

## STUDENT'S MATHEMATICAL CRITICAL THINKING ABILITY THROUGH THE APPLICATION OF CREATIVE PROBLEM SOLVING MODEL ASSISTED OPEN-ENDED APPROACH

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Received 13 May 2023; Received in revised form 29 August 2023; Accepted 16 September 2023

### Abstrak

Penelitian ini bertujuan untuk melihat peningkatan kemampuan berpikir kritis matematis siswa dengan menggunakan model *Creative Problem Solving* (CPS) berbantuan pendekatan *Open-Ended* (OE). Penelitian ini dilatarbelakangi oleh rendahnya kemampuan dalam menemukan solusi pemecahan masalah pada soal sehingga menyebabkan kemampuan berpikir kritis matematis siswa ikut rendah. Perlu dilakukan inovasi pembelajaran, salah satunya melalui implementasi model CPS. Model *Creative Problem Solving* (CPS) menekankan pada kemampuan pemecahan masalah yang harus dimiliki oleh siswa melalui 4 tahapan: klarifikasi masalah, penyampaian pendapat, evaluasi dan pemilihan, serta implementasi. Penelitian ini disertai dengan pendekatan *open-ended* sehingga membantu siswa dalam menyelesaikan masalah secara terperinci. Penelitian ini menggunakan jenis *quasi experiment* dengan desain *pretest-posttest control group* materi volume kubus dan balok. Penelitian ini dilaksanakan di dua kelas yaitu kelas VA dan VB dengan jumlah sampel masing-masing kelas sebanyak 19 siswa dari total populasi 58 siswa yang dipilih secara random. Instrumen penelitian yang digunakan yaitu melalui butir tes essay sebanyak 5 butir soal. Berlandaskan hasil uji T diperoleh nilai  $\text{Sig. } 0,000 > \alpha (0,05)$  dengan rata-rata *pretest* sebesar 47,42 dan rata-rata *posttest* sebesar 86 dengan peningkatan sebesar 38,58. Hal ini menandakan bahwa model CPS dengan pendekatan OE berhasil meningkatkan kemampuan berpikir kritis matematis siswa kelas V.

**Kata kunci:** Kemampuan berpikir kritis matematis, model *creative problem solving*; pendekatan *open-ended*, volume kubus dan balok

### Abstract

This study aims to see the improvement of students' mathematical critical thinking skills by using the *Creative Problem Solving* (CPS) model with an *Open-Ended* (OE) approach. This research is motivated by the low ability to find problem solving solutions to problems that cause students' mathematical critical thinking skills to be low. Learning innovation needs to be done, one of which is through the implementation of the CPS model. The *Creative Problem Solving* (CPS) model emphasizes problem solving skills that must be possessed by students through 4 stages: problem clarification, expression of opinions, evaluation and selection, and implementation. This research is accompanied by an *open-ended* approach that helps students solve problems in detail. This research uses a type of *quasi experiment* with a *pretest-posttest control group* design on the volume of cubes and beams. This research was conducted in two classes, namely VA and VB classes with a sample size of 19 students from a total population of 58 students selected randomly. The research instrument used is through essay test items as many as 5 questions. Based on the results of the T test, the value of  $\text{Sig. } 0.000 > \alpha (0.05)$  with an average *pretest* of 47.42 and an average *posttest* of 86 with an increase of 38.58. This indicates that the CPS model with the OE approach succeeded in improving the mathematical critical thinking skills of fifth grade students.

**Keywords:** Mathematical critical thinking ability, creative problem solving model; open-ended approach, volume of cube and block.



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DOI: <https://doi.org/10.24127/ajpm.v12i3.7729>

## INTRODUCTION

In line with the development of technology, character isn't the only thing that is developed by schools, but is able to develop students' thinking ability as a preparation for the 21st century workforce, such as critical thinking ability (Husain, 2023). The current learning implementation emphasizes learning that is carried out creatively in solving existing problems through direct experience to students, especially in mathematics (Adhelacahya, 2023). A progression of efficiently coordinated learning exercises will shape understudies' imagination in tackling issues straightforwardly in regular day to day existence (Salim, 2023). Creative learning can be used repeatedly to solve problems, especially in math (Inganah et al., 2023).

