(JIML) JOURNAL OF INNOVATIVE MATHEMATICS LEARNING
Volume 8, No. 1, March 2025
P-ISSN 2621-4733
E-ISSN 2621-4741
https://dx.doi.org/10.22460/jiml.v8i1.p27113

THE IMPROVEMENT OF STUDENTS' ADAPTIVE REASONING THROUGH CONNECTED MATHEMATICS PROJECT MODEL ON VOCATIONAL HIGH SCHOOL PP KUTACANE

Merna Wati[1]

[1]Sekolah Tinggi Ilmu Tarbiyah Babussalam Aceh Tenggara, Jl. Kutacane No. 225, Aceh Tenggara, Indonesia
mernawatimath@gmail.com

ARTICLE INFO

Article history:

Received Jan 27, 2025
Revised Feb 18, 2025
Accepted Mar 23, 2025

Keywords:

Adaptive Reasoning
Connected Mathematics Project Model
Vocational High School

ABSTRACT

The development of students' adaptive reasoning is a critical aspect of mathematics education, especially in preparing students to solve complex, real-world problems. The purpose of this study is to explore the effectiveness of the Connected Mathematics Project (CMP) model in improving the adaptive reasoning of Class X students at SMK PP Negeri Kutacane. This study used a classroom action research approach, conducted over two cycles, each consisting of three meetings (6x45 minutes). Each cycle included four stages: planning, action, observation, and reflection. In Cycle I, the CMP model was implemented, and students worked on problems that encouraged adaptive reasoning. Cycle II followed the same structure, with continued use of the CMP model and a focus on evaluating student progress. The results showed a significant improvement in student learning outcomes, with the class average increasing from 53.71 in the pre-cycle to 61.38 in Cycle I and 84.19 in Cycle II. The percentage of learning completeness also improved, from 9% in the pre-cycle to 47.61% in Cycle I and 83.33% in Cycle II. This indicates that the CMP model effectively enhanced students' adaptive reasoning. The study concludes that the CMP model is a promising method for improving students' mathematical reasoning and learning outcomes, but further research is needed to explore its broader applications in other educational contexts.

Corresponding Author:

Merna Wati,
Department of Mathematics Education,
Sekolah Tinggi Ilmu Tarbiyah Babussalam Aceh Tenggara,
Jl. Kutacane No. 225, Aceh Tenggara, Indonesia.
Email: mernawatimath@gmail.com

How to Cite:

Wati, M. (2025). The Improvement of Students' Adaptive Reasoning through Connected Mathematics Project Model on Vocational High School PP Kutacane. *JIML,* 8(1), 123-137.

INTRODUCTION

Based on Wasis & Sri (2022), namely regarding the national education system, education is a conscious effort that has been planned in realizing learning activities or learning processes so that students are active in developing their own potential by having spiritual, religious, self-control, intellectual, noble moral strength, and the abilities needed by themselves, many people, the nation or the state. This is also in line with the justification of (Farida Et al (2023; Fathurrohman, Muhammad 2017) who emphasize the need for learning based on four pillars, namely learning to know, learning by acting or doing (learning to do), learning to be yourself independently (learning to be), and learning to live together (learning to live together).

Referring to the four pillars above, giving birth to learning is often sought so that its model is developed, because basically education is not just something that is not moving or fixed, but something that is dynamic with continuous change or improvement. Changes can be made with teaching methods, books, tools, or learning materials. One example for the field of study of students in schools, namely mathematics. In mathematics at school, it is inseparable from students' adaptive reasoning.

Adaptive reasoning, which is an important component of mathematical thinking, refers to the ability to analyze, interpret, and adapt solutions when faced with complex and unfamiliar problems. These skills are essential for students to develop flexible thinking and problem-solving skills, which are highly needed in academic and real-world applications. However, there are significant challenges in developing adaptive reasoning in students, especially in Indonesia. Recent studies, such as the TIMSS 2023 report, show that Indonesian students' reasoning skills in mathematics are still below the international average. Specifically, Indonesia ranks low in reasoning skills, ranking 36th out of 48 countries (Hadi, 2019; Utomo, 2018). This gap is largely due to traditional teaching methods that emphasize memorization rather than critical thinking and adaptive reasoning. Teachers also face difficulties in engaging students in problem-solving tasks that require justification and reasoning, as confirmed by observations at SMK PP Negeri Kutacane. In its standards, NCTM provides five competency standards, namely problem-solving skills, communication skills, connection skills, reasoning skills, and finally representation. Then (Jamiah & Yulis, 2020; Yaqin, Ainul et al, 2020) stated that the purpose of learning mathematics is to form students' own abilities which are reflected through the ability to think critically, logically, systematically and have an objective, honest, disciplined attitude by solving a problem, be it in mathematics or in other subjects and in everyday life. And in line with the statement (Krisnadi & Elang, 2022; Rohmah, Siti Nur 2021) said that mathematics is a deductive and structured science. It contains mathematical concepts that are arranged hierarchically, structured, logically and systematically with the most complex concepts to use deductive thinking patterns. By obtaining a deductive mindset, students must also have good reasoning skills. From several opinions that we have seen above, it can be concluded that the utilization and development of students' reasoning abilities is something important for learning mathematics in schools. However, in real life, students' mastery of these reasoning abilities is very difficult to achieve just like that. Based on the results of observations that I have conducted at SMK PP Negeri Kutacane, Southeast Aceh Regency, I interviewed one of the mathematics teachers in class X, namely Mrs. Vera Khairani, S.Pd., who said that "students' abilities in learning are still low, for example from the results of the test on the geometry of solid shapes taken every year, there are still many students who are below the KKM, which is 75%. Students do not understand and find it difficult to learn about mathematics, especially material on mathematical reasoning". Students tend not to understand where the results that have been obtained from the mathematical problems come from.

