

## Nearpod as a Digital Learning Tool: Its Effect on Mathematical Critical Thinking Skills in Vocational High School

Windia Hadi<sup>1,2\*</sup>, Sri Mariana<sup>3</sup>, Widyah Noviana<sup>4</sup>, Fatimah az Zahra<sup>2</sup>, &  
Fanuel Alem Semere<sup>1</sup>

<sup>1</sup>Doctoral School of Education, University of Szeged, Hungary

<sup>2</sup>Department of Mathematics Education, Universitas Muhammadiyah Prof. DR. HAMKA, Indonesia

<sup>3</sup>Tadris Mathematics, Universitas Islam Sarolangun, Indonesia

<sup>4</sup>Department of Informatics Engineering, Universitas Pamulang, Indonesia

\*Corresponding email: [windia.hadi@edu.u-szeged.hu](mailto:windia.hadi@edu.u-szeged.hu)

Received: 11 November 2025

Accepted: 14 April 2026

Published: 28 April 2026

**Abstract:** Technology has become an important tool to assist student learning in the 21<sup>st</sup> century. Nearpod is an interactive digital learning platform that allows teachers to create, share, and manage learning materials with interactive features. In fact, critical thinking skills are still very low among vocational secondary school students. The purpose of this study is to determine whether the Nearpod intervention has a significant effect on critical thinking skills in both the experimental and control classes, and to assess the magnitude of this effect specifically in the experimental class. This study used an experimental method with a non-equivalent posttest design, involving 68 eleventh-grade students as samples. Purposive sampling was used as the sampling technique. There were two groups: the experimental group used Nearpod, while the control group used conventional learning, which is what teachers usually do without Nearpod. The instrument used in this study was a critical thinking test consisting of five valid and reliable essay questions. This study was analyzed using a normality test, a homogeneity test, a two-sample t-test, and Cohen's d to determine the magnitude of the effect. The results of this study show that Nearpod use influences students' critical thinking skills compared with students who do not use Nearpod, with an effect size ( $d = 0.50$ ) classified as a moderate, significant positive effect. Thus, Nearpod has a positive impact on the critical thinking skills of vocational high school students. Nearpod can help students develop their critical thinking skills and serve as an alternative digital learning tool for teachers to use in the classroom.

**Keywords:** mathematical critical thinking, nearpod, interactive learning, vocational high school students.

Article's DOI: <https://doi.org/10.23960/jpmipa.v27i2.pp721-733>

### ■ INTRODUCTION

Mathematics education plays a crucial role in the educational process and serves as a fundamental foundation for advances in education and technology. Initially grounded in individual cognitivist perspectives and later progressing toward social and sociocultural perspectives, views on the conditions of mathematics teaching and learning have become increasingly diverse, contributing to a deeper, more nuanced appreciation of its essence. In addition, changes in societal, environmental, and disciplinary

contexts, along with rising interdisciplinarity, introduce new conditions that influence these perspectives (Wagner et al., 2023). Although mathematics forms the basis of science and technology, it is important to note that, unlike other core sciences, mathematics education is strongly influenced by social and cultural changes (Sriraman & English, 2005). Learning mathematics is also essential because it strengthens critical thinking and problem-solving skills that are useful in everyday life and various careers, enhances logical reasoning, and helps

individuals navigate complex situations systematically and make well-informed decisions (Mangarin & Caballes, 2006).

Given the importance of mathematics, understanding each topic is essential, particularly those related to real-life applications. Mathematical learning requires critical thinking skills to analyze problems and determine appropriate solutions. Therefore, students must learn statistics as a key subject in school (Suliani & Saputri, 2021). Statistics has developed as a branch of mathematics that utilizes numerical concepts and patterns to process data and draw meaningful conclusions.

However, many students still struggle to understand statistics, despite the subject's importance and its close connection to daily life. Students often experience difficulties in solving mathematical problems, especially in statistical material (Munthe et al., 2023). These difficulties include challenges in understanding the language of the questions and translating them into mathematical representations. Intellectual factors, which are closely related to learners' critical thinking skills, are considered one of the main causes of these difficulties. Every student is therefore expected to master this ability along with critical thinking at school (Bredberg, 2020). Thus, understanding students' critical thinking skills is crucial to overcoming the difficulties they face in learning statistical concepts. Today, developing critical thinking skills is crucial.

