

Shifting from Rote to Reasoning: The Impact of the Connected Mathematics Project Model on Elementary Students' Mathematical Skills

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Abstract

This study aims to examine the effectiveness of implementing the Connected Mathematics Project (CMP) learning model on improving the mathematical reasoning abilities of elementary school students. The background of this study addresses the problem of students' low ability in reasoning geometric concepts, where students are often trapped in rote memorization of formulas without conceptual understanding. The researcher applied a quasi-experimental method with a Nonequivalent Control Group Design during the research process. The research subjects included all fifth-grade students of SDN 2 Tinigi, divided into two parallel classes (Experimental and Control). The test instrument collected data on reasoning abilities through valid and reliable essay questions based on four indicators: proposing conjectures, mathematical manipulation, providing reasons, and drawing conclusions. The results showed a significant increase in the experimental class with an N-Gain score of 0.88 (High Category), while the control class obtained an N-Gain score of 0.52 (Medium Category). The t-test proved that there was a significant difference between the two groups with a significance value of $0.000 < 0.05$. It is concluded that the contextual problem-based CMP model is effective in improving students' mathematical reasoning abilities, especially in the aspects of proposing conjectures and mathematical manipulation.

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INTRODUCTION

Education in the 21st century demands a paradigm shift in learning from merely memorizing facts to developing higher-order thinking skills, where numeracy literacy becomes a fundamental foundation for students to survive and compete in an increasingly complex and data-driven global era. However, the reality of education in Indonesia still faces major challenges, as

evidenced by the results of the Programme for International Student Assessment (PISA) survey, which consistently places Indonesian students at the bottom, particularly in the mathematics domain which requires reasoning skills and in-depth analysis (Ariati & Juandi, 2022; Suparya et al., 2022). These low achievements indicate a critical gap in the learning process at schools, where mathematics is often taught as a set of mechanical procedures without emphasis on strengthening mathematical reasoning abilities, which are essential for solving non-routine problems in daily life (Mukminah et al., 2024). Therefore, strengthening numeracy literacy through the development of reasoning skills must be a primary focus in the elementary education curriculum to prepare a golden generation capable of critical, logical, and analytical thinking in facing the rapidly changing challenges of the times.

A fundamental problem that often hinders the achievement of mathematics learning objectives is the students' perception that mathematics is a difficult and frightening subject. Farhan & Jumardi (2023), in their research on fifth-grade elementary students revealed that this learning difficulty is influenced by internal factors such as low interest and motivation, as well as external factors in the form of teacher teaching methods that tend to be monotonous and less varied. This is reinforced by the findings of Armiyansyah et al., (2021) and Heryanto et al., (2022) stating that the minimal use of visual teaching aids makes it difficult for students to understand abstract concepts and solve problems related to word problems. The absence of concrete media in the learning process causes students to only receive information passively, limiting their understanding to procedural memorization without being able to relate these concepts to real situations.

Mathematical reasoning ability at the elementary school level is not just a routine calculation skill, but a vital cognitive bridge that enables students to transform concrete problems into abstract models through a logical, analytical, and structured thinking process (Hung et al., 2026; Listiani et al., 2024; Wati, 2025). In meaningful learning activities, this reasoning process begins by stimulating students' courage to propose conjectures regarding solutions or problem patterns, followed by the ability to perform mathematical manipulations using appropriate calculation procedures (Daulay, 2022; Putri et al., 2019). Not stopping at obtaining the final answer, students are also required to be able to provide logical reasons or proofs for the steps taken, and conclude with the skill of drawing general conclusions from specific facts that have been tested for truth (Moreno & Reisslein, 2011; Rahmawati & Astuti, 2022). Complete mastery of these four reasoning indicators is crucial to changing the paradigm of mathematics from mere rote memorization of dead formulas into a powerful and adaptive thinking tool for solving real problems in students' daily lives.

