Pasundan Journal of Mathematics Education Volume 15, No. 1, 2005, pp. 58-70

The use of desmos-assisted creative problem-solving learning in improving critical thinking skills

Cepi Septian[1], Eka Firmansyah[1*], Rizki Safari Rakhmat[3], Rahayu Kariadinata[4]

[1] Universitas Pasundan, Bandung, Indonesia
[2]SMAN 9 Kota Bandung, Bandung, Indonesia
[3]Universitas Islam Negeri Sunan Gunung Djati, Bandung, Indonesia
*Email: eka_firmansyah@unpas.ac.id

Abstract

The low students' mathematical critical thinking ability in one of the high schools in Bandung City is a problem that requires teachers to develop and implement innovative learning approaches. Various previous studies have shown that creative learning and encouraging active involvement of students can improve critical thinking skills. This study uses a mixed method with an embedded design type, especially an embedded experimental design model, and adopts a pretest-posttest control group design. The purpose of this study is to examine the effectiveness of the Desmos-assisted Creative Problem Solving (CPS) learning model in improving students' mathematical critical thinking skills. The population of this study is high school students in the city of Bandung, with a purposive sampling technique to select two classes as a sample. The instruments used included mathematical critical thinking ability tests, observation sheets, and interview guidelines. The results of the data analysis showed that the improvement in mathematical critical thinking skills of students who obtained Desmos-assisted CPS learning was higher compared to students in the control class. Therefore, the Desmos-assisted CPS learning model is effectively used in an effort to improve students' mathematical critical thinking skills, especially in social studies classes students, and can be used as an alternative approach to learning mathematics in schools. This research is expected to contribute to the development of mathematics education, especially in the integration of technology with innovative learning models to encourage students' critical thinking skills.

Keywords: Creative Problem Solving, Critical Thinking Skills, Desmos, Early Mathematics Skills, Learning Applications.

How to Cite: Septian, C., Firmansyah, E., Rakhmat, R. S. (2025). The use of demons-assisted creative problem solving (CPS) learning in improving critical thinking skills. *Journal on Mathematics Education, 15*(1), 58-70. http://doi.org/10.23969/pjme.v15i1.24055

INTRODUCTION

Critical thinking is one of the High Order Thinking Skills (HOTS) that students need to have because one of the tools used in our daily lives to solve some problems critical thinking uses the logic of reasoning, interpretation, analysis and evaluation of information to enable one to make valid decisions (Chukwuyenum (Nugraha & Supianti, 2020)). Critical thinking is also related to the way of analyzing and evaluating something, meaning using mental processes, such as paying attention, categorization, making choices, and making decisions. (Kusyanto et al, 2022).

According to (Syarif, 2020), in every mathematics learning, students should use the process of thinking by thinking critically. Therefore, critical thinking is a very important ability to be developed in schools, the task of teachers is expected to be able to design and present learning that activates and

develops critical thinking skills. Critical thinking is needed by the student when facing challenges and he must make decisions, evaluate and consider well with the information received, make a plan and determine the actions taken.

According to Tilaar (Aziz, 2022), there are four important reasons to develop critical thinking in modern education, namely: (1) Respect as individuals; (2) Preparing students for adult life; (3) Realizing traditional ideals of education, especially in exact science; and (4) Supporting democratic life. Therefore, the development of critical thinking skills in education is very necessary, and this can be done by teaching the right way in the classroom.

Based on this, it is clear that critical thinking is very important for high school students, but the reality in the field shows that many high school students have low critical thinking skills. Students' critical thinking skills are still considered low in students' abilities (Agustia et al., 2024; Septiany et al., 2024). One of the causes of low student achievement is that students' ability to solve problems that require high thinking and reasoning skills is still very low (Banawi et al., 2024; Rizqi et al., 2023; Saleh, 2021). In addition, in various contexts (elementary, secondary, and professional schools), students report that critical thinking is rarely taught directly, and when it is, it is often not systematic or explicit (Sullivan et al., 2024; Sarwanto et al., 2021).

These problems are supported by the data of the critical thinking ability test conducted by the author in class XI IPS 1 SMA Negeri 9 Bandung on Trigonometry material. The results of the student test for the 2016/2017 school year, as shown in Table 1.

Table 1. Critical Thinking Ability Test Scores

Results	Critical Thinking Skills
Average	40,04
Highest Score	75
Lowest Score	15
Number of Students	34

By paying attention to the problems that have been described, the fact is obtained that the average value of critical thinking skills is still far from the minimum completion criteria that have been determined. Judging from the results of the researchers' observations at SMA Negeri 9 Bandung, there are several factors that cause low critical thinking skills. These factors include that the material that has been taken in some of the previous materials is mostly forgotten, even though all the mathematics material that has been taken is a prerequisite that must be mastered to be able to solve critical thinking problems. In addition, the mathematics learning process does not accustom students to thinking at a higher level with open-ended problems.