Critical thinking (CT) is an essential competency for global citizens in the 21st century. Students are required to develop critical thinking as a key competency and an effective skill that enables them to succeed in an ever-changing world by supporting their thought development (Aktoprak & Hursen, 2022). The use of logical reasoning grounded in factual information and persuasive arguments to make decisions or take action reflects the application of critical thinking skills (Kuncoro et al., 2021). The ability to

explain, analyze, generalize, and draw conclusions is a key aspect of critical thinking that helps students overcome learning difficulties, particularly in mathematics (Apriliana et al., 2019). Critical thinking refers to the ability to think independently and make wise and responsible decisions that affect one's life. It is an active and systematic effort to understand and evaluate arguments and a set of skills that combine analysis and evaluation of information (Mayer & Goodchild, 1990; Beyer, 1984). In mathematics, critical thinking involves analysis, evaluation, and complex problem-solving, which require abstract thinking, logical reasoning, and the ability to apply knowledge to new situations (Syaiful et al., 2025). In statistics, these skills are particularly important because students are required not only to perform calculations but also to understand fundamental principles, interpret results, and apply concepts across different problems.

Based on previous research, obstacles to embedding critical thinking in mathematics learning are largely due to time and resource limitations (71.34%), as well as inadequate pedagogical understanding, limited teacher confidence, and uncertainty about potential learning outcomes (Trisnani et al., 2024). Therefore, it is important to provide regular practice and facilitate classroom discussions to help students become accustomed to following comprehensive problem-solving steps and to avoid hasty conclusions (Ratnawati et al., 2020). Mathematical critical thinking skills significantly influence students' cognitive development; when these skills are low, students may have difficulty solving problems assigned by teachers (Apriliana et al., 2019). The development of critical thinking skills through various teaching methods is essential (Aktoprak & Hursen, 2022).

In addition, teachers must understand the difficulties students face and respond appropriately so that learners experiencing high levels of statistics anxiety feel supported and

acknowledged (Malik, 2015). Research by Khusna et al. (2024) also indicates that studies on critical thinking skills rarely examine vocational secondary school students, who account for only 2.04% of research samples. This indicates that the development of critical thinking skills among vocational secondary school students is still underexplored, even though these students will later enter direct field practice. Vocational secondary schools play a crucial role in education by providing students with the skills and training needed to enter the workforce.

Teachers play a vital role in developing students' critical thinking skills during the learning process. One approach that has been widely adopted is the use of technology in learning. It is undeniable that digital technology has been integrated into mathematics learning, both in classroom practice and assessment (Drijvers & Sinclair, 2024). At present, the integration of modern information and communication technology in teaching and learning is not only a valuable means of improving instructional methods, but also allows students to select and use tools that best support them in achieving optimal learning outcomes (Abachi & Muhammad, 2014).

Technological advances and their increasingly widespread integration into education have significantly facilitated the development of students' mathematical intuition (Popova et al., 2024). Technological progress is also a major contributor to change in the education sector. Today's increasingly sophisticated technologies make it easier for students to access information quickly and efficiently (Salsabila et al., 2020). Technology-supported education facilitates access to learning resources and opens opportunities for innovative teaching methods (Fazriyah et al., 2020). Experts argue that well-designed technology-based activities can align with students' values and interests by establishing meaningful and relevant learning goals while

enabling students to engage with characters and situations presented in technological environments (Gee, 2003; Squire, 2003). For example, Kahoot provides additional features such as quizzes, polls, surveys, games, and presentation tools, allowing users to utilize existing templates or create their own presentations according to their preferences (Fazriyah et al., 2020).

Unfortunately, previous research on technology-based learning media was conducted mainly on prospective elementary school teachers and did not specifically measure students' critical thinking skills. Therefore, there remains a strong need for technology-based learning media that can capture students' attention and support the development of critical thinking skills in the teaching and learning process. One form of technology-integrated learning media that is easily accessible and supports mathematics education is Nearpod.

