



Enhancing Students Creative Thinking and Self-Confidence through Creative Problem Solving with an Open-Ended Approach

Syarif Hidayatullah^{1*}, Elly Arliani²

¹Master's Program in Mathematics Education, Yogyakarta State University, Indonesia.

²Department of Mathematics Education, Yogyakarta State University, Indonesia.

Abstract

This study aimed to examine the effectiveness of two instructional models the creative problem solving model integrated with an open-ended approach and the direct instruction model employing a scientific approach in enhancing eighth-grade students creative thinking skills and self-confidence. The research adopted a quantitative approach within a quasi-experimental framework, specifically a pretest-posttest nonequivalent control group design. The population comprised all eighth-grade students at a public junior high school in Yogyakarta, Indonesia. Purposive sampling was applied to select classes with comparable academic profiles and initial learning conditions. Data were collected using creative thinking skills test and a self-confidence questionnaire. The findings indicated that the implementation of creative problem solving models with an open-ended approach significantly improved students' creative thinking and self-confidence, as confirmed by one-sample t-test results ($p = 0.000 < 0.05$) and proportion tests ($0.010 < 0.05$ and $0.000 < 0.05$). The direct instruction model with a scientific approach was also effective ($p < 0.05$). A comparative analysis using an independent samples t-test revealed significant differences between the two groups ($p = 0.010 < 0.05$ for creative thinking and $p = 0.000 < 0.05$ for self-confidence), indicating superior effectiveness of creative problem solving model with open-ended tasks. These results suggest that integrating creative problem-solving model with open-ended problem-solving not only enhances cognitive outcomes but also strengthens students' affective development, promoting flexible, creative, and confident learners. This provides a more comprehensive and impactful instructional strategy than conventional direct instruction.

Keywords:

creative problem solving model; open-ended approach; creative thinking skills; self-confidence.

(*) Corresponding Author:

syaridfhidayatullah@student.uny.ac.id

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INTRODUCTION

In the 21st century, education must prioritize the development of students creative thinking skills in order to effectively address complex academic and societal challenges. Creative thinking is crucial for generating innovative ideas and solving problems effectively (Akpur, 2020; Ritter et al., 2020). In mathematics, creative thinking is defined as the ability to generate novel ideas, explore diverse strategies, and apply prior knowledge to unfamiliar problems, and it plays a pivotal role in solving non-routine tasks (Haryani et al., 2021; Toheri et al., 2020). Therefore, fostering students creative thinking skills should be a fundamental goal in preparing them for dynamic, real-world contexts.

In Indonesia, only about 31% of students reach at least basic proficiency (Level 3) in the creative thinking domain of the Programme for International Student Assessment (PISA) 2022, which is significantly lower than the Organisation for Economic Co-operation and Development (OECD) average of 78%. While PISA does not directly measure creativity as a single construct, this domain reflects students' ability to generate

ideas, explore solution strategies, and demonstrate originality in familiar contexts (OECD, 2023). Previous studies have also raised similar concerns. Studies by, Junaedi et al., (2021); Hidajat, (2021) have highlighted frequent deficiencies in originality and flexibility, suggesting that prevailing classroom practices do not adequately provide opportunities for students to engage in complex, divergent, and innovative problem-solving.

In addition to cognitive factors, affective factors such as self-confidence play a crucial role in supporting student's creative thinking abilities (Gunawan et al., 2022; Haase et al., 2018). Self-confidence refers to an individual's belief in their capability to perform tasks and face challenges effectively (Yudiyanto et al., 2024). Students with high self-confidence are more likely to express ideas, try various strategies, and persist in the face of difficulties, while those with low self-confidence may avoid challenges and hesitate to present alternative ideas, thereby limiting their opportunities to generate creative solutions (Çiftçi & Yildiz, 2019; Egorova & Chertkova, 2016; Meriyati et al., 2025).

However, several studies have shown that students' self-confidence in mathematics learning remains relatively low. Kaur & Prendergast, (2022) reported that many students still experience anxiety and pressure when learning mathematics, which negatively affects their confidence in solving mathematical problems. Similarly, Mei et al., (2022) found that approximately one-third of students demonstrated low levels of self-confidence, particularly in the aspect of independent decision-making. These findings suggest that students' low creative thinking skills and self-confidence are influenced by various internal and external factors, including the instructional strategies employed.