CPS learning in mathematics learning is a learning that focuses on teaching and problem-solving skills, which is followed by strengthening skills. When faced with a question, students can practice problem-solving skills to choose and develop their responses. Not only by memorizing without thinking, problem-solving skills expand the thinking process (Choudhar et al., 2022; Putera et al., 2024). Creative Problem Solving is a creative problem-solving method, where this method emphasizes the ability of students to solve problems creatively (Wigert et al., 2022; Van Hooijdonk et al., 2023; Yang et al., 2022). The ability of students to create and solve problems shows students understanding of what has been learned, so in this case, students are required to think creatively which can increase motivation in students.

CPS learning is learning that provides the widest opportunity for students to express their opinions in coming up with ideas, by ending criticism and assessment until a final decision is made. The ideas that emerge are collected, filtered, discussed, and compiled until a solution is obtained for problem-solving (Sutiawan et al, 2021).

Therefore, CPS can be one of the solutions to improve students' critical and creative thinking skills, because CPS is learning that involves all student activities in full, the teacher is only a facilitator. This learning accustomed students to make observations, explain ideas, connect with previous knowledge or with other subject matter, and try to find solutions to problems from various information, both from the environment, books, the internet and documents.

In terms of supporting learning, the use of the internet which is integrated in mathematics learning encourages teachers to make various innovations in teaching activities. In this regard, the use of the Internet as a learning medium can help students learn actively and independently.

Desmos is a platform or service that offers a wide variety of mathematical tools, digital mathematics activities, and curricula to facilitate students to learn at a high level in a fun way (Antunes & Cambrainha, 2020; Kristanto, 2021). The mathematical tools provided by Desmos include graph calculators, scientific calculators, four-function calculators, matrix calculators, and geometry tools. Desmos also provides many digital math activities that teachers can search, use, or edit through its website. In addition, teachers can develop their interactive learning activities through the website and share them easily with other fellow teachers or their students.

According to Beski (2014), it reveals that Desmos can imagine a world of universal mathematical literacy, where no student thinks that mathematics is too hard or too boring to pursue. When learning activities become a journey of exploration and discovery, anyone can understand and enjoy learning mathematics. This will have a positive impact on the activities that students do in learning mathematics to be more fun. This can help every teacher create math activities digitally and go beyond the activities we create ourselves.

Based on the problems described earlier, the purpose of this study is to find out and analyze the influence of Desmos-assisted CPS learning strategies on improving students' mathematical critical thinking skills. In particular, this study aims to compare the improvement of critical thinking skills between students who participate in learning with the Desmos-assisted CPS strategy and students who receive conventional learning, both overall and reviewed based on the category of Initial Mathematics Ability. This research has problem limitations that cover two main aspects. First, the mathematics topic discussed in this study is the composition of functions, with a focus on deepening related concepts to analyze their influence on improving students' critical thinking skills. Second, the research subjects consisted of grade XI students majoring in Social Sciences at SMA Negeri 9 Bandung, who were purposively selected to suit the research objectives. Through the selection of this subject, it is hoped that the research can provide comprehensive insights into the effectiveness of functional composition learning among high school social studies students.

METHODS

The research method that will be used in this study uses a Mixed Method of the Embedded Design type with an Embedded experimental model. Embedded experimental models are qualitative data used in experimental design, both in pure and quasi-experimental experiments. The main priorities of this model are developed from quantitative, experimental methodologies, and qualitative data following,

complementing or supporting the methodology. The following is the Embedded design according to Creswell and Clark (Indrawan and Yaniawati, 2014):

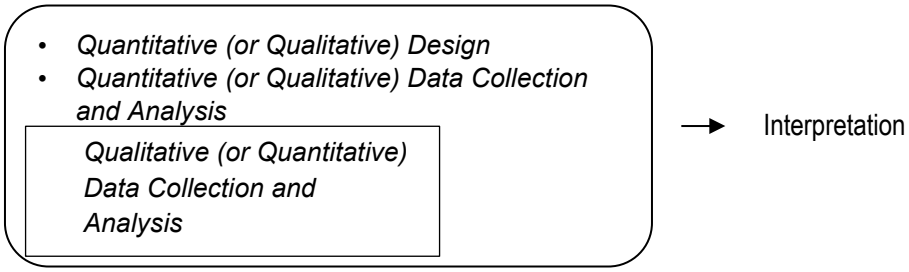

Figure 1. Embedded Experimental Model Research Procedure

The research design used in this study is pretest-postest control group design or by group design. The first class was to learn CPS-Assisted Desmos (experimental class) and the second class obtained conventional learning (control class).

