled "Understanding of Quadratic Equation Concepts Among Ninth Grade Students in Problem-Based Learning" indicated that the conceptual understanding of mathematics among ninth-grade students at SMP Madani Kayuagung fell into the adequate category, with an average score of 63.88.

Based on the above descriptions, the author has decided to conduct research title: "The Effectiveness of the Missouri Mathematics Project (MMP) Learning Model on Students' Understanding of Mathematical Concepts in Quadratic Equations and Functions for Class X at SMAN 1 Tambelang."

2 RESEARCH METHODS

The research was conducted with students from class X at SMA Negeri 1 Tambelang in Bekasi. This study involved 33 students during the 2022/2023 academic year. The research method used was a quantitative quasi-experimental design. Experimental research means that the researcher manipulates and controls one or more independent variables according to the manipulation of those variables and observes the dependent variable, with data collected through tests of mathematical concept understanding. This experimental research aims to investigate the presence or absence of causal effects in a given condition by applying specific treatments to the experimental group. The sample group in this method is divided into two groups: the experimental class and the control class. The experimental class used the MMP model during the learning process, while the control class employed the Direct (conventional) learning model.

This research method involved the researcher teaching mathematics in the experimental class, which is class X IPS 1, and the control class in class X IPS 2. The research design used was a Posttest-only Control Design. The mathematical concept understanding test consisted of 6 essay questions that had been validated. The test of mathematical concept understanding was based on indicators of conceptual understanding. The test questions referred to here are the questions that the researcher will provide to students, structured in descriptive form. The scoring for the concept understanding questions has a total weight of 26 points distributed across 7 indicator components.

3 RESULT AND DISCUSSION

The purpose of this research is to determine the effectiveness of the MMP learning model on students' understanding of mathematical concepts related to quadratic equations and functions in class X at SMA Negeri 1 Tambelang. In this study, the researcher administered a Posttest-only consisting of 6 essay questions. The posttest, in the form of essay questions, was given to assess the mathematical concept understanding of students in the control class, which served as a comparison with the experimental class.

Several discussions and interpretations of the research results are explained in detail below:

3.1 Subresults

Before the test was used for data collection, the test questions were piloted with students outside the sample. The instrument was tested on class X IPS 3. The researcher also conducted a feasibility test of the instrument to assess validity, reliability, difficulty level, discrimination power, and the effectiveness of distractors, ensuring that the data obtained through this research instrument is genuinely valid and reliable.

The steps taken for instrument testing are as follows:

3.1.1 Validity Test

A question is considered valid if it aligns with the material or content of the lesson being taught. Below are the results of the validity test administered to students, which consisted of 6 essay questions tested on 33 students. Based on the validity test calculations, it was found that the 6 questions had results of calculated $r > \text{table } r$, indicating that these 6 items are valid.

3.1.2 Reliability Test

The reliability test is used to determine whether the test items consistently produce the same measurement results. Based on the reliability test calculations for the 6 essay questions, the result was calculated $r = 0.917 > \text{table } r = 0.361$, indicating that the instrument is reliable with a very high level of reliability. Based on this data, the 6 questions can be reused for subsequent testing.

3.1.3 Difficulty Level Test

A question is considered good if it is neither too difficult nor too easy. Based on the 6 essay questions that were tested, the calculations of the difficulty levels for the items assessing mathematical concept understanding in quadratic equations and functions showed that, according to the difficulty criteria, the 6 essay questions are suitable for subsequent testing. Specifically, there was 1 question at an easy level, 4 questions at a moderate level, and 1 question at a difficult level.

3.1.4 Discrimination Power Test

After the validity, reliability, and difficulty level tests, a discrimination power test was conducted. The purpose of the discrimination power test in this research is to determine the criteria for the questions to be used. From the 6 essay questions, the results indicated that $0.40 < D \leq 0.70$, which falls within the good criteria.

3.2 Subdiscussion

Based on the research conducted by the researcher at SMA Negeri 1 Tambelang, the study involved class X as the sample divided into two groups: the experimental class and the control class. The experimental class, X IPS 1, consisted of 33 students using the MMP model during the learning process. In contrast, the control class, X IPS 2, also comprised 33 students and used the direct learning method.

The researcher created a discussion aimed at determining whether the mathematical concept understanding of students taught using the MMP model was better than that of students taught using the direct learning model on the topic of quadratic equations and functions. The effect of the MMP model was evaluated based on test results from essay questions totaling 7, each with varying levels of difficulty based on indicators of mathematical concept understanding.