Human resources are considered qualified if they possess a range of skills, including the capacity for decision-making, sophisticated thinking, the development of effective problem-solving techniques, and the capacity for teamwork (Poláková et al., 2023). This means that critical thinking skills are important because they emphasize the discovery of facts based on students' real lives (Witarsa & Muhammad, 2023). Critical thinking cannot be removed from educational institutions because of how crucial it is in resolving issues relating to student learning, particularly in mathematics learning (Siahaan et al., 2023).

Indonesia was ranked 64th out of 72 nations for critical thinking abilities in 2015, according to data from the Program for International Student Assessment (PISA) in mathematics (Mangelep et al., 2023). The poor problem-solving and critical thinking abilities of Indonesian pupils are to

blame for their low PISA scores (Rahmah et al., 2023). This is corroborated by observations collected at SDN 2 Tegalmulyo where fifth-grade pupils studying arithmetic concepts linked to cube and beam volume have a hard time coming up with solutions to the teacher's difficulties. Students only use formulae they have memorized, which means there is only one way to solve a problem. This must be taken into account so that students can think more about diverse issue solving efforts by coming up with original solutions to the difficulties offered.

Critical thinking skills can be improved through the implementation of problem-based learning models. This is because through a problem-based learning model, students can find their own problem-solving solutions (Dakabesi & Luoise, 2019). One of the problem-based learning models that can help students find creative problem solving solutions is through the implementation of the Creative Problem Solving model (CPS). This CPS learning model emphasizes divergent-convergent thinking that centers on providing ideas to students in finding problem-solving solutions (de Vink et al., 2023). Based of research from Maria (2018), this CPS learning model can improve students' critical thinking skills in learning mathematics material on relations and functions.

The Open-Ended (OE) approach will be used with the CPS learning model in this study to ensure that the teacher's problem-solving suggestions are widely disseminated and remain connected to the learning environment that is being given. The Open-Ended (OE) approach will be used with the CPS learning model in this study to ensure that the teacher's problem-solving suggestions are widely

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disseminated and remain connected to the learning environment that is being given (Koriyah & Harta, 2015; Sari et al., 2016).

For every learner, critical thinking abilities are necessary. Therefore, additional research using the CPS model and this OE approach is required in order to generate fresh insights about potential fixes that will enable students to develop their critical thinking abilities and deliver high-quality learning.

## RESEARCH METHOD

The type of research used is quasi experiment with pretest-posttest control group design. The experimental class (EC) was conducted by providing a Creative Problem Solving model with an Open-Ended approach to learning VA class math material on the volume of cubes and beams. The control class (CC) uses the Problem Based Learning model as a model that is often used during VB learning so that no meaningful treatment is given. The study population amounted to 58 students and a sample of 38 students was taken randomly selected with 19 VA class students and 19 VB class students.

This research was conducted on May 2, 2023 to May 9, 2023 in Class V SDN 2 Tegalrejo on mathematics learning material on the volume of cubes and beams. The research instrument used is a test item with a type of essay question in the form of a story with a total of 6 questions. The research instrument used was first tested for the validity of the items at the Sig level. 5% with  $r$  table of 0.433. Of the 6 items tested, the  $t$  value obtained was  $> 0.433$  so that each of the 5 items was declared valid and 1 item was invalid. From the validity test results, the item reliability value is 0, 721 with high reliability criteria.

Data analysis techniques in this study through 2 steps, namely; (1) descriptive analysis, describing the data obtained using numbers obtained from the results before and after treatment in the form of a CPS model with an open-ended approach (2) inferential data analysis, carried out by testing the hypothesis. Inferential analysis through 3 test stages, namely normality test, homogeneity test, and paired sample  $t$ -test with a significant level  $< 0.05$  so that it can be stated that the CPS model with an open-ended approach has an effect on students' mathematical critical thinking skills. The data analyzed were pretest and posttest data of students' mathematical critical thinking skills on the volume of cubes and beams.

## RESULTS AND DISCUSSION

Descriptive analysis is used in the initial analysis. This is done in order to be able to quantify the findings that students made during the research process by examining the means, standard deviation, and variance values. In Table 1, the findings of the descriptive analysis are presented.