Nearpod is a web-based learning platform that supports student engagement and enables teachers to manage classroom interactivity throughout the learning process. It allows teachers to present material interactively using various media, such as three-dimensional images, presentations, and quizzes. By using this technology, students are expected to become more engaged and gain richer learning experiences. Research shows that Nearpod can reduce classroom boredom and increase student participation (Nurmiati et al., 2022). Nearpod also integrates features that would normally require several different platforms, such as uploading slide presentations, embedding videos, web links, audio files, PDFs, and cloud-based files (Perez, 2017). Interactive tools such as Quiz, Draw It, Fill in the Blank, Memory Test, Time to Climb, and Matching Pairs can foster students' critical thinking skills. Consistent with this, Veng (2023) reported that Nearpod can increase student engagement in critical thinking-oriented classes for EFL teachers.

Both online and face-to-face learning environments can benefit from using Nearpod because its interactive features encourage active classroom participation (Hakami, 2020). According to Oktafiani & Mujazi (2022), implementing Nearpod enhances students' creativity and participation, making classroom learning more interactive. Additionally, Nearpod can be integrated with other media, such as YouTube, to further support interactive learning. However, Nearpod also has limitations, particularly because the application primarily uses English, which can pose challenges for students with limited English proficiency.

Several studies have examined the impact of Nearpod on student motivation in mathematics learning (Oktafiani & Mujazi, 2022). Other research has indicated that Nearpod is a feasible and effective active learning medium that can influence students' motivation and communication skills (Banjarnahor & Tarigan, 2023; Hakami, 2020; Oktafiani & Mujazi, 2022). However, previous studies have not sufficiently examined the extent of Nearpod's impact on students' learning outcomes and critical thinking skills, particularly in vocational high schools and in statistics learning. Therefore, this study investigates the effect of Nearpod and the extent of its influence on students' critical thinking skills in vocational high schools. The research questions of this study are

RQ1. Is there a significant influence on students' critical thinking skills when taught using Nearpod compared to those not taught with it?

RQ2. How significant is the effect of Nearpod on students' critical thinking skills?

The research hypotheses are formulated as follows:

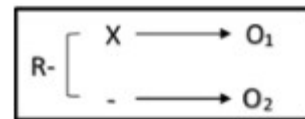
$H_0$ : There is no significant difference in critical thinking skills between students who learn using Nearpod and those who do not.

$H_1$ : Students who learn using Nearpod have significantly better critical thinking skills than those who do not use Nearpod.

## ■ METHOD

### Research Design and Procedures

This study used a quantitative approach with numerical data and a qualitative approach with descriptive data. The method used is a quasi-experimental posttest-only control group design with two groups: the experimental group. The experimental class receives special treatment, and the control group does not. The research design structure is shown in Figure 1 below.



**Figure 1.** Posttest-Only control design

The research procedure was carried out in three stages, namely the preparation stage, the implementation stage, and the final stage. In the preparation stage, instruments were developed, validated, and tested. The implementation stage involved administering critical thinking tests to students. Finally, in the final stage, data processing, data analysis, and research report writing were carried out. The data collection technique used in this study was a written test consisting of questions assessing students' critical thinking skills, administered after the treatment learning process was completed.

### Population

The population in this study consisted of all eleventh-grade students majoring in visual communication design at a vocational high school in Jakarta, Indonesia, in the even semester of the 2023-2024 academic year. The sample used in this study comprised class XI DKV 1 (33 students), the experimental class that used Nearpod for learning, and class XI DKV 2 (35 students), the control class that used conventional

learning. The technique used to select the study's classes was purposive sampling.

The variables in this study consisted of two variables: the independent variable (X), namely the use of Nearpods in mathematics learning, and the dependent variable (Y), namely students' mathematical critical thinking skills. These two variables were used to examine the relationship between Nearpod use and the development of critical thinking skills in solving statistical problems. Nearpod offers three accessible roles: students, teachers, and administrators. Users can access Nearpod by visiting <https://nearpod.com/> (Burton, 2019).

