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Research Article

Analysis of the Influence of the Missouri Mathematics Project Learning Model on Elementary Students' Mathematical Connection Skills and Habits of Mind

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Abstract: This study examined the effect of the Missouri Mathematics Project (MMP) on elementary school students' mathematical connection ability and habits of mind. A quantitative study employing a quasi-experimental pretest-posttest control group design involved fifth-grade elementary school students. Data were collected using a mathematical connection test and a habits of mind questionnaire. The data were analyzed using descriptive statistics and Multivariate Analysis of Variance (MANOVA) after satisfying the assumptions of normality and homogeneity. The findings revealed that students who learned through MMP obtained higher mean scores in both mathematical connection ability and habits of mind than those who received conventional instruction. The MANOVA results indicated that the differences were not statistically significant for mathematical connection ability ($p = 0.314$) or habits of mind ($p = 0.110$). These findings suggest that although the structured learning stages of MMP encouraged students to engage in problem-solving activities, review prior knowledge, and practice mathematical procedures systematically, the intervention duration was insufficient to produce significant improvements in students' mathematical connection ability and thinking dispositions. The value of this study lies in providing empirical evidence that the effectiveness of MMP should be interpreted by considering contextual factors, including students' initial mathematical competence, instructional duration, and classroom learning conditions, rather than relying solely on score improvement. The study concludes that MMP has the potential to support the development of mathematical connections and productive thinking habits; however, longer implementation periods and complementary instructional strategies are required to achieve statistically significant learning gains in elementary mathematics education.

Keywords: missouri mathematics project, mathematical connection ability, habits of mind, elementary mathematics, quantitative study.

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INTRODUCTION

Mathematics plays a vital role in developing the logical, analytical, systematic, and critical thinking skills required by students to understand and resolve various problems (Anggriani & Septian, 2019). Mathematics education emphasizes the mastery of concepts and procedures alongside the ability to connect distinct concepts so that acquired knowledge can be applied across different contexts (Daryanes et al., 2016). Numerous studies indicate that this connecting ability remains a challenge in primary school mathematics education. Previous findings have identified that students still experience difficulties in linking mathematical concepts, associating them with contextual situations, and utilizing prior knowledge to solve novel problems. This prevailing condition causes the learning process to be oriented toward procedural memorization rather than deep conceptual understanding (Dwirahayu et al., 2018).

Mathematical connection ability is one of the competencies instrumental in helping students understand the interrelations among mathematical concepts, the relationship between mathematics and other disciplines, and the application of mathematical concepts in daily life (Hanan & Alim, 2023). Mastery of this ability needs to be supported by habits of mind, namely the tendency of students to think reflectively, flexibly, thoroughly, and persistently when confronting a problem (Hidayat et al., 2023). These two attributes complement each other, given that the ability to connect concepts will not develop optimally without thinking habits that encourage students to explore alternative solutions. Preliminary observations at SDN 1 Jadimulya revealed that a segment of students still faces difficulties in relating previously learned concepts to subsequent material. The problem-solving process remains dominated by the direct application of formulas without accompanying rationale or conceptual connections, while persistent and reflective attitudes when facing non-routine problems have not developed optimally (Hasanah et al., 2025).

Various learning models have been developed to enhance the quality of mathematics instruction, including the Missouri Mathematics Project (MMP) (Lestari et al., 2024). Prior research reports that the MMP is effective in improving mathematics learning outcomes, problem-solving skills, mathematical communication, learning motivation, and student engagement by providing students with opportunities to learn through systematic stages, ranging from review, development, controlled practice, and seatwork, to homework (Kurniawati et al., 2021). These findings demonstrate that the MMP possesses the potential to develop various mathematical abilities through structured practice and student centered learning activities (Marschall, 2023).

Previous studies on the Missouri Mathematics Project (MMP) have primarily focused on improving mathematics achievement, problem-solving ability, mathematical communication, and learning motivation (Maulida et al., 2019). Although these studies demonstrate the instructional potential of MMP, they generally examine cognitive outcomes independently and provide limited evidence regarding the simultaneous development of students' mathematical connection ability and habits of mind. Moreover, little attention has been given to evaluating how contextual factors, such as instructional duration, students' prior mathematical competence, and classroom learning conditions, may influence the effectiveness of MMP in elementary mathematics education (Nasution & Panggabean, 2018). This limitation indicates the need for empirical studies that examine both cognitive achievement and productive thinking dispositions within an integrated analytical framework.