In addition, the learning model provided is not quite right so that when students are given questions that are slightly different from the examples given and must provide logical and precise reasons for the answers they give, many students complain and have difficulty solving them. Math problems seem to be a big problem for students, because in previous learning students are rarely faced with problems like this. This is also confirmed by the teacher, that students often have difficulty solving reasoning questions such as questions in the form of statements "Why?", "Give a reason!" and questions like this require student creativity to explain the question. This type of question is also an example of an adaptive reasoning question.

Based on the facts above, students have relatively low achievements in mathematical abilities, one of which is adaptive reasoning abilities. The low adaptive reasoning ability of students is because students are less able to understand learning so that there are many obstacles in

learning, among the factors that are the basis for obstacles in student learning is the learning itself.

With this, the importance of adaptive reasoning abilities, learning efforts are needed that use approaches or learning models that can provide opportunities by encouraging students to practice their adaptive reasoning abilities. In this case, one alternative solution to foster students' adaptive reasoning abilities is to use the Connected Mathematics learning model. One promising solution to overcome this challenge is the Connected Mathematics Project (CMP) model. CMP is designed to help students connect mathematical concepts to real-life situations, which encourages deeper understanding and development of reasoning skills. This model emphasizes inquiry-based learning, problem solving, and collaborative activities, which can stimulate adaptive reasoning by challenging students to think critically and creatively. Research has shown that CMP significantly improves students' mathematical reasoning and problem-solving abilities, making it an effective tool in improving adaptive reasoning. The Connected Mathematics model is to help students and teachers develop knowledge in mathematics, reasoning, skills, understanding, self-awareness and appreciation of the enrichment of the relationship between parts of mathematics and other materials. Connected Mathematics emphasizes students' ability to use mathematical tools, sources, procedures, knowledge, and ways of thinking by making sense of new situations (Harisuddin, 2019). Based on the problems above, it can be seen that there is a relationship between the Connected Mathematics Project learning model and students' adaptive reasoning abilities. So that the researcher conducted a study of the material on "Efforts to improve students' adaptive reasoning abilities at SMK PP Negeri Kutacane, Southeast Aceh Regency through the Connected Mathematics Project (CMP) model". The main objective of this study was to investigate the effectiveness of the CMP model in improving the adaptive reasoning abilities of Class X students at SMK PP Negeri Kutacane. Through this study, it is expected to show how the CMP model can improve students' mathematical reasoning and overcome the challenges faced by traditional teaching methods, by providing a more dynamic and interesting learning experience.

METHOD

This research is a research conducted in the classroom (Classroom Action Research). This research uses the Classroom Action Research (CAR) method which consists of two cycles, namely cycle I and cycle II. Each cycle has four main stages, namely planning, implementation, observation, and reflection.

The participants of this study were class X students of SMK PP Negeri Kutacane in the 2024/2025 academic year. The total number of participants was 30 students consisting of 1 class in the even semester of the academic year. Furthermore, the instruments used in this study include:

1. Questionnaire. The questionnaire was given to students at the end of each cycle to determine students' attitudes towards the application of the Connected Mathematics Project (CMP) model used in learning.
2. Observation Sheet. Used to monitor student activities during learning and to assess whether students are actively involved in each stage of learning.
3. Test. A written evaluation test was given to students at the end of each cycle to measure the improvement of students' adaptive reasoning abilities.

The steps of this research were carried out in two cycles, each consisting of three meetings (each meeting lasted 45 minutes). The steps of this research are as follows:

1. Cycle I
   a. Planning: Preparing a learning implementation plan using the CMP model with the material of spatial geometry (cubes and cuboids).
   b. Implementation: The implementation of learning begins with providing basic knowledge about spatial geometry. Then students carry out collaborative activities in groups, following the CMP model to solve the existing problems. At the third meeting, students are given an evaluation to measure their understanding and reasoning.
   c. Observation: During the learning process, the researcher observes student activities through observation sheets.
   d. Reflection: After cycle I, learning outcomes are evaluated. The results are compared with the objectives set, whether there is an increase in students' adaptive reasoning abilities.
2. Cycle II
   a. Planning: Planning further learning by improving strategies based on reflection on cycle I.
   b. Implementation: Same as cycle I, but with some improvements in learning strategies. Students are again given the opportunity to learn through the CMP model and given a final evaluation.
   c. Observation: Observation is continued using observation sheets to monitor student involvement during learning.
   d. Reflection: At the end of cycle II, an evaluation was carried out on the improvement of students' adaptive reasoning abilities.