Table 1. Descriptive analysis of mathematical critical thinking ability

| Data   | Means | Deviation Standart | Varians |
|--------|-------|--------------------|---------|
| PRE-CC | 47,27 | 6,509              | 42,368  |
| POS-CC | 86    | 6,675              | 44,556  |
| PRE-EC | 46,68 | 6,010              | 36,117  |
| POS-EC | 78,74 | 8,061              | 64,985  |

Based on Table 1, it can be seen that there is an increase in students' mathematical critical thinking skills in both the experimental and control classes. The difference in means of the experimental class before and after the students' mathematical critical thinking ability is 38.73, in the control class the difference in means is 32.06. Looking at

DOI: <https://doi.org/10.24127/ajpm.v12i3.7729>

the difference in posttest between the experimental class and the control class is 7.26. If based on the value in Deviation Standard there is a difference in different and distant results. This indicates that the resulting data is wider. Based on table 1, it can be concluded that the average results of critical thinking skills of the experimental class have higher results than in the experimental class. Indirectly it can prove that the Creative Problem Solving model with an Open-Ended approach helps students more in improving students' mathematical critical thinking ability compared to the Problem Based Learning learning model.

The analysis of inferential data is the next step. Starting with a normality check using the Shapiro-Wilk test, this inferential technique assumes that the data is normally distributed if the Sig value is more than 5%. Table 2 contains the results of the normalcy test.

Table 2. Normality test

| No | Data   | Significance |
|----|--------|--------------|
| 1  | PRE-CC | 0,467        |
| 2  | POS-CC | 0,053        |
| 3  | PRE-EC | 0,613        |
| 4  | POS-EC | 0,638        |

Table 2 indicates that both groups' Sig. values are greater than 5%, indicating that the data in both groups is normally distributed. The following step is to do a homogeneity test. If the Sig. value obtained is more than 5%, then the data is declared to have a homogenous variance. This homogeneity test is used to determine whether the resulting data variance is homogeneous or not. Table 3 shows the results of the homogeneity test.

Table 3. Homogeneity Test

| Data                         | Significance |
|------------------------------|--------------|
| <i>Based On Trimmed Mean</i> | 0,830        |

The obtained significance score is 0.830. This suggests that the generated data's variance is homogeneous. The Independent test is run because it satisfies the parametric assumptions. In order to meet the condition, the 2 tailed significance value must be greater than 5%. If it is, then H0 is approved, meaning that the learning model for creative problem solving with an open-ended approach to students' critical thinking skills has not improved. The learning model for creative problem solving with an open-ended approach to students' critical thinking skills is approved if the 2-tailed significance value attained is less than 5%, though. Ha is indirectly accepted in order for the use of the creative problem-solving model with an open-ended approach to have a good impact on students' critical thinking abilities. Table 4 presents the findings.

Table 4. Independent test

| Data   | T <sub>count</sub> | Df | Sig   |
|--------|--------------------|----|-------|
| POS-EC | 1.531              | 19 | 0,005 |
| POS-CC | 1.849              | 19 | 0,005 |

Based on the results of table 4, it is obtained that each posttest value in both groups has a Sig. < 5%, so it is stated that Ha is accepted and H0 is rejected. Referring to the results of descriptive analysis and inferential analysis proves that the Creative Problem Solving learning model with an Open-Ended approach succeeds in improving students' mathematical critical thinking skills in learning mathematics volume of cubes and beams.

Using research that was done by Effendi (2017); Huda et al (2017) stated that the volume of cubes and beams is one of the materials that is difficult to teach to students. This is because the concepts understood by students are

DOI: <https://doi.org/10.24127/ajpm.v12i3.7729>

only limited to memorizing formulas. This is supported by (Marlina et al., 2019; Mutia, 2017) the teacher's capacity to effectively explain the solution to the formula obtained is still lacking, which contributes to students' difficulty in grasping the volume of cubes and beams material. If students forget the formula, then students become unable to solve the given problem and indirectly imply that students do not have the ability to think critically mathematically in solving the given problem even though they forget the formula.