The Missouri Mathematics Project model is deemed appropriate to address this need because each learning stage is designed to build conceptual understanding incrementally. The review stage reactivates prior knowledge, thereby facilitating students in connecting previously learned concepts with new material. The development stage assists students in constructing conceptual understanding under teacher guidance, whereas controlled practice and seatwork provide opportunities for students to apply concepts independently by solving various types of problems (Ramadayu & Zulkarnaen, 2022). The homework stage serves to reinforce understanding while establishing sustainable study habits. These characteristics indicate that the MMP has the potential to enhance conceptual mastery and foster the development of thinking habits necessary in mathematics education. This study aims to examine the effect of the Missouri Mathematics Project on elementary school students' mathematical connection ability and habits of mind simultaneously. The novelty of this study lies in evaluating these two interrelated outcomes within a multivariate analytical framework while also interpreting the effectiveness of MMP by considering instructional duration, students' prior mathematical competence, and classroom learning conditions. The findings are expected to enrich the literature by providing a more comprehensive understanding of the conditions under which structured mathematics instruction supports both conceptual understanding and productive mathematical thinking in elementary school students.

THEORETICAL FRAMEWORK

Missouri Mathematics Project (MMP)

Missouri Mathematics Project (MMP) is a structured instructional model designed to improve students' mathematical understanding through a systematic sequence of learning activities (Ainurrachmani & Safa'atullah, 2022). The model consists of five interconnected stages, namely review, development, controlled practice, seatwork, and assignment. Each stage is intended to reinforce prior knowledge while gradually guiding learners toward independent problem solving (Suryono et al., 2020). MMP emphasizes continuous practice and progressive scaffolding, enabling students to construct mathematical concepts through repeated engagement with meaningful tasks rather than passive reception of information. This systematic organization is consistent with constructivist principles, which emphasize that knowledge develops through active participation and cognitive restructuring (Chasanah & Junaedi, 2025).

Structured exercises provided during controlled practice and independent work allow learners to strengthen mathematical reasoning while reducing misconceptions (Farman et al., 2022). Research in mathematics education has consistently demonstrated that instructional models integrating guided practice with reflective activities promote deeper conceptual learning, increase students' confidence, and improve long-term retention of mathematical knowledge (Mellawaty et al., 2019). Similar instructional characteristics have also been associated with improvements in mathematical reasoning, communication, and problem-solving performance in primary and secondary mathematics classrooms (Nurruzzahra & Maarif, 2024). The gradual transition from teacher-supported learning to independent practice provides opportunities for learners to identify relationships among mathematical concepts and connect mathematics with authentic contexts. Consequently, MMP offers a pedagogical framework that supports both conceptual understanding and higher-order mathematical thinking, making it an appropriate instructional approach for investigating students' mathematical connection abilities (Mellawaty et al., 2025).

Habits of Mind

Habits of Mind refer to intelligent dispositions that guide individuals in responding effectively when encountering unfamiliar situations or complex problems (Prihandhika et al., 2018). Rather than representing cognitive ability alone, Habits of Mind encompass patterns of thinking that encourage persistence, flexible reasoning, metacognitive awareness, and reflective judgment during problem solving (Rahmadhani & Wahyuni, 2020). Costa and Kallick conceptualized Habits of Mind as enduring intellectual behaviors that become increasingly automatic through repeated practice and meaningful learning experiences (Rodliyah et al., 2024).

The development of Habits of Mind has attracted increasing attention in mathematics education because successful mathematical learning depends not only on conceptual knowledge but also on students' thinking dispositions (Sa'adah & Lestari, 2024). Learners who consistently analyze problems from multiple perspectives, monitor their reasoning processes, and evaluate alternative solution strategies demonstrate stronger mathematical understanding than those who rely solely on procedural memorization. Recent studies have shown that inquiry-oriented and problem-based instructional approaches provide meaningful opportunities for cultivating these intellectual dispositions by encouraging students to question assumptions, justify reasoning, and reflect on their learning processes (Suri et al., 2023). Habits of Mind function as an essential psychological mechanism supporting mathematical reasoning and conceptual growth. Students who demonstrate persistence, reflective thinking, and flexibility are more likely to recognize relationships among mathematical concepts, transfer prior knowledge to new situations, and integrate mathematical ideas across different representations (Ubaidillah et al., 2022).