Specifically in geometry material, the concept of the perimeter of plane figures plays a vital role due to its vast application in daily life, yet it often becomes a source of cognitive difficulty for students. This difficulty generally occurs because students are trapped in the routine of memorizing standard formulas without understanding the basic spatial concept that perimeter is the total length of the boundary path enclosing a closed area. When students are faced with composite figures or contextual problems that require formula modification, they often fail to reason because their conceptual foundation is fragile (Davis, 2023; Mahanal et al., 2022). Therefore, learning the perimeter of plane figures must not stop at the activity of substituting

numbers into formulas but must involve physical investigation experiences to build solid mathematical logic.

Observations conducted at the elementary school level, specifically at SDN 2 Tinigi, revealed the fact that mathematics learning is still dominated by a teacher-centered approach that prioritizes formula memorization over building a solid conceptual understanding of the material taught to students. This condition is very evident in the material of the perimeter of plane figures in Grade V, where students tend to only memorize standard formulas without truly understanding the basic concept that perimeter is the total length of the edges limiting a closed area. As a result of this learning habit based only on memorization, students experience significant difficulties when faced with contextual problems or questions demanding mathematical reasoning, such as determining the perimeter of composite figures or solving problems related to their surrounding environment. This situation confirms an urgent need to improve learning strategies at SDN 2 Tinigi, specifically by presenting methods capable of facilitating students to construct their own knowledge and relate mathematical concepts to real situations in their environment.

To overcome the problems of rigid learning and low reasoning, the Connected Mathematics Project (CMP) learning model presents a constructive solution designed specifically to develop students' mathematical understanding through the exploration of problems relevant to their daily lives. This CMP model facilitates students to be actively involved in the problem Launch phase, concept Explore phase, and findings Summarize phase, so that mathematics is no longer viewed as a collection of abstract formulas but as a useful tool for solving real-world problems around them. Various previous studies have proven that the application of this inquiry-based model is effective in improving higher-order thinking skills because students are trained to investigate patterns, formulate conjectures, and build logical arguments during the mathematical problem-solving process (Fitriatien et al., 2021; Widyawati et al., 2025). This study offers novelty by adapting the CMP model into the context of local wisdom (farming/plantations) of SDN 2 Tinigi students, aiming to empirically test the effect of implementing the CMP model on the mathematical reasoning abilities of fifth-grade students, specifically on the material of the perimeter of plane figures in elementary school.

METHOD

This type of research is a Quasi-Experimental research with a Nonequivalent Control Group Design. The research was conducted at SDN 2 Tinigi, Tolitoli Regency. The research population included all fifth-grade students, who were then divided into two sample groups using the Purposive Sampling technique: Class V-A as the experimental class receiving the CMP model treatment and Class V-B as the control class with conventional learning. The sample consisted of 34 students divided into two parallel classes. The researcher used the concept understanding test as the main data collection instrument. This test contains 10 essay test questions covering the cognitive domains C3 and C4. The instrument test resulted in 5 valid questions out of a total of 10 initial questions. The results of the reliability test showed a Cronbach's Alpha coefficient of 0.852 in the very high category.

Research Procedure

1. Preparation Stage: Included initial observations at the school, preparation of learning tools (Teaching Modules and Student Worksheets) integrating the local context of clove and cocoa plantations, and validation of the mathematical reasoning test instrument by a team of experts.
2. Implementation stage: began with administering a pretest to measure the initial ability of both classes. Furthermore, the treatment implementation was carried out over 4 meetings. The experimental class was taught using the cmp model consisting of the launch phase (presentation of contextual problems), explore phase (investigation of perimeter using concrete props), and summarize phase (discussion and formula deduction), while the control class used conventional learning. The activity ended with the administration of a posttest.
3. Final Stage: Included processing of test result data, analysis prerequisite testing, statistical hypothesis testing, and drawing conclusions.

Data Analysis Techniques

The researcher analyzed the data through several statistical stages. These stages include a prerequisite test of normality and homogeneity before the hypothesis test. The researchers used the Independent Sample T-Test to test for significant differences with a significance level (α) of 0.05.