In classroom practice, direct instruction and the scientific approach are still widely used by teachers (Stockard et al., 2018; Utemov et al., 2020). This model or approach emphasizes structured learning through teacher explanations and demonstrations, and is effective in developing foundational conceptual understanding as well as ensuring the systematic achievement of learning objectives (Reavey & Zahay, 2022; Thahir et al., 2020). Thus, this model remains relevant in certain contexts depending on the characteristics of the subject matter and the intended learning goals. To strengthen students' creative thinking skills and self-confidence, more adaptive learning approaches are needed in line with current educational demands.

One of them is the implementation of the creative problem solving model. The creative problem solving model is an effective instructional approach for improving problem-solving flexibility and the practical application of creativity in addressing complex challenges (Haylock & Thangata, 2007; Puccio, 1999). This model has been shown to develop students' creative thinking and problem-solving skills, increase active engagement, and promote collaborative learning, thereby contributing positively to mathematics learning outcomes (Faturhman et al., 2020; Sholihah et al., 2020; Yurt, (2025). However, the implementation of creative problem solving has not yet optimally developed creative thinking skills and self-confidence simultaneously (Gunawan et al., 2022; Wicahyono et al., 2018). Therefore, integrating instructional approaches with learning models offers a more holistic alternative, one of which is the combination of the creative problem-solving model and the open-ended approach. The open-ended approach presents problems with multiple valid solution alternatives, thereby encouraging idea exploration, flexible thinking, and solution originality (Mourtos, 2010; Zick et al., 2007). In addition, open-ended tasks are effective in comprehensively assessing creative thinking skills, including fluency, flexibility, originality, and elaboration in students' problem-solving processes. (Sa'idah et al., 2024; Septiani et al., 2022).

Although both the creative problem-solving model and the open-ended approach have been extensively studied, previous research has primarily focused on these strategies separately rather than integrating them systematically within mathematics instruction. For

example Kartikasari et al., (2022) compared their effectiveness without combining strategies, while Widya et al., (2020) focused on creative problem solving to enhance problem-solving and critical thinking, neglecting the potential role of open-ended tasks in fostering students cognitive flexibility and confidence. This gap highlights the need for integrative research.

Therefore, this study presents novelty in the systematic integration of the creative problem solving model with an open-ended approach to simultaneously develop students creative thinking skills, cognitive flexibility, and self-confidence. In addition, this study contributes new insights by examining the effectiveness of this integrated model compared to direct instruction based on a scientific approach in mathematics learning, thereby providing more comprehensive empirical evidence regarding the impact of instructional strategies on both cognitive and affective aspects of students.

METHODS

This study employed a quantitative approach using a quasi-experimental design, specifically a pretest–posttest nonequivalent control group design (Creswell & Creswell, 2022: 179). The population comprised all eighth-grade students in a public junior high school in Yogyakarta, Indonesia. The sample was selected through purposive sampling by considering the equivalence of academic profiles and initial class conditions to ensure relatively comparable group characteristics. The research instruments consisted of a creative thinking skills test and a student self-confidence questionnaire. Data collection was conducted through pretests and posttests in both groups. Data analysis included descriptive analysis to describe data distribution and inferential analysis for hypothesis testing (Creswell & Creswell, 2022).

Hypothesis testing was conducted through several stages. A one-sample t-test was used to examine the achievement of learning mastery in the creative thinking test and standardized self-confidence scores. A proportion test was applied to assess classical mastery of $\geq 75\%$. Learning is considered effective if at least 75% of students achieve the mastery criteria. Furthermore, an independent samples t-test was employed to compare the effectiveness between the experimental and control groups in improving the research variables.

The research process began with conceptualization and the pre-intervention phase. The subjects were divided into an experimental group and a control group, followed by the administration of a pre-test. The experimental group received treatment using the creative problem solving model with an open-ended approach, while the control group used direct instruction with a scientific approach. Subsequently, a post-test was conducted, followed by data analysis, as well as drawing conclusions and reporting the research findings. The research flowchart in this study can be seen in Figure 1.