Mathematical Connection

Mathematical connection refers to students' ability to recognize, establish, and apply relationships among mathematical ideas, representations, procedures, and real-world situations (Cai et al., 2011). The concept extends beyond mastering isolated mathematical topics by emphasizing the interconnected nature of mathematical knowledge. Students with strong mathematical connection ability are capable of integrating concepts across different mathematical domains while relating classroom learning to authentic contexts. Such integration supports conceptual understanding and enables learners to apply mathematical reasoning flexibly in solving unfamiliar problems (Mellawaty et al., 2025).

The importance of mathematical connection has been emphasized in mathematics education because meaningful learning occurs when students actively construct relationships among concepts rather than memorizing disconnected procedures (Parmiyanti & Rismawati, 2023). Research has demonstrated that students who successfully connect mathematical ideas tend to exhibit higher levels of conceptual understanding, problem-solving ability, and mathematical communication. Instructional approaches grounded in constructivism, including collaborative learning and problem based learning, facilitate this process by encouraging learners to compare multiple solution strategies, interpret mathematical representations, and justify their reasoning through discussion and reflection. Mathematical connection also serves as an important indicator of higher-order mathematical thinking because it requires students to synthesize prior knowledge, identify structural similarities across mathematical concepts, and transfer learning to different contexts (Ünal et al., 2022).

METHODS

Research Design

This study employed a quantitative approach using a quasi-experimental method with a pretest–posttest control group design. This design was selected to examine the effect of the Missouri Mathematics Project (MMP) on students' mathematical connection ability and habits of mind by comparing learning outcomes before and after the instructional intervention between the experimental and control groups. The experimental group received mathematics instruction through the MMP learning model, whereas the control group was taught using conventional classroom instruction.

Sample

The participants consisted of 62 fifth grade students enrolled in a public elementary school. The sample was divided into an experimental group and a control group. The participants were selected using purposive sampling based on the school's existing classroom organization to ensure that both groups possessed comparable academic characteristics and followed the same mathematics curriculum during the study. Before the intervention, both groups completed a pretest to identify their initial mathematical connection ability and to ensure comparable baseline achievement prior to treatment.

Data Collection and Instruments

Data were collected using two research instruments: a mathematical connection ability test and a habits of mind questionnaire. The mathematical connection test was designed to assess students' ability to relate mathematical concepts, procedures, and real-life situations. The habits of mind questionnaire employed a four-point Likert scale to measure students' productive mathematical thinking dispositions during the learning process. Prior to data collection, both instruments were validated to ensure content validity and their alignment with the measured constructs. The mathematical connection test consisted of essay items designed to measure students' ability to identify relationships among mathematical concepts, connect mathematics with real-life situations, and apply previously learned concepts to solve unfamiliar problems. Students' responses were evaluated using an analytic scoring rubric, with higher scores indicating stronger mathematical connection ability. Habits of mind were measured using a four-point Likert-scale questionnaire adapted from the mathematical habits of mind framework. The questionnaire assessed several thinking dispositions, including persistence in solving mathematical problems, flexible thinking, reflective thinking, metacognitive awareness, and accuracy in mathematical reasoning. Prior to implementation, both instruments were evaluated through expert judgment to establish content validity and were pilot-tested to ensure acceptable reliability for research use.

Data Analysis

The collected data were analyzed using IBM SPSS Statistics. Descriptive statistics were first employed to summarize students' performance. The Shapiro–Wilk test was conducted to examine the normality of the data distribution as a prerequisite for parametric analysis. The effect of the Missouri Mathematics Project on mathematical connection ability was analyzed using multiple linear regression. Furthermore, Multivariate Analysis of Variance (MANOVA) was performed to examine the simultaneous effect of the learning model on students' mathematical connection ability and habits of mind. All statistical analyses were conducted at a significance level of $\alpha = 0.05$. Prior to hypothesis testing, the assumptions of multivariate analysis were examined through the Shapiro–Wilk normality test, Levene's Test of Equality of Error Variances, Box's M test for homogeneity of covariance matrices, and homogeneity

testing between groups. Because the study involved two correlated dependent variables, namely mathematical connection ability and habits of mind, Multivariate Analysis of Variance (MANOVA) was considered the most appropriate statistical procedure to evaluate the simultaneous effect of the learning model while controlling the Type I error rate that might occur if separate univariate analyses were performed.

RESULT

A normality test was conducted as a prerequisite prior to hypothesis testing using parametric statistical analysis. The normality testing in this study utilized the Shapiro-Wilk test on the data of mathematical connection ability, habits of mind, and the student response questionnaire. Data are declared to be normally distributed if the significance value (Sig.) is greater than 0.05. The results of the normality test are presented in Table 1.