To ascertain which teaching model had a greater impact on students' understanding of concepts, a hypothesis test was conducted using a t-test. The calculations yielded calculated $r = 4.9620$ and table $r = 1.9977$ with a significance level of $\alpha = 0.05$. Since calculated $r > \text{table } r$ ($4.9620 > 1.9977$), the null hypothesis H_0 is rejected, indicating that the mathematical concept understanding of students in the experimental class (X IPS 1) using the MMP model is better than that of students in the control class (X IPS 2) using the direct learning model.

3.3 Data Description

Data regarding students' understanding of mathematical concepts on quadratic equations and functions that have been studied can be analyzed to find the highest score (X_{max}) and the lowest score (X_{min}) in both the experimental and control classes. Subsequently, the central tendency measures, including mean, median, mode, and dispersion measures such as standard deviation (s) and variance, can be seen in the following table.

Table 1. Data Description of Mathematical Concept Understanding Scores

Class	X_{maks}	X_{min}	Central Tendency			Dispersion	
			$\bar{x}$	M_o	M_e	S	S_t^2
Experimental	96	63	81,32	83,50	81,89	8,723	76,09
Control	87	46	67,45	65,33	66,94	10,473	109,69

3.3.1 Normality Test

The normality test of the data using the Lilliefors method was conducted on the critical thinking ability test results for each data group: the experimental class and the control class. A summary of the normality test results for both classes is presented in the table below:

Table 2. Normality Test Results

Class	$L_{observasi}$	$L_{0.05}$	Test Decision
Experimental	0.1297	0.1542	H_0 accepted
Control	0.1202	0.1542	H_0 accepted

The table above indicates that at a 5% significance level, $L_{observasi}$ for the experimental class is 0.1297, which is less than $L_{0.05}$ at 0.1542, leading to the acceptance of H_0 . Thus, the data in the experimental class is normally distributed. For the control class, $L_{observasi}$ is 0.1202, which is also less than $L_{0.05}$ at 0.1542, resulting in the acceptance of H_0 ; hence, the data in the control class is normally distributed.

3.3.2 Homogeneity Test

The homogeneity test of variances was conducted on the dependent variable data, which is the students' understanding of mathematical concepts.

Table 3. Homogeneity Test Results

Class	F_{hitung}	F_{tabel}	Conclusion
Experimental	1.7081	1.8045	Homogeneous
Control			

Based on the information from the table above, in the homogeneity test of the critical thinking ability test results, it appears that $F_{hitung} < F_{tabel}$. This leads to the conclusion that H_0 is accepted, indicating that the samples originate from populations with equal variances.

3.3.3 Hypothesis Test

After determining that the data originates from a normally distributed population and is homogeneous, a hypothesis test was conducted using the t-test. The t-test is used to assess the equality of two means regarding students' understanding of mathematical concepts.

Table 4. t-Test Results

Class	$\bar{X}$	t_{hitung}	t_{tabel}	Note
Experimental	79,45	4,9620	1,9977	H_0 rejected
Control	68,36			

Based on the table above, the average score for students' understanding of mathematical concepts on the topic of equations and quadratic functions in the experimental class using the MMP model is higher than in the control class, which used direct teaching methods. With calculated $t = 4.9620 > \text{table } t = 1.9977$, this indicates that at a significance level of $\alpha = 0.05$, H_0 is rejected. Therefore, due to the difference in means between the two groups, it can be concluded that there is an effect of the MMP model on

the understanding of mathematical concepts among the students of class X at SMA Negeri 1 Tambelang. The results of other studies also state that there are differences in students' mathematics learning outcomes in trigonometry material taught using the cooperative learning method of the Missouri Mathematics Project (MMP) type and the Numbered Head Together (NHT) type for class X of SMKN 1 Gunung Putri (Erni Budiyanthi. et al., 2019). These results are supported by several researchers, including (Novalia, R., Makmuri, M., & Sudrajat, A: 2018) who stated that when viewed from these results, the Missouri Mathematics Project learning model can improve student learning outcomes in learning mathematics. Other researchers also stated that from the results of their research (Kurniasari, V. H. D., & Susanto, S: 2015) it can be concluded that the application of the Missouri Mathematics Project learning model is able to improve student learning outcomes.

4 CONCLUSION

Based on the analysis results from this research, it is evident that the understanding of concepts among students using the MMP teaching model is better than that of students taught using direct instruction at SMA Negeri 1 Tambelang. The average score for the MMP treatment in the experimental class X IPS 1 is higher than that of the direct instruction treatment in the control class X IPS 2. Thus, it can be concluded that the Missouri Mathematics Project (MMP) teaching model is more effective than the direct instruction model in enhancing students' understanding of mathematical concepts on equations and quadratic functions in class X at SMA Negeri 1 Tambelang.