Furthermore, data collection techniques in this study include:

1. Questionnaire Method. To measure students' attitudes and views on learning implemented through the CMP model.
2. Test Method. To measure the improvement of students' adaptive reasoning abilities through evaluation tests given at the end of each cycle.
3. Observation Method. To observe student activities during the learning process.
4. Documentation Method. To collect evidence in the form of photos or notes related to the implementation of learning.

As for the data analysis in this study, it was obtained in the following ways:

1. Questionnaire Data Analysis. Questionnaire data was analyzed to determine students' responses to learning using the CMP model.
2. Observation Sheet Analysis. The results of the observations were analyzed to determine the extent to which students were actively involved in the learning process.
3. Test Result Analysis. The results of individual tests and class tests were calculated using the following formula to calculate the passing rate:
   a. Individual Passing: Declared passing if the value obtained by the student is greater than or equal to the specified KKM (75).
   b. Classical Passing: Calculated using descriptive percentage analysis, through the formula:

      Classical Passing = $\frac{j}{s}x100\%$

Description:

S = Total number of students

j = Number of students studying individually

% = Percentage level achieved

4. Success Indicators: Learning success is said to be achieved if:
   a. The average student score is > 75 and
   b. At least 85% of students in the class get a score of ≥ 75.

   The improvement of students' adaptive reasoning is measured based on the results of evaluation tests and observations of student involvement in learning using the CMP model.

RESULTS AND DISCUSSION

Results

Based on the research objectives that have been set, namely to improve the adaptive reasoning abilities of class X students of SMK PP Negeri Kutacane through the application of the Connected Mathematics Project (CMP) model, the results of this study can be explained in two cycles that were carried out.

1. Pre Cycle

Before the research began, an interview was conducted with Mrs. Vera Khairani, S.Pd, a grade X mathematics teacher at SMK PP Negeri Kutacane. From the interview, it was found that mathematics is a very difficult subject for students, and the mathematics learning process at this school is still felt to be far from expectations. Several inhibiting factors are students' lack of focus in following the lesson, students' tendency to talk to their deskmates, and students' confusion when given questions so that many cheat without understanding the steps to solve them. The method often used by teachers is the lecture method, which turns out to be not effective enough in improving students' mathematical reasoning abilities. This shows that there is a need to improve the learning methods used to better support the development of students' adaptive reasoning.

2. Classroom Action Research Analysis Cycle 1

In the first cycle, learning planning was carried out by compiling a Learning Implementation Plan (RPP) that focused on learning the geometry of spatial shapes, especially calculating the area and volume of cubes. Learning implementation was carried out using the Connected Mathematics Project (CMP) model. Based on observations during cycle I, the following results were found:

a. Planning

In cycle I, the researcher has prepared: A learning implementation plan with indicators of success in the research, Facilities and supporting tools that will be needed in the research and Instruments to be able to record and analyze each process and the results of each action.

b. Implementation in Action

The first cycle has been carried out on November 9, 10, and 12, 2024 for 2 x 45 minutes. The learning model that will be used is the Connected Mathematics Project (CMP) model. The learning process in this meeting was carried out first with students praying together before carrying out the learning and then the teacher took attendance of the students. After that, the

teacher conveyed the main title of the discussion material in the learning with indicators in the Learning Implementation Plan (RPP) in Cycle I. The main topic of the material studied was calculating the Area and Volume of a cube. And the researcher motivated the students so that the students were enthusiastic about learning and provided apperception to remind them of the material on the cube. By reminding them of the material that had been studied, the researcher asked the students and the students participated in answering questions posed by the researcher. The researcher also provided an opportunity for students who did not understand and the researcher would repeat the explanation of the material that had not been understood by the students sufficiently. Then the researcher asked the students to create study groups that had been created randomly by the researcher. After all the students got a group, the researcher explained how to work in groups and students were advised to be responsible for their respective groups. The researcher distributed the question sheets to students in each group to be studied together with their group. The classroom atmosphere seemed active when each group understood the questions so that only a few students did not discuss and they tried to understand and ask each other questions, so that many talked and some joked with other group members until the researcher also gave directions again about how to work and responsibilities in each team. The students who spoke and the students who joked began to understand and comprehend and follow the discussion seriously. The class that previously seemed crowded with many telling stories and joking now turned into a conducive one so that the discussion went well. The researcher told the students that in each group there should be a series of activities such as the steps that had been given by the researcher. The researcher gave directions to the students so that all group members must participate in the discussion. The researcher provided guidance to each group that had difficulty in doing the exercises if necessary and the group leader and group members presented the results of their group or informed the researcher if there were obstacles experienced by their group, after the specified time was up, the researcher asked the group leader to come forward as a representative of his group to present the results of his discussion. The researcher gave other groups to respond or ask questions to the group that was presenting their group results. The researcher gave appreciation to students who had presented their discussion results. The researcher told the groups to return to their seats. When all presentations were complete, the researcher gave an evaluation test to students to be done individually. After that, the researcher ended the lesson and the researcher asked the students to read a prayer and the researcher closed the learning by reading Basmallah and saying greetings and greetings were answered by all students.