The population in this study is students of SMA Negeri 9 Bandung. The consideration of conducting research at SMA Negeri 9 Bandung is because SMA Negeri 9 Bandung has never been able to learn Creative Problem Solving with the help of Desmos. The selection of samples was carried out from the population in purposive sampling and was carried out on the consideration that one of the research materials related to Desmos is the composition function contained in class XI.

In this study, students in the experimental class and the control class were grouped based on their initial mathematical ability into two levels, namely the superior group and the inferior group. According to (Sumini, 2021; Harahap et al., 2024; Supardi et al., 2021), the Initial Mathematics Ability test is carried out to determine the initial mathematical ability of students in the control class and the experimental class.

Students are grouped into the initial math ability category by being given a pre-assessment test related to the research material. After being given the initial math ability test for both classes, the average of the experimental class was 56.84 while the average of the control class was 50.07. The criteria for the student's initial math ability category based on the results of the prerequisite test before the research is carried out are presented in Table 2 as follows:

Table 2. Criteria for Initial Mathematics Ability

Research Classes	Initial Math Ability Score	Category
Experiment	Initial mathematics ability score ≥ 56.84	Superior
	Initial mathematics ability score < 56.84	Humility
Control	Initial mathematics ability score ≥ 50.07	Superior
	Initial mathematics ability score < 50.07	Humility

After being given the initial math ability test, each sample in each class was categorized based on superior and inferior groups according to the criteria in Table 2. There were 17 superior groups and 15 inferior groups in the experimental class. Then there were 14 superior groups and 20 people in the control class.

The research instrument used is a test. The test used in this study is a test of critical thinking ability. The critical thinking ability test was obtained from the results of pretests, posters and N-gains. The results of the critical thinking ability pretest and the results of the mathematics critical thinking ability posts obtained after the CPS class learning assisted by Desmos and conventional learning classes were carried out. Tests were administered before and after learning to determine a significant improvement in critical thinking skills in students who received Desmos-assisted CPS learning and students in the control group

who received conventional learning. Meanwhile, non-test instruments are given in the form of observations, and interviews.

Observation is the activity of recording a phenomenon/event with the help of instruments to record/record it for scientific purposes or other purposes. Thus, the observer uses all the senses to collect data through direct interaction with the person being observed. The observer must witness firsthand all the events/symptoms that are being observed. Interview recordings are a collection of information that is explored through oral questions and answers and daily conversations. There are two types of interviews, namely structured interviews and unstructured interviews. Interviews/conversations that are guided by a grid of written questions prepared before the interview is conducted are called structured interviews. In unplanned interviews, the topic of conversation is free and can happen anytime and anywhere, and spontaneous questions are called unstructured interviews.

The preparation of questions begins with the creation of a grid of question instruments that include basic competency standards, learning indicators, and measured ability indicators. The preparation of critical thinking ability test questions in this study refers to the material of composition functions and inverse functions. The question set for the mathematical critical thinking ability test is in the form of a description consisting of six questions. The critical thinking ability test is tested on the question to see the validity and reliability of the question. Based on the results of the critical thinking ability test, the reliability of the test instrument is obtained in Table 3 below.

Table 3. Results of Calculation of Reliability Items for Test Instrument Trial Questions

Test Instruments	Cronbach's Alpha	A lot of questions
Mathematical Critical Thinking	0,580	6

Based on Cronbach's Alpha value in table 3 for the mathematical critical thinking ability test instrument, a value was obtained that was interpreted with the criteria made by Guilford (Ruseffendi, 2005) including the medium category.$r_{11} = 0{,}580$

The following is a recapitulation of the results of the mathematical critical thinking ability instrument test presented in table 4 below:

Table 4. Recapitulation of Critical Thinking Ability Instrument Trial Results

No.	Validity		Differentiating Power		Difficulty Index		Conclusion
	Value	Interpretation	Value	Interpretation	Value	Interpretation	
1	0,625	Keep	0,79	Excellent	0,714	Easy	Used
2	0,649	Keep	0,27	Enough	0,724	Easy	Used
3	0,614	Keep	0,47	Good	0,234	Difficult	Used
4	0,215	Low	0,067	Ugly	0,692	Keep	Revised so that the differentiating power is not bad
5	0,673	Keep	0,41	Good	0,22	Difficult	Used
6	0,705	Tall	0,38	Enough	0,123	Difficult	Revised to make it less difficult

Based on Table 4, most of the questions on critical thinking instruments have moderate validity, with one question having high validity and the other having low validity. In terms of differentiating power, three questions are classified as good to very good, one is sufficient, and two questions need to be revised because they have low discriminating power. The difficulty index shows that three questions

include difficult, two easy, and one moderate. Overall, four questions were declared suitable for use, while two questions needed to be revised to improve their quality.