The research hypotheses tested are:

- H_0 : There is no significant effect of the application of the CMP learning model on the mathematical reasoning abilities of fifth-grade students at SDN 2 Tinigi.
- H_a : There is a significant effect of the application of the CMP learning model on the mathematical reasoning abilities of fifth-grade students at SDN 2 Tinigi.

The hypothesis testing criterion is to reject H_0 if the significance value (Sig. 2-tailed) < 0.05 at a 95% confidence level.

The independent variable in this study is the CMP learning model, while the dependent variable is the students' mathematical reasoning ability on the material of Perimeter of Plane Figures. The data collection technique used an essay test designed to measure 4 reasoning indicators: (1) Proposing conjectures, (2) Mathematical manipulation, (3) Providing reasons/proofs, and (4) Drawing conclusions. Data analysis was carried out quantitatively including prerequisite tests (Shapiro-Wilk Normality and Levene's Test Homogeneity) as well as hypothesis testing using Independent Sample t-test and effectiveness testing using N-Gain Score.

RESULTS AND DISCUSSION

Result

Initial data (pretest) showed that the abilities of both classes were relatively equivalent before treatment was given. The average pretest score of the experimental class was 57 and the control class was 58. After learning was implemented, there was a significant increase in learning outcomes. The experimental class reached a posttest average of 95, while the control class only reached 80. Details of the average student scores are presented in Table 1.

Table 1. Average Score Recapitulation

Class	Average Pretest	Average Posttest	Gain
Experiment (V A)	57	95	38
Control (V B)	58	80	22

Before hypothesis testing, analysis prerequisite tests were conducted, which included normality and homogeneity tests. Based on the Shapiro-Wilk normality test (Table 2), Sig. values > 0.05 were obtained for the pretest and posttest data of both classes, meaning the data were normally distributed.

Tabel 2. Data Normality Test Results (Shapiro-Wilk)

Class	Data	Statistik	Sig.	Information
Experiment	Pretest	0,983	0,892	Normal (Sig $> 0,05$)
	Posttest	0,945	0,210	Normal (Sig $> 0,05$)
Control	Pretest	0,952	0,481	Normal (Sig $> 0,05$)
	Posttest	0,961	0,554	Normal (Sig $> 0,05$)

Furthermore, the Levene's Test for homogeneity (Table 3) produced a Sig. value of 0.597 (> 0.05), indicating that the data variance between the experimental class and the control class is homogeneous.

Table 3. Homogeneity Test Results (Levene's Test)

Data	Levene Statistic	Sig.	Information
Student Learning Outcomes	0,285	0,597	Homogen (Sig $> 0,05$)

Since the data were normally distributed and homogeneous, hypothesis testing continued using parametric tests. The results of the Independent Sample t-test comparing the experimental and control classes (Table 4) showed a Sig. (2-tailed) value of 0.000. Since the value $0.000 < 0.05$, H_0 is rejected and H_a is accepted, statistically proving that the application of the CMP model treatment had a real effect on improving student abilities.

Table 4. Hypothesis Test Results (Independent Sample T-Test)

Group Comparison	Mean Difference	t	df	Sig. (2-tailed)	Information
Experimental - Control Class (Posttest)	15,000	7,415	32	0,000	Significant

Effectiveness Test (N-Gain)

Effectiveness analysis showed a difference in the quality of improvement between the two classes. Based on Table 5, the Experimental Class obtained an average N-Gain of 0.88 (High Category), far superior to the control class which obtained an N-Gain of 0.52 (Medium Category).

Table 5. Effectiveness Test Results (N-Gain)

Class	Average Pretest	Average Posttest	N-Gain	Category
Experiment	57	95	0,88	High
Control	58	80	0,52	Medium

Specifically, the improvement per reasoning indicator can be seen in Table 6 below.