**Instrument**

The instrument used in this study was a mathematical critical-thinking test developed by the author, consisting of five essay questions (see Table 1). The questions were compiled based on critical-thinking indicators, according to Ennis (1985), namely: elementary clarification, decision justification, inference, advanced clarification, and strategies and tactics. To ensure objectivity in assessment, a scoring rubric was used as a

guideline for scoring students' answers. Scoring guidelines were based on the Illinois Critical Thinking Essay Test, with the lowest score being zero and the highest being 3 for each indicator.

The instrument's validity was assessed using content validity, involving two experts, namely, two mathematics education lecturers. The results of the expert assessment showed that all items were deemed valid and suitable for use after minor revisions to the wording of the questions. Experts can test the validation results with improvements. The first expert validator provided comments, including suggestions to link indicators to the material, avoid unnecessary sentences, and correct writing errors. For the second expert validator, add a link between the material and the indicators, and further explore each question and possible answer. The reliability test using Cronbach's alpha yields a value of 0.776. Based on the reliability interpretation criteria, this value falls into the acceptable category because it exceeds the minimum threshold of 0.70. This indicates that the instrument has good internal consistency and can be trusted to measure the research construct.

**Table 1.** Critical thinking skills instrument

Indicator	Question
Basic clarification	Table 1 shows the statistics of the test scores of 70 students.

**Table 1.** Statistics test scores

Value	Frequency
60-64	2
65-69	6
70-74	15
75-79	20
80-84	16
85-89	7
90-94	4

Is it true that the mean value is approximately equal to the mode of the data above?

Justification of Decisions (Providing Reasons for a Decision)	Data analysis in Table 2 below:
---	---------------------------------

**Table 2.** Weight of swimming participants

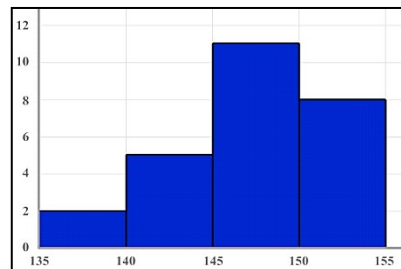
Name	(Kg)
Andin	42

Arsy	42
Bulan	40
Diskyah	41
Ersya	44
Harsya	43
Indah	38
Kencana	38
Laras	39
Mutiara	40
Nur	37
Oesya	41
Putra	38
Sakinah	37
Zaskia	40

Is it correct to say that the average weight of the swimmers is 50 kg? Explain your answer!

Reasoning The average score for the math test of 20 students is 65. If we add several students who have an average score of 70, the average score becomes 68. How many students were added? In your opinion, how did the average score change before and after the addition of these students?

Further Clarification (Further Explanation) Please refer to Figure 1 below.



**Figure 1.** Height of students

Is it true that the lower quartile is greater than the upper quartile? Include your reasoning.

Acceptance and Integration (Assumptions and Cohesion) Mr. Haris and Mr. Jamal each have five goats. The average weight of Mr. Haris' goats is 26 kg, while the average weight of Mr. Jamal's goats is only 24 kg. One of Mr. Jamal's goats was exchanged for one of Mr. Haris' goats so that the average weight of Mr. Jamal's goats was the same as the average weight of Mr. Haris' goats. What was the difference in weight of the goats that were exchanged?

### Data Analysis

The test results were analyzed using statistical inference, including calculating the mean, maximum, and minimum values, and conducting hypothesis tests to answer the research questions. The data analysis was carried out using SPSS

version 25 and Microsoft Excel. Prerequisite test analysis is conducted after the data have been obtained. The prerequisite tests included a normality test (Shapiro-Wilk) and a homogeneity test (Levene's test). Subsequent hypothesis testing was performed using an independent

samples t-test, along with an effect size analysis based on Cohen's guidelines (Cohen, 1988). To obtain the effect size in SPSS, the "Estimate effect sizes" option was selected in the Independent Samples T-Test dialog box. The interpretation of the effect size follows established criteria that indicate the strength of the treatment's impact on students' abilities, as shown by the point estimate values presented in Table 2 of the output.