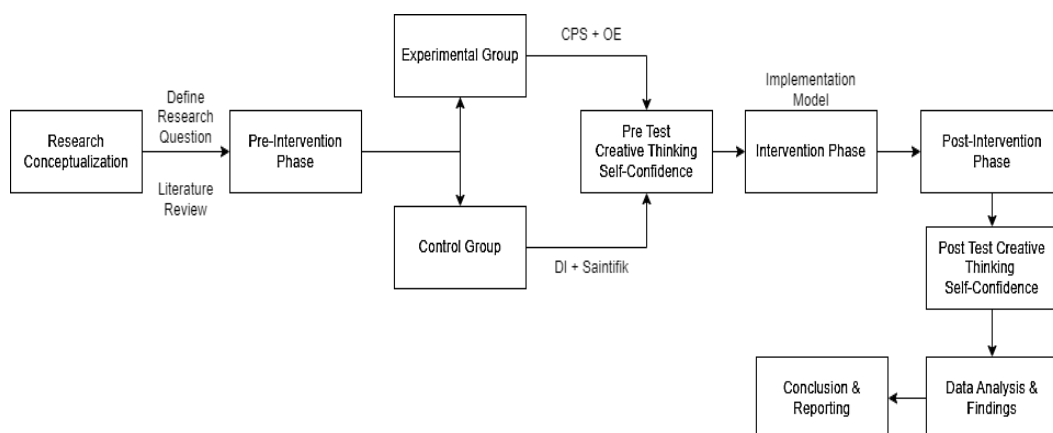


Figure 1. Research Flowchart

RESULTS & DISCUSSION

Results

The data analysis was conducted through prerequisite tests, which included normality and homogeneity tests. The normality test was intended to examine whether the data followed a normal distribution, whereas the homogeneity test was conducted to confirm the equality of variances across groups. To assess multivariate normality, the Henze–Zirkler test was applied at a significance level of $\alpha = 0.05$, and the outcomes are reported in Table 1.

Table 1. Results of the Multivariate Normality Test

Class	Data	Henze–Zirkler	$p - value$	Description
CPS + Open Ended	Pre-test	0,695	0,101	Normal
	Post-test	0,428	0,489	Normal
DI + Saintifik	Pre-test	0,637	0,147	Normal
	Post-test	0,148	0,996	Normal

Based on Table 1, all $p - value > 0.05$; therefore, H_0 is accepted. This indicates that creative thinking skills and self-confidence are multivariately normally distributed in each group. As the assumption is satisfied, univariate normality testing is not required. Furthermore, homogeneity of variance covariance matrices was tested using Box's M test, and the results are presented in Table 2.

Table 2. Results of the Homogeneity Test of Variance Covariance Matrices

Data	Chi-square	P-Value	Description
Pre-test	2.111	0.549	Homogeneous
Post-test	0.873	0.831	Homogeneous

Based on Table 2, the homogeneity analysis of the variance–covariance matrices indicates that both the pretest and posttest data satisfy the assumption of homogeneous covariance matrices. With this assumption met, hypothesis testing was subsequently conducted in a stepwise manner to address the research problems formulated in this study. The results of the hypothesis tests are presented in the following tables.

Table 3. One-Sample t-Test Results for Creative Thinking and Self-Confidence

Class	Variable	Uji T	<i>P-Value</i>
Experimental	Creative Thinking Skills	6,079	0,000
	Self-Confidence	27,504	0,000
Control	Creative Thinking Skills	3,885	0,000
	Self-Confidence	20,807	0,000

Table 4. Results of the Proportion Test for Creative Thinking Skills and Self-Confidence

Class	Variable	<i>Z_{hitung}</i>	<i>P-Value</i>
Experimental	Creative Thinking Skills	2.319	0,010
	Self-Confidence	3.162	0,000
Control	Creative Thinking Skills	1.897	0,028
	Self-Confidence	3,162	0,000

The hypothesis testing results indicate that both the creative problem solving model with an open-ended approach and the direct instruction model with a scientific approach effectively enhance students creative thinking and self-confidence. A subsequent comparative analysis using an independent samples t-test, presented in Table 5, examined the differences in their effectiveness.

Table 5. Results of the Independent Samples t-Test Comparing Creative Thinking Skills and Self-Confidence

Variable	Uji T	<i>P-Value</i>	Description
Creative Thinking Skills	2,1113	0,019	H ₀ Rejected
Self-Confidence	5,869	0,000	H ₀ Rejected

Based on the data analysis and sequential hypothesis testing, the creative problem solving model with an open-ended approach is more effective than the direct instruction model with a scientific approach in enhancing students creative thinking and self-confidence. Superiority test results support this, indicating its potential as an alternative mathematics instructional strategy with ongoing evaluation.