The observation sheet is proposed as a guideline for observing student activities during the learning process focused on mathematical critical thinking skills, teachers' attitudes, and interactions between students and teachers when implementing the CPS strategy with the help of Desmos in the classroom. The interview serves to explore the problems encountered by students in learning related to the CPS strategy with the help of Desmos. Interviews were conducted with several students representing the experimental class and the control class 3 students in the superior category and 3 students in the low category in the experimental class and the control class which were considered to be able to help express their attitude and appreciation for improving mathematical critical thinking skills in learning using the CPS learning strategy with the help of Desmos.

In this study, quantitative data were obtained from the results of pretest data instruments, postes. The results of the critical thinking ability test were used to see an increase in critical thinking of students whose learning was using the CPS learning strategy with the help of Desmos compared to students with ordinary learning. Furthermore, data processing was carried out based on the category of Initial Mathematics Ability of students in the superior and inferior categories.

RESULTS AND DISCUSSION

Postest Data Analysis of Critical Thinking and Discussion

A series of research stages that have been carried out in experimental classes using the Creative problem-solving learning strategy with the help of Desmos (CPS-D) and control classes with conventional learning (CL) obtained data from the research results presented in the Weiner table. The Weiner table shows the relationship between the free variable, the bound variable, and the control variable.

Table 5. Weiner Table Average Recapitulation of Posts between Independent Variables, Bound Variables, and Control Variables

Class	Critical Thinking	
	Experiment	Control
Superior	63,47	43,71
Humility	41,73	28,05
Sum	105,20	81,76

Table 4 shows that there is a difference in the average results of the mathematical critical thinking ability posts of the experimental class that are higher than the average of the control class posts. The average result of the experimental class postes was higher than the average of the control class postes with an average difference of 8.61 in the two classes.

The data in Table 5 shows that the mathematical critical thinking skills of students in the experimental class were higher than those in the control class. These findings reflect the effectiveness of treatments applied in experimental classrooms, which may involve problem-solving-based learning strategies or other innovative approaches. With the average number of experimental class posts in the superior category being larger than the humility category, it can be seen that this strategy has succeeded in supporting students at various levels of initial ability, both those who are superior and arrogant.

According to Ennis (2011), critical thinking includes the ability to think reflexively and reason that aims to decide what to believe or do. Higher average posts in experimental classes indicate that students

who learn with innovative strategies can hone these skills, for example through problem-solving-oriented learning or in-depth exploration of the material. Ennis also emphasized that learning should provide space for students' active involvement so that they can develop analytical and evaluative skills, which are at the core of critical thinking.

This opinion is reinforced by Facione (2021), who identifies that critical thinking is the foundation of effective decision-making, including in the context of mathematics learning. Facione highlighted that critical thinking requires not only analytical skills but also an attitude of openness to new perspectives. Learning strategies in experimental classes may have facilitated this openness by allowing students to explore problems and find solutions independently, thereby increasing their average postes.

Pratama and Mardiani (2022), stated that the Problem-Based Learning model can encourage students to be more actively involved in learning, thereby improving critical thinking skills. In this model, students are placed in learning centres, where they must understand problems, analyze data, and solve problems collaboratively. This approach allows students to connect theory with real applications, which are relevant to the needs of mathematical critical thinking.

Yaniawati et al, (2023) add a more contemporary perspective by showing that technology, particularly Mobile Augmented Reality (MAR), can improve critical thinking skills. MAR allows students to visualize abstract concepts concretely, encouraging exploration and deep reflection. In the context of mathematics learning, this technology is particularly beneficial for helping students understand complex material, such as three-dimensional geometry or mathematical functions.

The effectiveness of the treatment applied to the experimental classroom, as seen in the data, suggests that mathematics education can no longer rely on traditional methods of lectures. This data underscores the importance of transforming pedagogy from a passive approach to an interactive and constructivist approach. These results also make a strong argument for integrating technology and problem-based learning strategies in mathematics curricula, as proposed by recent research.

However, it should be noted that this success requires a high commitment from teachers to design meaningful learning and provide adequate support to students. An innovative approach must be balanced with continuous evaluation to ensure that every student gets the maximum benefit from learning. Furthermore, collaboration between teachers, researchers, and policymakers is needed to develop learning guidelines that are adaptive to the needs of students and the times.

At the beginning of the implementation of CPS-D, students experienced confusion because they had to adjust to the use of the Desmos browser application. Although the integration of technology in learning offers various benefits such as increased accessibility and flexibility, its implementation still faces a number of challenges (Rintaningrum, 2023; Djalalov, 2023). One of them is the technology access gap, where not all students have adequate devices or internet connections to support the learning process. In addition, the lack of training and technology skills among educators is a significant obstacle to effectively utilizing technology in teaching. Data privacy and security issues are also an important concern in the use of digital platforms for education. Therefore, collaborative efforts are needed between the government, educational institutions, and other stakeholders to overcome these challenges in order to maximize the potential of technology to improve the quality of education.