The conclusion of the learning carried out, students were divided into groups that had been determined randomly, and each group was given questions that had to be discussed together. Although the classroom atmosphere became more active after the direction and clarification from the researcher, there were still some obstacles, including students who did not participate actively and often diverted attention. However, even so, there were some students who began to dare to give opinions and ask questions.

c. Observation Results Cycle I

The results of observations obtained by researchers in cycle I are as follows: Students are not making maximum use of the time provided, not all students are active in giving their opinions and are still shy to ask their friends in the group when the discussion is taking place, so that only a few students dare to explain verbally to their friends and only a few dare to ask the researcher and when students answer questions in a hurry so that there is no time to discuss with their respective groups so that they rely on their own answers, sometimes many of their answers are wrong.

Thus, the observation results show that although there is an increase in student participation, there are still many students who do not make maximum use of their time. Some students are

still embarrassed to ask questions or give opinions during group discussions. There are also some students who prefer to answer questions in a hurry without sufficient discussion with their group, which leads to less precise answers.

d. Reflection Results on Cycle I

In the implementation of learning using the Connected Mathematics Project model in cycle I, there are still many shortcomings that must be corrected by researchers. Based on the data obtained, researchers and teachers need to hold discussions so that they can draw conclusions about things that have not been achieved in cycle I and need to be fixed, namely: 1. Student cooperation in their groups has not been achieved as expected, so that their discussion activities have not run smoothly as expected, 2. There are still many students who are busy themselves and many students talk to other groups and many students are less brave to ask researchers so they are less active in giving their opinions or less brave in commenting on their friends' answers. Only a few students are starting to dare to ask and give their opinions. 3. The allocation of time is not perfectly organized, so students feel that the time given by the researcher is not enough. 4. The explanation given by the researcher to students is still incomplete, so that students do not understand the material given by the researcher. 5. The learning outcomes of students in cycle I have not all achieved the success indicators expected by the researcher. In cycle I that has been carried out by the researcher, the results are not optimal so that cycle II is needed.

In conclusion, based on reflection after cycle I, there are several problems that need to be fixed in the next cycle. Among others:

a. Cooperation between students in groups is not optimal, which causes discussions to not run smoothly.
b. Some students still tend to talk to their group mates without focusing on the discussion material.
c. The irregular allocation of learning time causes some students to feel that the time available is not enough.
d. The explanation of the material given by the researcher is still not complete enough, so that some students find it difficult to understand the material.

3. Cycle II Research Analysis

Based on the reflection and analysis of the first cycle, improvements were made in the second cycle by preparing a more mature plan. The second cycle was carried out on November 16, 17, and 19, 2024, using the same time (2x45 minutes per meeting).

a. Planning

With the second cycle, researchers and mathematics teachers at SMK PP Negeri Kutacane together prepared: Plans for implementing their learning with better research success indicators than the previous cycle, Facilities with supporting facilities needed in the classroom when learning takes place. And provide instruments to record and analyze the research process with the results of its actions.

b. Implementation of action

The results of the research in cycle I can be seen that the target of this research has not been maximally successful so it needs to be continued to cycle II. When cycle I was not optimal so it will be improved in cycle II. Cycle II was carried out on November 16, 17 and 19, 2024 with a time allocation of 2x45 minutes at each meeting. Learning was carried out using the Connected Mathematics Project model and the learning process in cycle II began with students

praying before studying and continued by the researcher by taking attendance of students. Then the researcher wrote the main topic of the material at this meeting and conveyed the indicators in the RPP in Cycle II. The material studied in cycle II is Calculating the area and volume of cuboids. The researcher motivated students and gave stimulating questions on the material studied to students to recall the cube material in cycle I. By reminding students about the material that had been studied previously, students participated in answering questions given by the researcher. The researcher gave students the opportunity to ask questions for students who did not understand the material and the researcher repeated the explanation to the students. Then the researcher divided the students' study groups as had been done in cycle I. The researcher explained to the students that each group would carry out activities according to the stages that had been carried out in the previous cycle I. The researcher gave appreciation to all group members who had to participate when learning took place by discussing. The researcher guided the students evenly to the group of students who had difficulty in the learning process and the group leader gave or conveyed to the researcher when they encountered obstacles felt by members of their group, when the discussion time was up, the researcher asked one of the students to come forward as a representative of their group to present the results of their group's work. They were very happy to be able to come forward to present the results of their group discussions, this was evidenced by the many students who raised their hands who wanted to be representatives of their group to come forward to present the results of their group discussions. The researcher gave students the opportunity to respond to the results of other group presentations. In this cycle II, students asked many questions to students who were presenting their groups, so the researcher helped them to condition who would ask questions. After the time was up, the researcher asked the groups that had completed their presentations to return to their original seats. When everything was finished, the researcher gave an evaluation test sheet that was done by students individually. The researcher distributed response questionnaires to students regarding the learning that had been done and asked students to be honest in filling them out. When students filled out the questionnaire given by the researcher, the researcher gave directions to the students to improve their learning at home. After that, the researcher ended the lesson by asking one of the students to read a prayer and the researcher gave a greeting and the researcher's greeting was answered by all students.