**Table 2.** Criteria effect size

<i>Effect Size (d)</i>	<i>Interpretation</i>
$d < 0.20$	Ignored
$0.20 \leq d < 0.50$	Small
$0.50 \leq d < 0.80$	Medium
$0.80 \leq d < 1.20$	Large
$1.20 \leq d$	Very Large

(Cohen, 1988)

## ■ RESULT AND DISCUSSION

### Descriptive Data Analysis of Mathematical Critical Thinking Skills

The data obtained in this study are presented to provide an initial overview of the

students' characteristics and the results for the variables studied. Table 3 presents descriptive data on students' critical thinking skills in both the experimental and control classes. It also shows data for students in the Nearpod and conventional learning classes.

In Table 3, the descriptive analysis of the experimental and control classes' mathematical critical thinking ability shows that each has a maximum, minimum, average, and standard deviation (SD). Both classes have the same minimum value: 8.00. However, the maximum value of the experimental class is higher than that of the control class, namely 18.00 and 16.00, respectively. The average (mean) of the experiment class, with the results of 13.24, is more than the average of the control class, which is 12.11, and the SD value of the experiment class, with a value of 2.55, is more than the SD value of the control class, which is 1.95. which indicates that students' critical thinking skills in the experimental class exhibit greater variation, whereas those in the control class tend to be more homogeneous.

**Table 3.** Students' mathematical critical thinking skills

<b>Class</b>	<b>Statistic</b>	<b>Mathematical Critical Thinking Skills</b>
Experimental	Min	8.00
	Max	18.00
	Mean	13.24
	SD	2.55
Control	Min	8.00
	Max	16.00
	Mean	12.11
	SD	1.95

### Analysis Prerequisite Testing

Prerequisite testing is conducted to ensure that the assumptions required for applying the t-test model are met. This involves two types of tests: the normality test and the homogeneity test. The normality test was applied to the data on students' mathematical critical thinking abilities by examining the output of the Shapiro-Wilk test at

$\alpha = 0.05$ . The results of the normality test, obtained in SPSS using the Shapiro-Wilk method, are presented below. Based on the Shapiro-Wilk normality test, the post-test data for the experimental class and control class had a score of 0.972 ( $df = 33$ ,  $p = 0.542 > 0.05$ ), and the control class score was 0.962 ( $df = 35$ ,  $p = 0.259 > 0.05$ ), indicating that the data for both groups

were normally distributed. Once the data were confirmed as being normally distributed, the next step was to perform a homogeneity test. Based on Levene's Test, both data sets are homogeneous ( $F(1, 66) = 1.183, p = 0.183 > 0.05$ ). This indicates that both groups come from populations with the same variance.

### Analysis Hypothesis Testing

**RQ 1. Is there a significant influence on students' critical thinking skills when taught using Nearpod compared to those not taught with it?**

Having met the assumptions of normality and homogeneity, the analysis proceeded with

hypothesis testing using the t-test. The independent-samples t-test was used to compare two independent groups in the study. The t-test results, calculated using the Independent Samples T-Test procedure in SPSS, are presented below. The statistical hypothesis formulation for testing the similarity of two means of post-test data on students' critical thinking skills with a one-tailed test is:

$H_0$ : There was no significant difference between the critical thinking skills of students in the experimental class and the control class.

$H_1$ : The critical thinking skills of students in the experimental class were significantly higher than those in the control class.