Desmos-assisted CPS learning consists of four main stages. The first stage is problem clarification, where students in groups identify and understand problems in the Desmos application. The second stage is the expression of ideas related to mathematical problems faced in activities such as the "function carnival" at Desmos. The third stage involves the evaluation and selection of the ideas that have been expressed. According to Ennis (2011), clarifying problems is an important first step in developing critical

thinking skills, because students need to understand the core of the problem before trying to solve it. Facione (2021) added that the evaluation stage is the core of the critical thinking process, where students must be able to choose the most relevant and strong ideas from the various existing ideas. The fourth stage is implementation, where students determine the right strategy and apply it until they find a solution that suits the given problem.

However, in the implementation of Desmos-assisted learning, researchers faced several obstacles. One of them is the condition of the laboratory at the Bandung City Senior High School which cannot be used due to computer-based national exam preparation, so the research is carried out in the classroom. Another problem arises when accessing the internet using the Wi-Fi service around the classroom, the location of the classroom at the end causes a weak Wi-Fi signal. To overcome this, researchers used hotspot services from smartphones. According to Sucipto (2024), the main challenges in implementing technology-based learning include limited infrastructure and internet access, with 65% of respondents stating that unstable internet connectivity is the biggest obstacle.

In addition, the time required to use the Desmos-assisted CPS model is affected by the student's ability to solve the problem and the time required to understand the problem on the Desmos display, especially since the application uses English which must be translated into Indonesian. As a result, some meetings cannot be completed on time and must be resumed at the next meeting. This emphasizes the importance of infrastructure readiness, mastery of technology, and digital literacy support for students and teachers to achieve the effectiveness of technology-based learning.

Data Analysis on Improving Students' Mathematical Critical Thinking Skills and Discussion

Table 8 below presents a description of the data on improving students' mathematical critical thinking skills based on the category of students' initial mathematical ability, namely superior and arrogant. This data is presented through various indicators, such as average, standard deviation, average difference, and N-gain category. The analysis was carried out to evaluate the improvement of students' mathematical critical thinking skills in two components, namely divergent problem-solving skills and critical thinking skills.

Table 8. Description of Critical Thinking Skills Improvement Data

Category	Statistics	Critical Thinking Skills			
		CPS-D	CL	Average Difference	Total
Superior	Average	0,55	0,31	0,24	0,86
	Deviasi Std.	0,12	0,12		0,24
	Category N-gain	Keep	Keep		
Humility	Average	0,31	0,15	0,16	0,46
	Deviasi Std.	0,07	0,07		0,14
	Category N-gain	Keep	Low		
Overall	Average	0,44	0,21	0,23	0,65
	Deviasi Std.	0,15	0,14		0,29
	Category N-gain	Keep	Low		

This proves descriptively that there is an increase in mathematical critical thinking skills after learning is implemented. The results of the analysis prerequisite test were obtained with a Sig. Value of the normality test of increasing critical thinking with Shafiro-Wilk overall in the CPS-D class of 0.151 and for the control class of 0.052. According to the provision, the criterion of normality is "if the p-value (sig)

> 0.05, it means that the data in both classes are normally distributed". The Shafiro-Wilk normality test is used because it is suitable for small samples and ensures the data is distributed normally.

The homogeneity test for data on the improvement of mathematical critical thinking skills in CPS-D and CL classes used the Homogeneity of Variance (Levene statistical) statistical test. The Levene homogeneity test was used to ensure the similarity of variance between groups. Based on the results of the analysis, the overall analysis has a significance value, which means that the data $0{,}256 > 0{,}05$ on the improvement of mathematical critical thinking skills in the CPS-D class and the PK class as a whole have homogeneous variance (Sugiyono, 2013).

The higher increase in mathematical critical thinking skills in the group of students with superior initial math ability compared to the lower group showed that students' initial abilities also affected the CPS-D-based learning process. The problem-Based Learning model can improve students' critical thinking skills, especially if supported by good initial skills. The study shows that students with higher initial abilities tend to be more able to adapt and utilize the PBL approach in solving problems (Sarkingobir & Bello, 2024; Knöpfel et al., 2024; Asri et al., 2024). Therefore, teachers should consider learning differentiation to support students with low KAM to achieve more optimal results.