Discussion

The Effectiveness of the Creative Problem Solving Model with an Open-Ended Approach in Terms of Students Creative Thinking Skills and Self-Confidence

After implementing the creative problem solving model with an open-ended approach, we observed improvements in all indicators of creative thinking skills, with the most significant gains in flexibility and originality. These improvements are significant, as these aspects are typically the most challenging to develop through conventional instruction. This finding suggests that integrating the creative problem solving model with an open-ended approach reduces students' reliance on routine procedures and encourages them to come up with more diverse and innovative solutions. In a broader sense, these findings affirm that mathematical creativity can be nurtured through instructional designs that strike a balance between structure and openness. These results are further supported by the findings of Kadir et al., (2022), Rasmuin et al., (2020), and Simanjuntak et al., (2021) which indicate that innovative instructional interventions can significantly enhance students' creativity. Descriptively, the majority of students were classified as moderately creative (62%) or creative (31%), with no students falling into the category of very low creativity.

In addition to creative thinking skills, students' self-confidence improved significantly and consistently, reaching a high category. This improvement encompasses personal dimensions, including self-belief, persistence, and courage, as well as social behavioral aspects such as openness to feedback, respect for others' opinions, and responsibility for learning. The relatively balanced improvement indicates that the learning process was not biased toward specific aspects. These findings suggest that integrating the creative problem-solving model with an open-ended approach is effective in developing self-confidence as a comprehensive affective construct, as it accommodates active engagement, reflection, and social interaction in mathematics learning. These findings are reinforced by Adharini & Herman, (2020), who reported that students self-confidence reached an average of 72% after instructional intervention, with "adaptability and socialization" showing the highest percentage (72.22%) and "confidence in one's abilities" the lowest (58.64%). Furthermore, Rosmawati & Sritresna, (2021); Yuniarti et al., (2023) found that students' self-confidence levels were categorized as very high, reaching 93% across all indicators.

The success of implementing the creative problem-solving model with an open-ended approach is further confirmed by the achievement of classical mastery, where more than 75% of students obtained creative thinking scores above 75 and self-confidence scores above 68. Consistent with Madrasah et al., (2020); Rahayuningsih et al., (2021); Septian et al., (2019), these findings demonstrate that the creative problem-solving model with an open-ended approach effectively reached classical mastery, with more than 70% of students meeting the minimum standards in creative thinking and showing positive attitudes toward mathematics. This success was supported by students' active engagement, flexible thinking, fluency in solving open-ended tasks, and confidence in presenting and defending their solutions.

The Effectiveness of the Direct Instruction Model with a Scientific Approach in Terms of Students Creative Thinking Skills and Self-Confidence

After the implementation of the direct instruction model with a scientific approach, students' creative thinking skills showed a fairly significant improvement. This combination of model and approach was effective in building the foundation of creative thinking, particularly in structured learning contexts. This was reflected in higher achievement in the indicators of fluency and elaboration, which indicate students' ability to develop ideas in a detailed and systematic manner, although it was relatively less effective in encouraging diversity and originality of solutions.

These findings contribute to the broader discourse by demonstrating that different learning models tend to develop different dimensions of creativity. Direct instruction plays an important role in strengthening procedural clarity and conceptual understanding; however, it is relatively limited in facilitating divergent thinking if not combined with more open approaches. Consistent with the findings of Kencanawati et al., (2020); Levinta et al., (2024) after the implementation of the direct instruction model with a scientific approach, the majority of students (71%) were categorized as having moderate creative thinking skills, while a smaller proportion (16.1%) achieved the high category.

In terms of self-confidence, students also showed improvement from moderate to high levels, with higher achievement in personal dimensions, such as confidence in their own abilities, compared to social dimensions, such as appreciation of others' opinions. This suggests that a structured learning environment is more effective in building individual confidence through guided success experiences, but relatively limited in developing self-confidence in social interaction contexts. In line with the findings of Zamnah & Ruswana,

(2019); Sofianti et al., (2021) student engagement in learning through the direct instruction model with a scientific approach strengthens their confidence in understanding concepts and enhances their ability to solve various mathematical problems more independently and systematically.