5 REFERENCES

- Akbar, R., Irvan, I., Nasution, M. D., & Azis, Z. (2022). Differences in Mathematics Learning Outcomes of Students Taught with the Think-Talk-Write Learning Model and the *Missouri Mathematics Project*. *PHI: Journal of Mathematics Education*, 6(2), 168-174.
- Dewi, S., Anggraini, B., & Endah. (2016). Think Talk Write Learning Strategy in Improving Elementary School Students' Social Studies Learning Outcomes. *JISD*, 7(2), 1-8. <https://doi.org/10.36706/jisd.v3i1.8611>
- Budiyanthi, E., Kusuma, A. P., & Arihati, D. B. (2019). Application of MMP and NHT Methods to Mathematics Learning Outcomes in Trigonometry Material. *Buana Matematika: Scientific Journal of Mathematics and Mathematics Education*, 9(1), 25-30.
- Evi, E., Yurniwati, Y., & Ulfa, M. (2024). Optimizing Algebraic Thinking in Elementary Students: Exploring the Impact of Generative Learning. *Jurnal Ilmu Pendidikan (JIP) STKIP Kusuma Negara*, 16(1), 1-8.
- Kurniasari, V. H. D., & Susanto, S. 2015. Implementation of the Missouri Mathematics Project Learning Model in Improving Student Activities and Student Learning Outcomes Sub-topic of Drawing Graphs of Simple Algebraic Functions and Quadratic Functions for Grade X Students of SMAN Balung in the Odd Semester of the 2013/2014 Academic Year. *Pancaran*: 4 (2): 153-162.
- Mangentang, D. F., Kusuma, A. P., Arihati, D. B., & Rahmawati, N. K. (2018, September). Implementation of the Brain Based Learning Model and the Accelerated Learning Cycle Learning Model on Mathematics Learning Outcomes in Logarithm Material. *In National Seminar and Multidisciplinary Panel Discussion of Research Results and Community Service*. 2018 (Vol. 1, No. 1)
- Mardhiyah, R. H., Aldriani, S. N. F., Chitta, F., & Zulfikar, M. R. (2021). The Importance of Learning Skills in the 21st Century as a Demand in Human Resource Development. *Journal of Education*, 12(1), 29-40. <https://doi.org/10.31849/lectura.v12i1.5813>

- Nasrika. (2019). Human Resource Development in the Globalization Era. Revitalization of Early Childhood Education Management (PAUD) in the Industrial Revolution 4.0 Era, 149–157.
- Novalia, R., Makmuri, M., & Sudrajat, A. (2018) Application of Type Cooperative Learning Models Missouri Mathematics Project (MMP) to increase Learning Result Math. *American Journal of Education Research*, 6 (8), 1085-1092
- Rachmantika, A. R., & Wardono. (2019). The Role of Students' Critical Thinking Skills in Mathematics Learning with Problem Solving. *Proceedings of the National Mathematics Seminar*, 2, 439–443. <https://journal.unnes.ac.id/sju/index.php/prisma/article/view/29029>
- Rahmadhani, F., Kusuma, A. P., & Zuhriyah, A. (2023). The Influence of the Game Based Learning Model on Students' Mathematical Conceptual Understanding. *In Proceeding of International Conference on Education* (Vol. 2, pp. 104-108).
- Rahmat. (2016). The Effect of Missouri Mathematics Project (MMP) Learning Model on Junior High School Students' Understanding of Mathematical Concepts. *Tulip*, 5(2), 30–34. <https://jurnal.stkipbanten.ac.id/index.php/tulip/article/view/83>
- Repelita, T. (2019). The Effectiveness of the TTW (Think Talk Write) Model in Short Story Material in Grade IX (Case Study at SMP Negeri 3 Padaherang, Pangandaran Regency). *Jurnal Literasi*, 3(2), 104–110.
- Sopiyah, S., Nurikhsan, J., & Hafina, A. (2020). Efektivitas Teknik Konseling Cognitive Behavioral untuk Meningkatkan Self-Efficacy Siswa Pada Pelajaran Matematika. *Jurnal Ilmu Pendidikan (JIP) STKIP Kusuma Negara*, 11(2), 102-124.
- Utami, P. P., Ayuningrum, S., Vioreza, N., Nugraheny, D. C., & Putra, N. L. J. (2023). Teacher Personality Ethics In The Perspective of Islamic Educational Philosophy. *Edukasi Islami: Jurnal Pendidikan Islam*, 12(001).
- Wulan, S. (2024). Factors Affecting Teacher Performance. *Jurnal Ilmu Pendidikan (JIP) STKIP Kusuma Negara*, 16(1), 112-118.