Before conducting further analysis of the influence of classes and initial mathematical ability on the improvement of students' mathematical critical thinking skills, a statistical test was conducted using a two-path Variance Analysis (ANOVA). This test aims to identify whether there is a significant difference in the normalized gain score based on the grade factor (CPS-D and CL), the initial mathematical ability factor (superior and humility), and the interaction between the two factors. Thus, the results of the two-track ANOVA test are expected to be able to provide a more comprehensive picture of the influence of learning models and initial mathematical abilities on students' critical thinking achievements.

The following is presented Table 9 showing the results of the two-path ANOVA test for the normalized gain score:

Table 9. Anova Test Results Two-Track Normalized Gain Score

Factor	Df	Mean Square	F	Sig.	H_0
Class	1	0,757	70,743	0,000	Rejected
CAME	1	0,580	54,157	0,000	Rejected
Class*DVD	1	0,008	0,758	0,387	Accepted

The following is an explanation based on the table above; the class has a sig value of 0.000; since the sig value < 0.05, this means that there is a significant difference in the improvement of students' mathematical critical thinking skills between the CPS-D class and the CL class. Initial mathematics ability has a sig value of 0.000; Because the GIS value < 0.05, this means that there is a significant difference in mathematical critical thinking skills between students in the superior and humility groups. The mathematical Initial Ability class has a sig value of 0.387; because the GIS value of > 0.05 means that it can be said that there is no influence of Mathematical Initial Ability on the two classes of learning models in terms of students' mathematical critical thinking skills.

Based on the results of the two-track ANOVA test in Table 9, it can be seen that the class factor and mathematical Initial ability have a significant influence on improving students' mathematical critical thinking skills. The significance value on the class factor was recorded as 0.000, indicating a significant difference in the improvement of critical thinking skills between the CPS-D class and the CL-class. The CPS learning model has been proven to significantly improve students' critical thinking skills compared to various other learning models (Ma et al., 2021; Liu et al., 2021).

On the other hand, the significance value for the initial mathematics ability factor also reached 0.00, indicating a significant difference in critical thinking skills between students with superior and inferior. This is supported by the research of Razak (2017), which shows a strong correlation between students' initial ability and mathematical critical thinking skills, with a correlation coefficient of r = 0.748

However, the interaction between the classroom and mathematical Initial Ability showed a significance value of 0.387, which means that there was no effect of the interaction between the learning model and initial ability on the improvement of students' mathematical critical thinking skills. These results are in line with the research (Slamet et al., 2021; Siagian et al., 2023; Arifa et al., 2024), which concluded that there was no significant interaction between the learning model and early mathematical ability in influencing students' critical thinking abilities.

In general, the implementation of CPS-D is going well and smoothly. According to research conducted by Budiana et al (2013), the CPS learning model is effective in improving students' critical thinking skills because it encourages them to understand problems in-depth and explore various alternative solutions. Based on the results of this study, it was found that learning using Desmos-assisted CPS can improve students' critical thinking skills. This is in line with the findings presented by some research who show that the integration of technology in mathematics learning can significantly improve students' critical thinking skills and engagement.

CONCLUSION

Based on the results of data analysis and the findings of this study, it shows that the improvement of mathematical critical thinking skills of students who participate in learning through the Desmos-assisted CPS strategy is better than that of students who use conventional learning, both reviewed based on the mathematical Initial ability category and as a whole. These results are consistent with the findings of previous research that suggest that innovative learning such as technology-assisted CPS is more effective in improving high-level cognitive abilities compared to conventional learning. These findings indicate that the use of relevant technology in learning can be one of the important strategies to improve the quality of mathematics learning processes and outcomes. Therefore, the use of the Desmos-assisted Creative Problem Solving earning model is effective in improving the mathematical critical thinking skills of social studies students, so that it can be an alternative approach in mathematics learning in schools. This research is expected to be able to contribute to the development of science in the field of mathematics education by integrating technology in the CPS learning model to improve students' critical thinking skills

REFERENCES

Agustia, Z., Yennita, Y., & Fakhruddin, F. (2024). Profile of critical thinking ability of class viii state middle school students in science learning. *Journal of Education and Learning Research*. https://doi.org/10.62208/jelr.2.1.p.46-53.

Arifa, F., 'Adna, S., & Chasanah, A. (2024). Problem based learning models assisted by mathcard on students' critical thinking abilities and mathematical dispositions. *Range: Jurnal Pendidikan Matematika*. https://doi.org/10.32938/jpm.v6i1.5612.

Asri, I., Jampel, N., Bagus, I., Arnyana, P., Suastra, W., & Nitiasih, P. (2024). Profile of problem based learning (pbl) model in improving students' problem solving and critical thinking ability. *KnE Social Sciences*. https://doi.org/10.18502/kss.v9i2.14898.