The results of the proportion test indicate that the implementation of the direct instruction model with a scientific approach resulted in more than 75% of students achieving creative thinking scores above 75 and self-confidence scores above 68. These results are consistent with the studies of Putra et al., (2021); Treffers, (2019) showing that the direct instruction model with a scientific approach successfully achieves classical mastery, with over 75% of students meeting minimum criteria in creative thinking and demonstrating satisfactory self-confidence in mathematics. This success is reinforced by active teacher guidance. Additionally, Salam et al., (2019), further report that direct instruction is particularly effective for students with low self-confidence or learning difficulties, yielding higher average mathematics achievement than integrative approaches.

A Comparative Study on the Effectiveness of the Creative Problem Solving Model Using an Open-Ended Approach and the Direct Instruction Model Employing a Scientific Approach in Enhancing Students Creative Thinking Ability and Self-Confidence

The findings reveal that students creative thinking abilities and self-confidence in the group taught through the creative problem solving model integrated with an open-ended approach surpassed those of students who received instruction via the direct instruction model with a scientific approach. This difference is evident from the average scores obtained in the creative thinking assessment and self-confidence questionnaire, where the creative problem solving group achieved mean scores of 84.58 and 85.10, respectively, while the direct instruction group recorded averages of 80.20 and 80.10. Here is a presentation of several student responses representing each indicator of creative thinking ability.

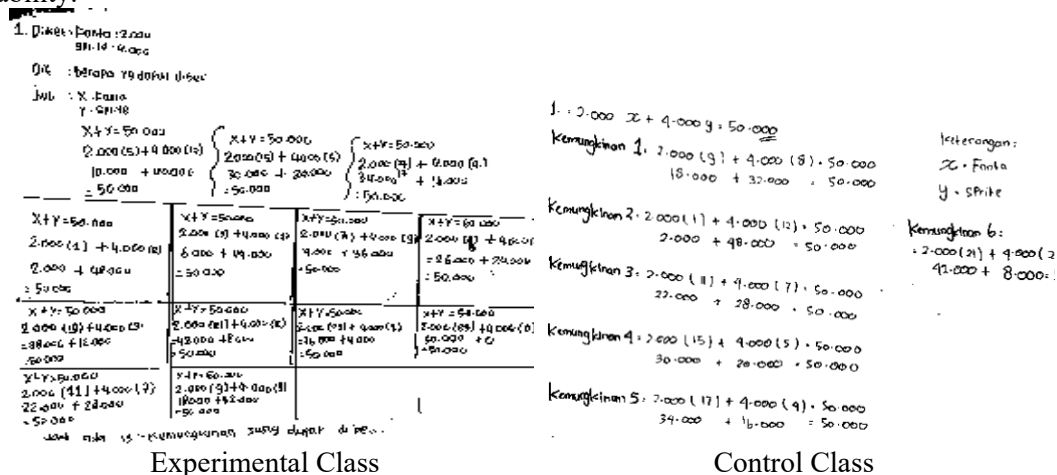


Figure 2. Comparison of Students Responses in the Experimental and Control Classes on the Fluency Indicator

Based on Figure 2, the *fluency* indicator reveals a difference in the level of achievement between the experimental class and the control class. Students in the experimental class were able to present relevant, clear, and relatively complete ideas at

each stage of the problem-solving process, resulting in final answers that met the requirements of the problem. In contrast, students in the control class demonstrated more limited fluency in thinking, characterized by less complete and less systematic ideas in constructing the mathematical model, leading to solutions that were not yet fully comprehensive.