Table 6. Comparison of Improvement (Gain) Reasoning Mathematic Indicator

Reasoning Indicators	Class	Pretest	Posttest	Gain
1. Filing Suspicions	Experiment	14,2	24,7	10,5
	Control	14,5	20,6	6,1
2. Mathematical Manipulation	Experiment	14,3	24,8	10,5
	Control	14,8	20,4	5,6
3. Giving a Reason	Experiment	14,6	22,8	8,2
	Control	14,8	19,8	5,0
4. Drawing Conclusions	Experiment	13,9	22,7	8,8
	Control	14,2	19,2	5,0

Data in Table 6 shows that the CMP model had the greatest impact on the indicators of Proposing Conjectures and Mathematical Manipulation, with a fairly large difference in improvement points compared to the control class.

Discussion

Based on the results of the inferential statistical analysis performed, it was found that the application of the Connected Mathematics Project (CMP) learning model had a very significant effect on improving the mathematical reasoning abilities of fifth-grade students at SDN 2 Tinigi compared to the conventional learning model. The effectiveness of this model is inseparable from the main characteristics of CMP, which consistently requires students to actively build their own understanding through solving contextual problems (Asmasari et al., 2025), so that mathematics is no longer seen as a set of dead formulas but as a living and meaningful solution tool (Agustina et al., 2025; Satriani et al., 2025). These empirical findings are very much in line with the basic principles of Jean Piaget’s constructivism learning theory, which emphasizes that deep and long-lasting knowledge can only be formed if students construct that understanding themselves through direct and active interaction with objects or their learning environment (Arafah et al., 2023). By presenting real-world problems relevant to the students’ environment as a starting point for learning, the CMP model successfully bridged the cognitive gap that has existed between abstract mathematical concepts and students’ concrete experiences, allowing mathematical reasoning abilities to grow optimally.

The superiority of the CMP model in this study was very prominent in the Explore phase, where students were given full freedom to investigate the concept of the perimeter of plane figures through a series of group investigation activities designed specifically to stimulate their curiosity and reasoning. In these learning activities, students used concrete teaching aids available in the surrounding environment, such as raffia string and floor tiles, to physically measure the length of

the boundary paths of various shapes of plane figures, an experience often overlooked in traditional teaching methods. Through direct experiments manipulating these objects, students slowly began to realize the logical pattern that perimeter is simply the sum of all outer sides of the figure, without having to rely on rote memorization of formulas whose physical meaning they often do not understand. This process of independent discovery culminated when students were able to formulate for themselves the conclusion that the perimeter of a rectangle is twice the sum of the length and width, a conceptual understanding far deeper and more logical than merely accepting a ready-made formula from the teacher.

The results of this study reinforce findings from previous studies stating that the CMP model has a consistent positive impact on students' higher-order cognitive abilities, while also confirming that a problem-based approach is a key to reforming mathematics education in elementary schools. In line with research Harahap & Nasution (2021) which found that CMP was effective in improving the mathematical concept understanding of junior high school students in Medan, this study proves that such a strong conceptual foundation is also an absolute prerequisite for the development of reasoning abilities in elementary school students in Tinigi. Furthermore, these findings also answer the challenges identified in the literature study Ariati & Juandi (2022), which highlighted the need for learning model innovations to overcome the low mathematical reasoning abilities of Indonesian students who have been trapped in routine procedural methods and mere rote memorization. The success of applying CMP at the elementary school level provides new empirical evidence that the model, originally developed for the secondary level, turns out to be very adaptive and effective when applied to younger students, provided that the problem context is adjusted to their concrete operational thinking level.

In-depth analysis of mathematical reasoning indicators showed that the highest increase occurred in the aspects of proposing conjectures and performing mathematical manipulations, indicating that the CMP model is very powerful in training students' courage to predict patterns and process quantitative data independently. The high achievement in these indicators was caused by the stimulus of agricultural contextual problems that are close to students' daily lives, so they felt confident to formulate initial hypotheses and perform mathematical calculations without fear of making rigid procedural errors as in ordinary learning. Although the aspects of providing logical reasons and drawing conclusions had improvement scores slightly below the other two indicators, this achievement still showed significant progress compared to the control class, indicating that students are beginning to get used to verbalizing their mathematical arguments in a structured and systematic manner. Overall, this learning intervention succeeded in changing the students' cognitive profile from mere passive information receivers to active thinkers capable of validating the truth of their answers through a series of logical proofs, a core competency highly needed in strengthening today's numeracy literacy.