Aziz, M. (2022). Kemampuan berpikir kritis dan motivasi belajar siswa melalui pembelajaran open-ended. *Pasundan Journal of Mathematics Education: Jurnal Pendidikan Matematika*, *12*(2), 45-55. https://doi.org/10.23969/pjme.v12i2.3788

Banawi, A., Rumasoreng, M., Hasanah, N., Rahawarin, D., & Basta, I. (2024). The Relationship between Problem-Solving Skills and Student Academic Achievement: A Meta-Analysis in Education. *Journal of Ecohumanism*. https://doi.org/10.62754/joe.v3i3.3413.

Choudhar, S., Bi, N., Singh, P., & Talwar, P. (2022). Study on Problem Solving Skills and Its Importance. *World Journal of English Language*. https://doi.org/10.5430/wjel.v12n3p47.

Djalalov, M. (2023). Digital Challenges in Education. *Uzbek Journal of Law and Digital Policy*. https://doi.org/10.59022/ujldp.127.

Harahap, A., Bentri, A., Musdi, E., Yerizon, Y., & Armiati, A. (2024). Analysis of students' critical thinking skills in solving mathematics problems in terms of students' initial ability. *Indonesian Journal of Science and Mathematics Education*. https://doi.org/10.24042/ijsme.v7i1.18014.

Knöpfel, M., Kalz, M., & Meyer, P. (2024). General problem-solving skills can be enhanced by short-time use of Problem-Based Learning (PBL). *Journal of Problem Based Learning in Higher Education*. https://doi.org/10.54337/ojs.jpblhe.v12i1.7871.

Kristanto, Y. (2021). Pelatihan desain aktivitas pembelajaran matematika digital dengan menggunakan Desmos. *Indonesian Journal of Community Engagement*, 27, 192-199. https://doi.org/10.24114/JPKM.V%VI%I.23908.

Kusyanto, K., Irwan, E., & Yazid, I. (2022). Implementasi pendekatan STEM untuk meningkatkan kemampuan berpikir kritis, berpikir kreatif dan *self – efficacy*. *Pasundan Journal of Mathematics Education : Jurnal Pendidikan Matematika*, *12*(2), 1–16. https://doi.org/10.23969/pjme.v12i2.5438

Liu, T., Yu, X., Liu, M., Wang, M., Zhu, X., & Yang, X. (2021). A mixed method evaluation of an integrated course in improving critical thinking and creative self-efficacy among nursing students. *Nurse education today*, 106, 105067. https://doi.org/10.1016/j.nedt.2021.105067.

Ma, H., Zhao, M., Wang, H., Cavanaugh, T., & Liu, J. (2021). Promoting pupils' computational thinking skills and self-efficacy: a problem-solving instructional approach. *Educational Technology Research and Development*, 69, 1599 - 1616. https://doi.org/10.1007/s11423-021-10016-5.

Mwaniki, F. M., Nyamu, F. K., & Waititu, M. M. (2024). An exploration of the integration of ict in mathematics lessons in secondary schools, garissa county, Kenya. *Journal of Education*, *4*(1), 12-22. https://doi.org/10.70619/vol4iss1pp12-22.

Nugraha, G. S., & Supianti, I. I. (2020). Penerapan model *discovery learning* untuk meningkatkan kemampuan berpikir kritis matematis siswa SMK. *Pasundan Journal of Mathematics Education : Jurnal Pendidikan Matematika*, *10*(1), 78–87. https://doi.org/10.23969/pjme.v10i1.2439

Pratama, B. A., & Mardiani, D. (2022). Kemampuan berpikir kritis matematis antara siswa yang mendapat model *problem based learning* dan discovery learning. *Jurnal Inovasi Pembelajaran Matematika: PowerMathEdu*, *1*(1), 83-92. https://doi.org/10.31980/pme.v1i1.1368

Putera, R., Baiti, N., Meilina, A., Jenderal, J., No, S., Metro, K., Pusat, K., & Metro, L. (2024). Problem Solving Method In Improving Students' Critical Thinking Abilities In Social Studies Learning. *International Journal of Educational Research*. https://doi.org/10.62951/ijer.v1i3.41.

Razak, F. (2017). Hubungan kemampuan awal terhadap kemampuan berpikir kritis matematika pada siswa kelas VII SMP Pesantren IMMIM Putri Minasatene. *Mosharafa: Jurnal Pendidikan Matematika*, *6*(1), 117-128. https://doi.org/10.31980/mosharafa.v6i1.434

Rintaningrum, R. (2023). Technology integration in English language teaching and learning: Benefits and challenges. *Cogent Education*, 10. https://doi.org/10.1080/2331186X.2022.2164690.

Rizqi, P., Darmayanti, R., Sugianto, R., Choirudin, C., & Muhammad, I. (2023). Problem solving analysis through tests in view of student learning achievement. *Indonesian Journal of Learning and Educational Studies*. https://doi.org/10.62385/ijles.v1i1.26.