In conclusion, just like the first cycle, the second cycle begins with a joint prayer, student attendance, and reminders of previously studied material (cubes). However, in the second cycle, the researcher improved several aspects, including:

1. Increasing student motivation by giving awards to active students.
2. Providing a clearer and more structured explanation of the material on calculating the area and volume of cuboids.
3. Managing time better so that group discussions and presentations can run smoothly.

c. Observation Results in Cycle II

The results of the observations obtained by the researcher in cycle II are as follows: 1. The researcher has increased student motivation from the way they direct and guide them when they start to lose their enthusiasm for learning and sometimes feel lazy to learn. 2. Students can understand the material that has been given when the researcher's delivery is clear and good. 3. Time allocation can be used usefully and well by the researcher and students. 4. Students are seen to be active and brave in giving opinions and brave in asking their friends in the group and to the researcher when their discussion takes place. 5. Students answer questions by being seen discussing with their group members so that the discussion goes well.

Thus, it was concluded that in the second cycle, the observation results showed significant improvements:

1. Student Motivation: Students appeared more motivated, as seen from their enthusiasm in answering questions and discussing in groups.
2. Understanding the Material: Clearer and more structured explanations helped students to better understand the material being taught.
3. Time Allocation: Time was used more effectively and efficiently, with each group having enough time to discuss and complete their assignments.
4. Student Activities: Students showed greater courage to give opinions, ask questions, and discuss with group members and with researchers. Group discussions ran more smoothly and productively compared to the first cycle.

d. Reflection Results

At this stage, the researcher conducted a reflection with the results of the reflection in cycle II as follows: 1. The researcher can increase students' learning motivation by giving awards so that students can understand and do not get difficulties when students follow the teaching and learning process in the classroom. 2. Students are seen actively giving opinions and have dared to ask questions to their friends in their groups when their discussions are taking place. 4. By answering questions, students are seen discussing with their group members so that the discussion takes place well. 5. Students' learning outcomes have obtained the expected indicators of success.

In conclusion, in the second cycle, reflection shows that:

1. Increased Motivation: The researcher succeeded in increasing student motivation by giving awards to active and successful groups.
2. Student Activeness: Student activeness in discussions and asking questions increased, they were more courageous in expressing opinions and discussing with group members.
3. Learning Outcomes: Student learning outcomes in the second cycle showed significant improvement, with many students successfully achieving the established success indicators (score ≥ 75).

Discussions

The results of this study highlight the significant improvement in student learning outcomes and adaptive reasoning abilities when applying the Connected Mathematics Project (CMP) model, compared to the traditional lecture-based approach. The following discussion presents a comparison of the research findings with similar studies, emphasizing the strengths and areas for further improvement.

a. Pre Cycle

In the pre-cycle, the researcher recruited initial data in the form of daily scores for basic cube material (calculating area and volume) for class X students of SMK PP Negeri Kutacane in the 2024-2025 academic year. The researcher also asked permission from the teacher to give an initial test of students' abilities regarding the material to be studied. Because the material about cubes has been studied before in junior high school. The average score of class X SMK PP Negeri Kutacane in the 2024-2025 academic year was 53.71 with a classical completion result of 9%. The learning outcomes obtained with classical completion in the pre-cycle were:

Table 1. Pre-cycle values

Learning outcomes	Classical completion
53.71	9%

b. Cycle I

The implementation of cycle I is 3 days on Monday, Wednesday and Thursday, December 9, 11 and 12, 2024. On the first day, the researcher provided material in a brief way regarding the definition of a cube, area and volume formulas. After that, the students were asked by the researcher to do the exercises individually. And at the second meeting, the researcher asked the students to find the suitability of the groups that had been determined in the implementation of learning with the Connected Mathematics Project model. With each group, students worked on questions and concepts about the main material of cubes (calculating area and volume). After that, the use of the Connected Mathematics Project Model was carried out. After the implementation of the Connected Mathematics Project model was complete, the researcher asked the students to sit back in their original places. The third meeting was for students to work on the evaluation test carried out by students individually. From the data obtained, the average value of student learning outcomes was 61.38 with a classical percentage of completeness of 47.61%. This can be seen from the researcher's observations. From the results of the average student learning scores in cycle I, it can be seen that the success indicators of the researcher have not been achieved as expected with the average learning outcome score being ≥ 65 and the classical completeness being ≥ 75%, so it is necessary to continue to cycle II.