Table 1. Results of Normality Test

	Model pembelajaran MMP		
	Statistic	df	Sig.
Pretest Connection	.974	62	.220
Posttest Connection	.963	62	.059
Pretest Habits of Mind	.964	62	.064
Posttest Habits of Mind	.980	62	.415
Response Survey	.988	125	.327

Normality test results for the mathematical connection ability variable indicate that the pretest data obtained a Shapiro-Wilk statistic value of 0.974 with a significance value of 0.220, whereas the posttest data obtained a statistic value of 0.963 with a significance value of 0.059. The pretest data for habits of mind yielded a statistic value of 0.964 with a significance value of 0.064, whereas the posttest data for habits of mind achieved a statistic value of 0.980 with a significance value of 0.415. Testing conducted on the student response questionnaire revealed a Shapiro-Wilk statistic value of 0.988 with a significance value of 0.327.

The significance values across all research variables are above the 0.05 significance level, confirming that the pretest and posttest data for mathematical connection ability, habits of mind, and the student response questionnaire satisfy the assumption of normality. These outcomes demonstrate that the research data are eligible for further analysis using parametric statistical analysis. The effect of the Missouri Mathematics Project (MMP) learning model on mathematical connection ability was analyzed using multiple linear regression testing. The results of the regression analysis are presented in Table 2.

Table 2. Result of Multiple Linear Regression Test of Connection Ability using Missouri Mathematics Project

Model	B	Std. Error	t	Sig
(Constant)	67.179	10.804	6.218	.000
MMP	.219	.160	1.366	.177
a. Dependent Variable: Y1,				

Regression analysis results indicate that the constant value is 67.179 with a significance value of 0.000, whereas the Missouri Mathematics Project (MMP) learning model variable

obtained a regression coefficient (B) of 0.219, a standard error of 0.160, a t-value of 1.366, and a significance value of 0.177. The positive regression coefficient demonstrates that the implementation of the Missouri Mathematics Project learning model possesses a positive relationship with mathematical connection ability. Every one-unit increase in the MMP variable is followed by an increase in the mathematical connection ability score of 0.219 units. The significance value of 0.177 is greater than the 0.05 significance level, meaning that this relationship is not statistically significant. This outcome demonstrates that based on the regression model utilized, the implementation of the Missouri Mathematics Project learning model has not exerted a significant effect on students' mathematical connection ability. The results of the regression analysis are presented in Table 3.

Table 3. Result of Multiple Linear Regression Test of Mathematical Thinking Habits Using the Missouri Mathematics Project

Model	B	Std. Error	t	Sig
(Constant)	84.169	7.024	11.982	.000
MMP	-.073	.104	-.706	.483
a. Dependent Variabel Y_2				

Regression analysis results indicate that the constant value is 84.169 with a significance value of 0.000, whereas the Missouri Mathematics Project (MMP) learning model variable possesses a regression coefficient (B) of -0.073, a standard error of 0.104, a t-value of -0.706, and a significance value of 0.483. The negative regression coefficient demonstrates that the regression model shows a negative direction in the relationship between the implementation of the Missouri Mathematics Project learning model and habits of mind. Every one-unit increase in the MMP variable is followed by a decrease in the habits of mind score of 0.073 units. The significance value of 0.483 is greater than the 0.05 significance level, meaning that this relationship is not statistically significant. This outcome demonstrates that based on the regression model utilized, the implementation of the Missouri Mathematics Project learning model has not exerted a significant effect on students' habits of mind. A Multivariate Analysis of Variance (MANOVA) was conducted to determine the simultaneous effect of the learning model on mathematical connection ability and habits of mind. The results of the Tests of Between-Subjects Effects are presented in Table 4.

Table 4. Result of Manova Test

Source	Dependent Variabel	df	Mean Square	Sig.
Intercept	MCA	1	227769.216	.000
	HM	1	210134.834	.000
Corrected Model	MCA	19	105.284	.203
	HM	19	40.011	.314
Learning Model	MCA	19	40.011	.314
	HM	19	282.133	.110
Error	MCA	42	77.793	
	HM	42	77.793	
Total	MCA	62	420681.000	
	HM	62		
Corrected Total	MCA	61		
	HM	61		

The results indicate that the learning model did not have a statistically significant effect on either dependent variable. For Mathematical Connection Ability (MCA), the significance value was 0.314 ($p > 0.05$), indicating that students who learned through the Missouri Mathematics Project did not demonstrate significantly different mathematical connection ability compared with those who received conventional instruction. Likewise, for Habits of Mind (HM), the significance value was 0.110 ($p > 0.05$), suggesting that the implementation of the Missouri Mathematics Project did not significantly influence students' mathematical thinking dispositions.