There needs to be a learning reform in overcoming this, one of which is to provide opportunities for students to think creatively in solving problems in the problem. Creative thinking in solving problems in problems is an important thing. One way to overcome this can be through the implementation of the Creative Problem Solving model. Based on research done by Zulfikar et al (2022) that the CPS model is able to improve students' critical thinking skills in solving problems given by the teacher. CPS model is more effective in improving students' critical thinking skills compared to other problem solving models (Hobri et al., 2020; Manurung, 2021). This is because the CPS model does not only involve students' ability to solve problems, but also increases students' creativity to think in finding solutions to each problem.

The problem clarification stage is where the CPS paradigm is first put into practice. The teacher divides the class into small groups and gives each student a worksheet at the problem clarification stage. The worksheet includes learning resources, learning challenges that the students are attempting to answer, and their solutions. At the problem

clarification step, the teacher clarifies the problems on the worksheet with the students and gives them prompts to help them quickly come up with the best answer. The problem clarification stage helps students to be able to think early and draw students' attention in order to be able to find the right solution to the learning problem presented in the problem (Malahayati, 2017). This is supported by the opinion of Nurdiansyah et al (2021) the problem clarification stage with a good stimulus will make it easier for students to think about finding a solution. At this stage of problem clarification, students give their opinions to the teacher regarding the problem solving solution to the problem.

The problem clarification stage, the majority of students only provide a single solution. The teacher does not just stay silent but takes an open-ended approach to students by organizing learning in solving the problem in detail. This organizing stage is expected to provide open-mindedness to find new solutions. Based on researches by Hendriana et al (2017; Rohmalina et al (2020) that Open-Ended approach is able to help students in improving students' reasoning ability on the stimulus given by the teacher. This is supported by Yanti et al (2019) that the open-ended approach allows students to think creatively in presenting solutions to existing problems. Apparently, during the implementation of learning after being given a stimulus with the Open-Ended approach, students found three solutions in solving learning problems.

The next stage is the openness of students in providing ideas for existing problems. The more ideas given, the more problem solutions will be presented. Research by Aldeirre et al



DOI: <https://doi.org/10.24127/ajpm.v12i3.7729>

(2018) brainstorming can increase students' interest in thinking, if they have different opinions. The brainstorming stage can improve students' ability to think critically (Hobri et al., 2020; Nurhasanah & Djukri, 2019). This brainstorming stage, the teacher provides a stimulus to students that leads to problem-solving efforts from the opinions given by students. Therefore, the next stage carried out by the teacher is evaluating and selecting students' ideas together with other students in order to find the right problem-solving solution.

The effort to evaluate and select ideas aims not only for students to be able to find appropriate problem-solving strategies but also to improve students' thinking skills. At the evaluation and selection stage, students and teachers together discuss the right ideas in solving the problem (Alt, Kapshuk & Dekel, 2023; Asmawati et al., 2018). In its implementation, the teacher can propose a selection of ideas from students that students think are appropriate and students are required to provide reasons for choosing these ideas. The most selected ideas with reasonable reasons can be taken into consideration in choosing the right solution. In this stage, the teacher also uses the Open-Ended approach by directing students and providing guidance to students before deciding to choose ideas in problem solving. This process helps students to have mathematical critical thinking skills in solving problems.

The last stage is the implementation process. This stage provides a decision in choosing the right solution. After being considered correct, then students are given questions by the teacher. Giving questions is done to check whether students' mathematical

critical thinking skills have improved or not.

From the results of the research that has been conducted, it states that the Creative Problem Solving model is able to have a positive influence on students' creative thinking in processing information both obtained through classroom learning and the student environment. Learning is done in detail by presenting an Open-Ended approach so that it can help students in reconstructing knowledge and reasoning. Through the integration between the CPS model and the OE approach, it provides benefits to students in finding the right solution to solve problems in the problem, increasing student activeness, and the main goal is that students' mathematical critical thinking skills will also increase.

## CONCLUSIONS AND SUGGESTIONS

Based on the results of the discussion above, it can be concluded that the CPS learning model with an open-ended approach has a positive influence in improving students' mathematical critical thinking skills. The new thing obtained in this study is not only the improvement of higher-level thinking skills, but students' confidence in exploring various ways to solve problems, the development of creative thinking skills is an ability that develops due to the implementation of the CPS model with this Open-Ended approach.

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