Complete details can be seen in the following table:

Table 2. Comparison of the results of the values from the pre-cycle and cycle I

	Pre cycle values	Cycle I Value
Learning outcomes	53.71	61.38
Classical completion	9%	47.61%

c. Cycle II

The implementation of the second cycle is also 3 days on December 16, 17 and 19, 2024. On the first day, the researcher informed the students who got the highest score, after that explained the material briefly and clearly about the definition of a cuboid, the formula for the area and volume of a cuboid, and how to calculate the area and volume of a cuboid. then students work on the practice questions that will be done independently and individually. The second meeting, the researcher asked students to find the suitability of the group that had been determined in the implementation of learning with the Connected Mathematics Project model. With each group, students work on questions and concepts about the main material of cubes (calculating area and volume). After that, the use of the Connected Mathematics Project Model was carried out. After the implementation of the Connected Mathematics Project model was complete, the researcher asked students to sit back in their original places. The third meeting was for students to work on the evaluation test given by the researcher and the students worked on it individually. The implementation in the second cycle has gone well. This can be seen in the increase in the average value, which is 84.19 and classical completeness, which is 76.19%.

Tabel 3. Pre-cycle, cycle I and cycle II improvement gains

	Pre cycle	Cycle I	Cycle II
Learning outcomes	53.71	61.38	84.19

Classical completion	9%	47.61%	76.19%

From the data, it can be seen that student learning outcomes have increased and have reached the success indicators set by the researcher, namely the average value of learning outcomes ≥75 and classical completeness ≥75% so that cycle II is considered sufficient, so the research was stopped only until cycle II. And it turns out that the application of the Connected Mathematics Project model can improve the learning outcomes and adaptive reasoning of class X students at SMK PP Negeri Kutacane in the 2024-2025 academic year.

This research aimed to assess the effectiveness of the Connected Mathematics Project (CMP) model in improving the adaptive reasoning abilities of Class X students at SMK PP Negeri Kutacane. The results showed a clear progression in student performance from the pre-cycle to Cycle II, with significant improvements in both learning outcomes and classical completion rates.

In the pre-cycle, the average score of 53.71 with a classical completion rate of only 9% highlighted a significant gap in students' understanding of the basic cube material. This result aligns with the challenge of engaging students who had prior exposure to the topic but struggled to apply their knowledge effectively. The low initial performance indicated the need for a more interactive and engaging teaching approach.

Cycle I introduced the CMP model, which shifted the learning environment to a more collaborative and problem-solving-based approach. Although improvements were observed, with the average score rising to 61.38 and classical completion increasing to 47.61%, the results did not meet the success indicators set for this phase. This suggests that while CMP began to show promise, further refinement and adaptation were necessary to fully engage students and enhance their reasoning abilities.

In Cycle II, the implementation of the CMP model showed substantial improvements. The average score increased to 84.19, and classical completion rose to 76.19%, meeting the desired benchmarks. These outcomes suggest that the CMP model was effective in fostering a more active learning environment, where students were able to connect mathematical concepts to real-life situations. The group's collaborative efforts, combined with individual assessments, allowed for deeper engagement with the material and demonstrated the benefits of the CMP model in improving student performance and adaptive reasoning.

The findings of this study indicate that the CMP model is a promising alternative to traditional lecture-based teaching methods. It not only improved student learning outcomes but also encouraged active participation, which is essential for developing adaptive reasoning. The positive response from students about the relevance of real-world problems in the learning process further supports the effectiveness of the CMP model.

While the results are promising, they also suggest that there is room for continued development. Although adaptive reasoning improved, the level of improvement was categorized as moderate, indicating that further adjustments to the teaching approach may be needed to achieve even greater gains. Further studies could explore additional strategies or extended implementation periods to enhance these outcomes.

Overall, this research contributes to the growing body of evidence supporting the use of the CMP model as an effective teaching strategy for improving adaptive reasoning in mathematics. It offers valuable insights for educators looking to implement more engaging, student-centered learning approaches in the classroom.

1. Pre-Cycle vs. Cycle I: Early Improvements

In the pre-cycle, the students' average score was 53.71, with only 9% achieving classical completion. This suggests that, despite prior exposure to the cube material in junior high school, the students struggled to apply their knowledge effectively. This initial low performance aligns with findings in other studies, such as those by Nilimaa (2023), which emphasized the difficulty students face when transitioning from basic knowledge to problem-solving skills. The need for a more interactive teaching approach was evident, and the introduction of the CMP model in Cycle I began to address this issue. In Cycle I, the average score increased to 61.38, and classical completion rose to 47.61%, marking an improvement. However, the success indicators were not met, highlighting the necessity for further refinement of the teaching approach. Similarly, research by Kersting, et al. (2023) observed that initial implementations of inquiry-based models, like CMP, show early signs of improvement, but additional cycles are often required for significant breakthroughs in student engagement and understanding.

2. Cycle I vs. Cycle II: Substantial Gains

The most significant improvements occurred in Cycle II, where the average score reached 84.19, and classical completion jumped to 76.19%. These results indicate that the changes implemented in Cycle I were effective and that refining the learning process led to substantial improvements. This trend mirrors findings from similar research, such as that by Chen (2022), which found that iterative cycles of inquiry-based learning, like CMP, contribute to better learning outcomes and greater student participation. The shift in learning from individual exercises to collaborative group work in Cycle II helped engage students more deeply with the material, supporting the argument that collaborative problem-solving enhances understanding (Ruddin, 2024).