Although the descriptive results showed a positive tendency in students' performance following the implementation of the Missouri Mathematics Project, the inferential analysis demonstrates that these differences were insufficient to reach statistical significance. These findings suggest that the effectiveness of the Missouri Mathematics Project in improving mathematical connection ability and habits of mind may depend on additional factors, such as the duration of the intervention, students' prior mathematical competence, learning motivation, and classroom learning conditions.

DISCUSSION

The present study demonstrated that the implementation of the Missouri Mathematics Project (MMP) did not produce statistically significant improvements in either mathematical connection ability or habits of mind. Although students in the experimental group achieved higher descriptive mean scores than those in the control group, the observed differences were insufficient to demonstrate a significant treatment effect (Siregar, 2023). These findings suggest that the structured stages of MMP alone may not be adequate to generate measurable improvements within the relatively limited period of intervention. The effectiveness of structured mathematics instruction appears to depend not only on the instructional model itself but also on students' readiness, learning intensity, and opportunities to repeatedly construct conceptual relationships throughout the learning process (Uiterwijk-Luijk et al., 2019).

The characteristics of the Missouri Mathematics Project model inherently possess the potential to support the development of mathematical connection ability through systematically structured stages of review, development, controlled practice, seatwork, and homework (Upara et al., 2024). Each stage provides opportunities for students to recall prior knowledge, construct new concepts, and apply these concepts in various forms of practice so that connections between concepts can be formed gradually (Zahira et al., 2022). From a constructivist perspective, the effectiveness of these instructional stages depends on the extent to which students actively reconstruct prior knowledge through repeated mathematical experiences.

Therefore, structured learning procedures alone cannot guarantee significant conceptual development without sufficient opportunities for sustained cognitive engagement. The findings of this study differ from those reported in previous studies, which generally concluded that the Missouri Mathematics Project significantly improves mathematical connection ability and other mathematical competencies (Lestari et al., 2024; Prihandhika et al., 2018). One possible explanation for this discrepancy is the difference in instructional duration, participant characteristics, mathematical content, and classroom implementation across studies. Previous investigations that reported significant improvements commonly implemented the intervention over a longer period or under learning conditions that allowed

students to become more familiar with the structured stages of MMP. Consequently, the effectiveness of the model should be interpreted within its instructional context rather than assumed to be universally applicable.

Research results also demonstrate that the implementation of the MMP model has not provided a significant effect on students' habits of mind. This finding indicates that the formation of habits of mind is a long-term process influenced not only by instructional strategies within a single topic or a few meetings but also by repeated learning experiences, classroom culture, and the continuous habituation of reflective thinking. Habits of mind develop through an internalization process requiring opportunities for students to consistently utilize thinking strategies, evaluate problem-solving processes, and reflect on their learning experiences.

The implications of this research indicate that the implementation of the Missouri Mathematics Project model needs to be supported by more consistent execution, longer learning durations, and the provision of activities that encourage students to connect mathematical concepts and reflect on their thinking processes. Future research also needs to consider other factors potentially affecting mathematical connection ability and habits of mind, such as initial ability, learning motivation, and student engagement during the learning process, so that the effectiveness of the learning model can be evaluated more comprehensively.

CONCLUSION

This study concludes that the implementation of the Missouri Mathematics Project (MMP) showed a positive tendency to improve elementary school students' mathematical connection ability and habits of mind; however, these improvements were not statistically significant. The findings indicate that although MMP provides structured learning activities that support conceptual understanding and systematic problem-solving, its implementation alone was insufficient to produce significant learning gains within the context of this study. This study contributes to the literature by providing empirical evidence on the application of MMP in elementary mathematics education and emphasizing that the development of mathematical connection ability and habits of mind is influenced by multiple factors, including students' prior knowledge, instructional duration, and classroom learning conditions. Therefore, future research should investigate the long-term implementation of MMP with larger and more diverse samples while incorporating additional variables, such as learning motivation, prior mathematical achievement, and student engagement, to better understand the conditions under which MMP can effectively enhance students' cognitive and thinking dispositions.

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