CONCLUSION

The application of the Connected Mathematics Project (CMP) learning model on the material of Perimeter of Plane Figures proved to have a significant effect on the mathematical reasoning abilities of fifth-grade students at SDN 2 Tinigi. This is indicated by the t-test significance value of 0.000 and the achievement of an N-Gain in the High category (0.88). This

model is most effective in improving students' abilities in proposing conjectures and performing mathematical manipulations. It is suggested for elementary school teachers to adopt local contextual problem-based learning models to train students' reasoning, as well as to provide more time allocation in the discussion phase to strengthen students' abilities in providing logical reasons.

REFERENCES

- Agustina, BK, M. K. U., & Mustakim. (2025). Peningkatan Hasil Belajar Matematika Melalui Penggunaan Worksheet Bermuatan Numerasi Edukasi dengan Memanfaatkan Media Gambar Bergerak Di SDN 3 Tolitoli. *PHI: Jurnal Pendidikan Matematika*, 9(1), 124–131. <https://doi.org/10.33087/phi.v9i1.466>
- Arafah, A. A., Sukriadi, & Samsuddin, A. F. (2023). Implikasi Teori Belajar Konstruktivisme pada Pembelajaran Matematika. *Jurnal Pendidikan MIPA*, 13(2), 358–366. <https://doi.org/10.37630/jpm.v13i2.946>
- Ariati, C., & Juandi, D. (2022). Kemampuan Penalaran Matematis: Systematic Literature Review. *LEMMA: Letters Of Mathematics Education*, 8(2), 61–75. <https://doi.org/10.22202/jl.2022.v8i2.5745>
- Armiansyah, Sugiarno, & Bistari. (2021). Hambatan siswa dalam belajar matematika dikaji dari kepercayaan matematis. *Jurnal AlphaEuclidEdu*, 2(1), 40–50. <https://doi.org/10.26418/ja.v2i1.42878>
- Asmasari, Suharti, Abrar, A. I. P., Nur, F., & Majid, A. F. (2025). Penerapan Model Connected Mathematics Project (CMP) untuk Meningkatkan Kemampuan Berpikir Kritis Siswa SMP. *Jurnal Penelitian Inovatif (JUPIN)*, 5(3), 1917–1928. <https://doi.org/10.54082/jupin.1472>
- Daulay, L. A. (2022). Peningkatan Kemampuan Penalaran Matematis Siswa dengan Menggunakan Pembelajaran Connected Mathematics Project (CMP). *OMEGA: Jurnal Keilmuan Pendidikan Matematika*, 1(2), 22–28. <https://doi.org/10.47662/jkpm.v1i2.221>
- Davis, J. B. (2023). Objectivity in economics and the problem of the individual. *Journal of Economic Methodology*, 30(4), 276–289. <https://doi.org/10.1080/1350178X.2023.2181374>
- Farhan, M. N., & Jumardi. (2023). Faktor Kesulitan Siswa Sekolah Dasar Dalam Belajar Matematika. *Jurnal Educatio*, 9(2), 874–879. <https://doi.org/10.31949/educatio.v9i2.4934>
- Fitriatien, S. R., Leksono, I. P., & Matematika, P. (2021). Pengaruh Model Pembelajaran Connected Mathematics Project (CMP) Terhadap Kemampuan Pemecahan Masalah Matematis Siswa SMP. *Jurnal Penelitian Matematika Dan Pendidikan Matematika*, 4(2), 48–55. <https://doi.org/10.30605/proximal.v4i2.1243>
- Harahap, T. H., & Nasution, M. D. (2021). Matematika Menggunakan Model Pembelajaran Connected Mathematics Project (CMP). *Journal Mathematics Education Sigma [JMES]*, 2(1), 8–12. <https://doi.org/10.30596/jmes.v2i1.6746>
- Heryanto, Sembiring, S. B., & Togatorop, J. B. (2022). Analisis Faktor Penyebab Kesulitan Belajar Matematika Siswa Kelas V Sekolah Dasar. *Curere*, 6(1), 45–54. <https://doi.org/10.36764/jc.v6i1.723>
- Hung, E. E., Vanderberg, M., Krause, G., & Skuratowicz, E. (2026). Making Abstraction Concrete in the Elementary Classroom. *Proceedings of the 55th ACM Technical Symposium on Computer Science Education V. 1*, 540–546. <https://doi.org/10.1145/3626252.3630890>
- Listiani, Hamna, & Mustakim. (2024). Implementasi Model Pembelajaran Problem Posing & Solving (PPS) untuk Meningkatkan Pemahaman Numerik Siswa SDN 2 Tambun Menggunakan Media Dakota Tradisional. *Jurnal Review Pendidikan Dan Pengajaran*, 7(4), 13786–13794. <https://doi.org/10.31004/jrpp.v7i4.34878>