3. Impact of Collaborative Learning on Adaptive Reasoning

The improvement in adaptive reasoning, although categorized as moderate, reflects the positive impact of collaborative learning in the CMP model. Research by Purwandari, et al. (2024) suggests that students working in groups tend to improve their problem-solving skills and adaptive reasoning abilities, as they are encouraged to explain their thinking and confront different perspectives. In this study, the increased student interaction and discussion during group work in Cycle II likely facilitated deeper cognitive engagement with mathematical concepts. Students not only solved problems but also refined their reasoning as they articulated their thought processes to peers, leading to improved conceptual understanding.

4. Comparison with Lecture-Based Learning

The results of this study contrast sharply with traditional lecture-based methods, which are often teacher-centered and passive for students. In the pre-cycle, the low engagement and understanding in students suggested that traditional teaching methods were ineffective. This supports previous studies (e.g., Izzatul, 2024), which found that traditional lecture methods rarely foster adaptive reasoning or active student participation. Conversely, the CMP model's emphasis on real-world problems and collaborative learning led to increased student activity and participation, supporting the effectiveness of student-centered approaches in developing adaptive reasoning.

5. Student Perceptions and Feedback

Another significant finding from this research is the positive feedback from students regarding the CMP model. Students found the learning process enjoyable and engaging, particularly because it involved real-life applications. This positive perception aligns with findings by Darma, et al. (2022), who reported that students often respond better to collaborative and

problem-based learning environments, as they find the content more relevant and engaging. The use of real-world contexts in the CMP model helped students connect abstract mathematical concepts to everyday life, fostering both engagement and deeper understanding.

In conclusion, the implementation of the Connected Mathematics Project (CMP) model in this study significantly improved students' learning outcomes and adaptive reasoning abilities. Compared to traditional methods, CMP created a more dynamic, interactive learning environment that encouraged student engagement and collaboration, resulting in better academic performance. Although the improvement in adaptive reasoning was moderate, it suggests that the CMP model is a promising strategy for fostering deeper learning in mathematics.

The research also indicates that further adjustments are needed to fully optimize the CMP model's impact on student learning. For example, more extended implementation periods and additional strategies, such as differentiated group tasks or more targeted support for struggling students, could potentially enhance the outcomes further. These findings contribute to the growing body of evidence supporting the use of student-centered learning models like CMP in improving adaptive reasoning in mathematics education.

CONCLUSION

Based on the results of the research that has been done with a discussion of the research data using the Connected Mathematics Project model with an effort to improve the adaptive reasoning of class X students at SMK PP Negeri Kutacane, it can be concluded as follows: The improvement of students' adaptive reasoning abilities with the CMP model is better than the lecture method commonly used by teachers and Students give a positive response to mathematics learning using the Connected Mathematics Project (CMP) model. Students think that learning with this model is very enjoyable because they are given several problems related to everyday life so that students are active during the learning process. So based on the results of the research and discussion obtained using the Connected Mathematics Project (CMP) model, namely: Based on the results of the study using the Connected Mathematics Project (CMP) model, it can improve the adaptive reasoning abilities of class X students at SMK PP Negeri Kutacane, so that the Connected Mathematics Project (CMP) learning model can be one of the choices of learning models in mathematics lessons applied by teachers in class and the improvement of adaptive reasoning in students through the Connected Mathematics Project (CMP) model is included in the moderate category, so that further efforts are needed so that students' adaptive reasoning abilities increase for the better.

ACKNOWLEDGMENTS

I would like to express my sincere gratitude to my advisor for their invaluable guidance throughout this research. My appreciation also goes to SMK PP Negeri Kutacane for granting permission and providing the necessary facilities, and to the Class X students for their active participation. I hope the findings of this research will contribute to enhancing adaptive reasoning skills in students and further development of teaching methods like the Connected Mathematics Project (CMP). Thank you all for your support.

REFERENCES

Ariati, C., & Juandi, D. (2022). Kemampuan penalaran matematis: Systematic literature review. *LEMMA: Letters Of Mathematics Education, 8*(2), 61-75. https://ejournal.upgrisba.ac.id/index.php/jurnal-lemma/article/view/5745

Chen, J. (2022). Cognitive Mapping for Problem-based and Inquiry Learning: Theory, Research, and Assessment (1st ed.). Routledge, https://doi.org/10.4324/9781003305439.

Darma, I., Karma1., & Santiana, I. (2022). Inovasi Pembelajaran Matematika Bagi Pendidikan Vokasional dengan Blended Learning Masa Pandemi Covid-19. *PRISMA, Prosiding Seminar Nasional Matematika*, *5*, 162-176. Retrieved from https://journal.unnes.ac.id/sju/prisma/article/view/54091.