Saleh, N., Ali, G., Mohamed, M., & Ftah, S. (2021). Impact of critical thinking and problem solving skills on academic achievement among nursing students'. *Egyptian Journal of Health Care*. https://doi.org/10.21608/EJHC.2021.172815.

Sarwanto, S., Fajari, L., & Chumdari, C. (2021). Critical thinking skills and their impacts on elementary school students. *Malaysian Journal of Learning and Instruction*. https://doi.org/10.32890/mjli2021.18.2.6.

Septiany, L., Puspitawati, R., Susantini, E., Budiyanto, M., Purnomo, T., & Hariyono, E. (2024). Analysis of high school students' critical thinking skills profile according to ennis indicators. *IJORER : International Journal of Recent Educational Research*. https://doi.org/10.46245/ijorer.v5i1.544.

Slamet, D., Yudi, R., & Sugiman, S. (2021). The application of mathematics learning model to stimulate mathematical critical thinking skills of senior high school students. *European journal of educational research*, 10, 509-523. https://doi.org/10.12973/EU-JER.10.1.509.

Siagian, Q., Darhim, D., & Juandi, D. (2023). The effect of cooperative learning models on the students' mathematical critical and creative thinking ability: Meta-Analysis Study. *Jurnal Cendekia : Jurnal Pendidikan Matematika*. https://doi.org/10.31004/cendekia.v7i1.2281.

Sarkingobir, Y., & Bello, A. (2024). Helping students become proficient physics problem solvers through problem-based learning. *International Journal of Essential Competencies in Education*. https://doi.org/10.36312/ijece.v3i1.1813.

Sucipto. (2024). Tantangan dan peluang implementasi pembelajaran berbasis teknologi di era digital. *Jurnal Ilmiah Pendidikan Citra Bakti*, *11*(3), 902–916. https://doi.org/10.38048/jipcb.v11i3.4192

Supardi, A., Nindiasari, H., & Syamsuri, S. (2021). Perbandingan persepsi dan kemandirian belajar matematika siswa madrasah terhadap pembelajaran daring ditinjau dari kemampuan awal matematis. *Tirtamath: Jurnal Penelitian dan Pengajaran Matematika*. https://doi.org/10.48181/TIRTAMATH.V3I1.10145.

Sutiawan, I., Yaniawati, P., & Toharudin, U. (2021). Penggunaan pembelajaran *Creative Problem Solving (CPS)* dalam upaya meningkatkan kemampuan pemecahan masalah matematis dan self-efficacy siswa SMP. *Garda Guru*, *3*(1), 49-61. https://doi.org/10.23969/gardaguru.v3i1.3796

Sullivan, A., Hayes, M., Beltran, C., Cohen, A., Soffler, M., Cooper, S., Wisser, W., & Schwartzstein, R. (2024). Do we teach critical thinking? A mixed methods study of faculty and student perceptions of teaching and learning critical thinking at three professional schools.. *Medical teacher*, 1-8 . https://doi.org/10.1080/0142159X.2024.2316862.

Sumini, S. (2021). Pengaruh model pembelajaran kooperatif student teams achievement division dengan kemampuan awal matematis terhadap pemahaman konsep matematis siswa. , 3, 927-933. https://doi.org/10.34007/JEHSS.V3I3.435.

Syarif, M. (2020). Pembelajaran dengan pendekatan problem solving untuk meningkatkan kemampuan berpikir kritis dan kreatif matematika siswa SMA. *Pasundan Journal of Mathematics Education : Jurnal Pendidikan Matematika*, *6*(1), 56-75. https://doi.org/10.23969/pjme.v6i1.2723

Van Hooijdonk, M., Mainhard, T., Kroesbergen, E., & Van Tartwijk, J. (2023). Creative problem solving in primary school students. *Learning and Instruction*. https://doi.org/10.1016/j.learninstruc.2023.101823.

Wigert, B., Murugavel, V., & Reiter-Palmon, R. (2022). The utility of divergent and convergent thinking in the problem construction processes during creative problem-solving.. *Psychology of Aesthetics, Creativity, and the Arts*. https://doi.org/10.1037/aca0000513.

Yang, W., Green, A., Chen, Q., Kenett, Y., Sun, J., Wei, D., & Qiu, J. (2022). Creative problem solving in knowledge-rich contexts. *Trends in Cognitive Sciences*, 26, 849-859. https://doi.org/10.1016/j.tics.2022.06.012.

Yaniawati, P., Indrawan, R., & Mubarika, M. P. (2023). The potential of mobile augmented reality as a didactic and pedagogical source in learning geometry 3D. *Journal of Technology and Science Education*, *13*(1), 4-22. https://doi.org/10.3926/jotse.1661