- Mahanal, S., Zubaidah, S., Setiawan, D., Maghfiroh, H., & Muhaimin, F. G. (2022). Empowering College Students' Problem-Solving Skills through RICOSRE. *Education Sciences*, 12(3), 196. <https://doi.org/10.3390/educsci12030196>
- Moreno, R., & Reisslein, G. O. and M. (2011). Teaching With Concrete and Abstract Visual Representations : Effects on Students ' Problem Solving , Problem Representations , and Learning Perceptions. *Journal of Educational Psychology*, 103(1), 32–47. <https://doi.org/10.1037/a0021995>
- Mukminah, Hirlan, & Hasanah, M. (2024). Peran Guru Dalam Mengatasi Kesulitan Belajar Matematika. *Indonesian Journal of Education Research and Technology (IJERT)*, 4(1), 6–9. <https://doi.org/10.69503/ijert.v4i1.578>
- Putri, D. K., Sulianto, J., & Azizah, M. (2019). Kemampuan Penalaran Matematis Ditinjau dari Kemampuan Pemecahan Masalah. *International Journal of Elementary Education*, 3(3), 351–357. <https://doi.org/10.23887/ijee.v3i3.19497>
- Rahmawati, K. D., & Astuti, D. (2022). Kemampuan Penalaran Matematis Siswa SMA pada Materi Pertidaksamaan Dua Variabel. *Plusminus: Jurnal Pendidikan Matematika*, 2(2), 187–200. <https://doi.org/10.31980/plusminus.v2i2.1096>
- Satriani, I., Astuti, & Wahyuni, M. (2025). Pengaruh Model Connected Mathematics Project (CMP) pada Pembelajaran Matematika Terhadap Kemampuan Koneksi Matematis Siswa Kelas IX Di MTS Darul Falah Salo. *Inspiramatika: Jurnal Inovasi Pendidikan Dan Pembelajaran Matematika*, 11(1), 73–87. <https://doi.org/10.52166/inspiramatika.v11i1.9365>
- Suparya, I. K., I Wayan Suastra, & Putu Arnyana, I. B. (2022). Rendahnya Literasi Sains: Faktor Penyebab dan Alternatif Solusinya. *Jurnal Ilmiah Pendidikan Citra Bakti*, 9(1), 153–166. <https://doi.org/10.38048/jipcb.v9i1.580>
- Wati, M. (2025). The Improvement of Students' Adaptive Reasoning Through Connected Mathematics Project Model on Vocational High School PP Kutacane. *(JIML) Journal Of Innovative Mathematics Learning*, 8(1), 123–137. <https://doi.org/10.22460/jiml.v8i1.p27113>
- Widyawati, S., Rosydah, U., Setyawati, A., & Lestari, S. (2025). Evaluating the CMP model's impact on mathematical connection abilities : Insights through self-efficacy levels. *Al-Jabar: Jurnal Pendidikan Matematika*, 16(01), 353–362. <https://doi.org/10.24042/ajpm.v16i1.26543>