Diniyah, A. N., et al. (2018). Analisis kemampuan penalaran dan self confidence siswa SMA dalam materi peluang. *Journal on Education, 1*(1), 14-21, https://doi.org/10.31004/joe.v1i1.5.

Farida, A., Rois, S., & Ahmad, E. S. (2023). *Sekolah yang menyenangkan: Metode kreatif mengajar dan pengembangan karakter siswa*. Nuansa Cendekia, Bandung.

Fathurrohman, M. (2017). *Belajar dan pembelajaran modern: Konsep dasar, inovasi dan teori pembelajaran*. Garudhawaca, Yogyakarta.

Fitriatien, S. R., Leksono, I. P., & Prayogo, P. (2021). Pengaruh model pembelajaran connected mathematics project (CMP) terhadap kemampuan pemecahan masalah matematis siswa SMP. *Proximal: Jurnal Penelitian Matematika dan Pendidikan Matematika, 4*(2), 48-55, https://doi.org/10.30605/proximal.v4i2.1243.

Hadi, S., & Novaliyosi, N. (2019). *TIMSS Indonesia (Trends in International Mathematics and Science Study)*. Prosiding Seminar Nasional & Call For Papers, https://jurnal.unsil.ac.id/index.php/sncp/article/viewFile/1096/754.

Hamzah, A. M. (2023). Trends in International Mathematics and Science Study (TIMSS) as a measurement for students' mathematics assessment development. *Waiheru, 9*(2), 189-196, https://doi.org/10.47655/12waiheru.v9i2.144.

Harisuddin, M. I., & M. Pd, S. T. (2019). *Secuil esensi berpikir kreatif & motivasi belajar siswa*. Pantera Publishing, Bandung.

Izzatul, Amirah (2024) *Penerapan Model Pembelajaran Accelerated Learning Berbantuan Media Autograph Terhadap Kemampuan Penalaran Adaptif Dan Literasi Lingkungan.* Diploma Thesis, Uin Raden Intan Lampung. https://repository.radenintan.ac.id/id/eprint/32796

Kersting, M., Karlsen, S., Ødegaard, M., Olufsen, M., Kjærnsli, M., & Suhr Lunde, M. L. (2023). Studying the quality of inquiry-based teaching in science classrooms. A systematic video study of inquiry-based science teaching in primary and lower-secondary schools. *International Journal of Science Education*, *45*(17), 1463–1484. https://doi.org/10.1080/09500693.2023.2213386

Krisnadi, E. (2022). Pemanfaatan alat peraga matematika sebagai jembatan proses abstraksi siswa untuk pemahaman konsep. *Prosiding Temu Ilmiah Nasional Guru, 14*(1), 365-376, https://conference.ut.ac.id/index.php/ting/article/view/579.

Nilimaa, J. (2023). New Examination Approach for Real-World Creativity and Problem-Solving Skills in Mathematics. *Trends in Higher Education*, *2*(3), 477-495. https://doi.org/10.3390/higheredu2030028

Nurlan, F. (2019). *Metodologi penelitian kuantitatif*. CV. Pilar Nusantara, Semarang.

Purwandari, W., Safitri, I. N. ., & Karimah, M. M. . (2024). Eksplorasi Hakekat Pembelajaran Matematika di Madrasah Ibtidaiyah dalam Konteks Kurikulum Merdeka. *Indonesian Research Journal on Education*, *4*(4), 1045–1060, https://doi.org/10.31004/irje.v4i4.1130

Rohmah, S. N. (2021). *Strategi pembelajaran matematika*. UAD PRESS.

Ruddin, R. H. (2024). Pengaruh Model Pembelajaran PjBL Terhadap Hasil Belajar Siswa Di SMK Negeri 7 Makassar. *Jurnal MediaTIK*, *7*(3), 41–47. Retrieved from http://journal.unm.ac.id/index.php/MediaTIK/article/view/4428.

Sihombing, Y. Y. (2021). Upaya peningkatan hasil belajar pendidikan agama islam dan budi pekerti melalui penggunaan media audio visual dalam pembelajaran daring pada siswa. *JRTI (Jurnal Riset Tindakan Indonesia),* *6*(2), 187, http://dx.doi.org/10.29210/30031124000.

Utomo, A. P., et al. (2018). Students' errors in solving science reasoning-domain of Trends in International Mathematics and Science Study (TIMSS). *Jurnal Pendidikan IPA Indonesia, 7*(1), 48-53, https://doi.org/10.15294/jpii.v7i1.11352.

Yaqin, A., Noor, N. A., & Misbahudin, M. (2020). Peningkatan hasil belajar matematika materi segiempat melalui metode guided discovery learning. *Prosiding Seminar Nasional Pendidikan STKIP Kusuma Negara III*, https://jurnal.stkipkusumanegara.ac.id/index.php/semnara2020/article/view/755.

Wasis, S. (2022). Pentingnya penerapan merdeka belajar pada pendidikan anak usia dini (PAUD). *Pedagogy: Jurnal Ilmiah Ilmu Pendidikan,* *9*(2), 36-41, https://doi.org/10.51747/jp.v9i2.1078.