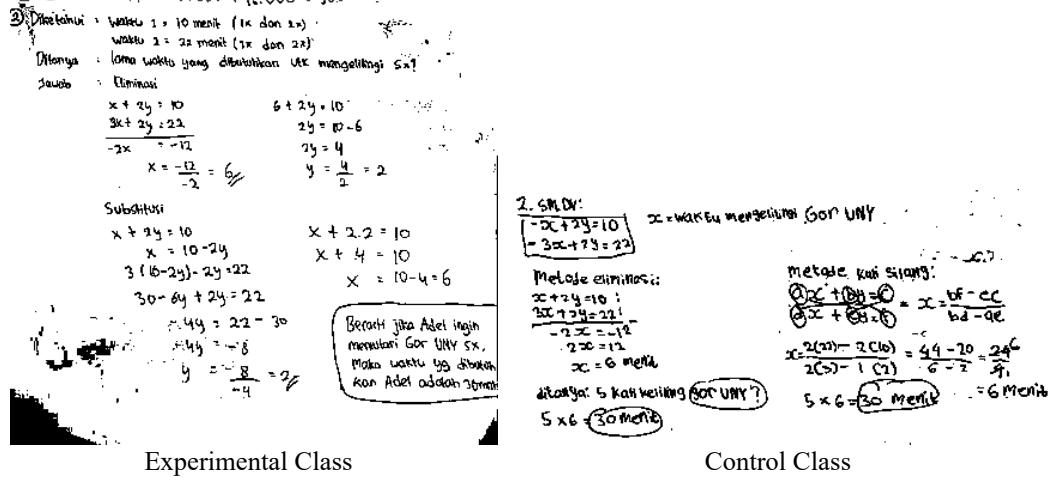


Figure 3. Comparison of Students Responses in the Experimental and Control Classes on the Flexibility Indicator

Based on Figure 3, the *flexibility* indicator shows a difference in the level of achievement between the experimental class and the control class. Students in the experimental class were able to apply various solution strategies appropriately with systematic and accurate calculation steps, resulting in final answers that met the problem requirements, although the mathematical model was not written explicitly. In contrast, students in the control class only reached a moderate level, as the strategies used were not accompanied by variable representation and the conclusions presented were not fully complete.

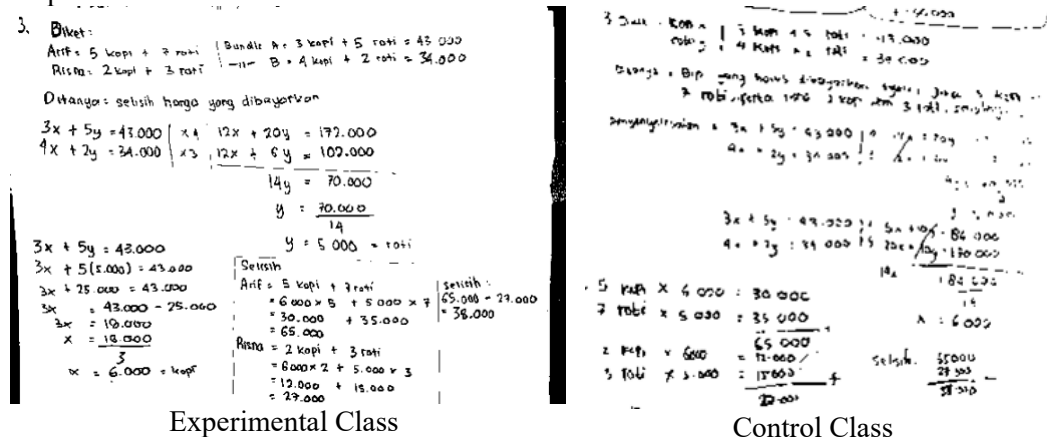


Figure 4. Comparison of Students Responses in the Experimental and Control Classes on the Elaboration Indicator

Based on Figure 4, the *elaboration* indicator in both classes falls within the good category, although with different characteristics. Students in the experimental class were able to provide correct and relatively detailed answers and applied a combination of

elimination and substitution methods, although the mathematical model and final conclusion were not written explicitly. In contrast, students in the control class also produced correct answers, but the solution process was less complete, as the mathematical model and explicit solution steps were not presented, and only a single method, namely elimination, was used.

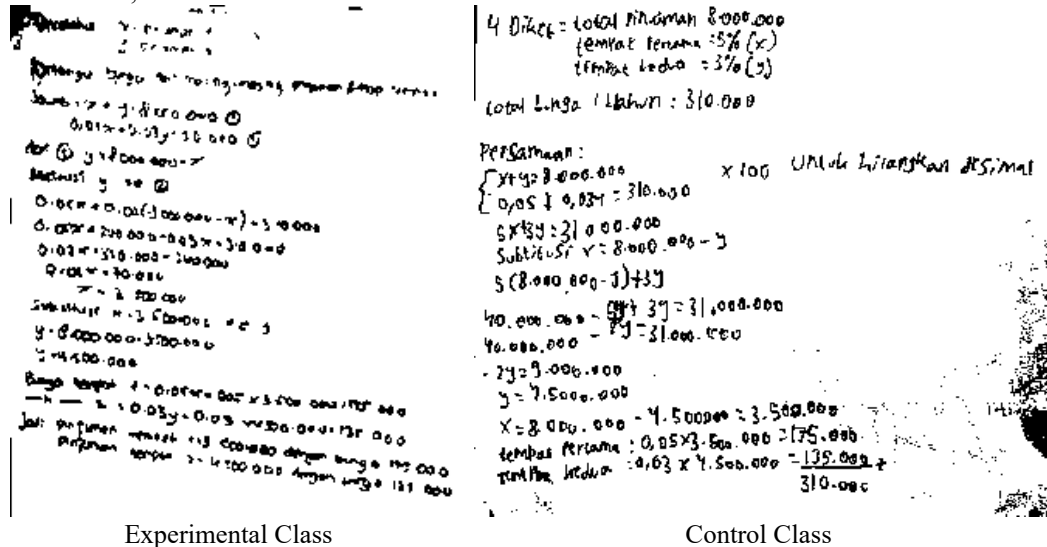


Figure 5. Comparison of Students Responses in the Experimental and Control Classes on the Originality Indicator

Based on Figure 5, the *originality* indicator reveals a difference in achievement between the experimental and control classes. Students in the experimental class demonstrated originality by applying their own solution strategy presented in a logical, systematic, and conceptual manner, accompanied by a relevant final conclusion, although only the substitution method was used. In contrast, students in the control class showed moderate originality, as the solution method was not explicitly explained and no final conclusion was provided, limiting the overall clarity of the solution.

These findings indicate that the creative problem solving model with an open-ended approach effectively enhances students' creative thinking skills. Consistent with Desti et al., (2020); Luthfia, (2024) classes implementing problem-based learning demonstrate superior performance compared to those employing a scientific approach across all creativity indicators. Elaboration reached 71.33% compared to 57.67%, while flexibility and fluency attained 73.20% and 76.33%, exceeding 54.80% and 61.67%, respectively. Originality also remained higher at 67.60% compared to 58.40%. Furthermore, Ibrahim & Widodo, (2020) reported greater improvement in the experimental group (N-Gain = 37.07) than in the control group (24.94). These results highlight the significant role of open-ended problem-solving in fostering mathematical creativity.

These findings further confirm that instruction using the creative problem solving model with an open-ended approach is effective in enhancing students' self-confidence, as evidenced by the improvement observed across all measured indicators. Studies by Maifi et al., (2021); Suren & Kandemir, (2020) reported an increase in students' self-confidence following instructional intervention, rising from 77% to 81%. This indicates that the implemented learning strategy contributes positively to strengthening students' affective development. Similarly, Arwadi, (2021); Dolapcioglu & Doğanay, (2022) found that students engaged in problem-based learning demonstrated higher average self-confidence (79.35) compared to those in conventional classes (77.45), reflecting greater peer interaction and active involvement during learning.

In this study, the control group utilized a direct instruction model with a scientific approach, where the teacher played a dominant role in guiding the learning process. However, the scientific approach was only partially integrated throughout the instruction and was not fully implemented in all stages. This condition represents one of the limitations that should be considered when interpreting the comparative results between the instructional models. As an implication, future research is recommended to enhance the consistency of instructional implementation in the comparison group and to extend the duration of the creative problem solving model based on an open-ended approach. This is expected to produce more comprehensive and representative findings regarding its impact on students' creative thinking skills, cognitive flexibility, and self-confidence.

CONCLUSION

The implementation of the creative problem solving model with an open-ended approach has been proven highly effective in enhancing students' creative thinking skills and self-confidence, as evidenced by mean scores exceeding established benchmarks and mastery proportions surpassing minimum standards. Comparative analysis indicates that creative problem solving with an open-ended approach is significantly more effective than the direct instruction model with a scientific approach, yielding superior cognitive and affective outcomes. The creative problem solving model with an open-ended approach promotes flexible, creative, and original thinking, as well as complex problem-solving abilities, while simultaneously strengthening students' confidence. These findings confirm that integrating creative problem solving with open-ended tasks provides a comprehensive, innovative, and effective learning framework, representing a superior strategy to improve mathematics learning quality and support the development of students higher-order thinking skills in an integrated manner.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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