**Table 4.** The T-Test

Mathematical Critical Thinking Skills	F	Sig.	t	df	Sig. (1-tailed)
Equal variances assumed	1.18	0.18	2.06	66.00	0.02

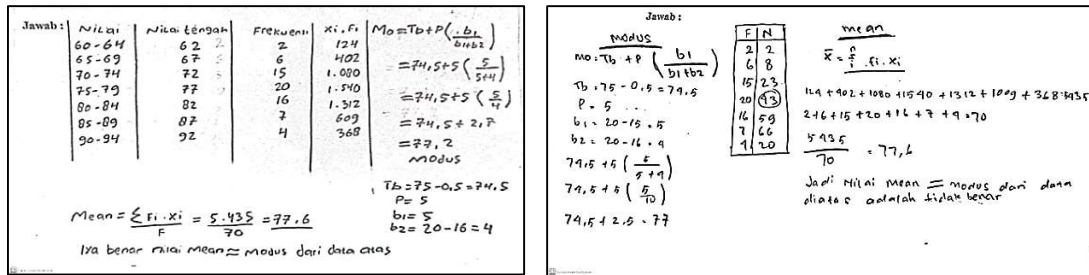
Based on the results of the independent samples t-test, a t-value of 2.056 was obtained with a degree of freedom ( $df = 66$ ) and a significance value (Sig. 1-tailed) of 0.02 ( $< 0.05$ ). Thus,  $H_0$  is rejected, which means that the critical thinking ability of the experimental class is significantly higher than that of the control class. Since there was a significant effect of the treatment in the experimental class, the next step is to answer the researcher's question about the extent to which the delayed treatment affected critical thinking skills.

**RQ2. How significant is the effect of Nearpod on students' critical thinking skills?**

Based on the statistical analysis, Cohen's  $d$  was calculated to quantify the magnitude of the treatment effect. The calculation yielded  $d = 0.50$ , which falls in the medium-to-large effect size category according to Cohen's criteria. These results indicate that the use of Nearpod as an

instructional tool has a meaningful, practically significant impact on students' critical thinking skills. In other words, the differences observed between students before and after the treatment, or between the experimental and comparison groups, are not only statistically significant but also substantively educational. Therefore, it can be concluded that the use of Nearpod positively enhances students' critical thinking skills, demonstrating its effectiveness as a learning medium for developing higher-order thinking. Below are the results of the experimental class students' answers to the questions.

These results indicate that Nearpod positively influences students' critical thinking skills, as evidenced by students' responses in the experimental class. The basic clarification indicator requires students to identify, analyze, and answer questions. The following are the answers to the basic clarification questions from one student in the experimental class and one student in the control class (Halimatun et al., 2020).



(a) (b)  
**Figure 2.** Answers from students (a) with Nearpod and (b) without nearpod

Students in the experimental class were able to determine the answers by rewriting the data presented in the questions and analyzing the questions asked (Darhim et al., 2020). Meanwhile, in the control class, many students were able to identify the information by rewriting the data presented in the question; however, only a few of them solved the question correctly because they did not analyze what was being asked. They looked only for the mode without the mean, or vice versa; they looked only for the mean without the mode; and some reached incorrect conclusions because they did not further analyze the meaning of the questions provided. The results of a small-scale study by Delacruz (2014) show that using Nearpod on iPads in guided reading activities can be easily implemented and increase student engagement. Teachers are encouraged to try this application or similar applications to integrate technology into learning in a meaningful, student-centered way.

Teachers hold a vital role in developing students' critical thinking skills throughout the learning process. One strategy to support this development is integrating technology into instruction. Consequently, an effective learning medium is required to facilitate both teaching and learning activities. In this research, the Nearpod platform was utilized to support the instructional process. This is in agreement with (Naumoska et al., 2022) that using Nearpod, students are more engaged during lessons and actively participate in activities, and these activities have proven successful in maintaining students' attention,

encouraging their class participation, and increasing their motivation to learn, so students appear motivated to work and satisfied with the class implementation.

To access learning through Nearpod, students only need a class code or a link sent by their teacher. This allows them to learn in groups or individually. To access and use Nearpod features, teachers must first register for an account. Using Nearpod's features, teachers can create classes and lesson plans on the website. Teachers can choose to use lessons, videos, activities, or Google Slides in the create section.

Not only for cognitive abilities, but Nearpod implementation is also useful for students' affective development. The implementation of Nearpod in the experimental class created a renewed learning environment, thereby enhancing student motivation (Naumoska et al., 2022). Additionally, its use was found to have a positive effect by helping reduce students' stress levels during learning (Shehata et al., 2020). Nearpod offers user-friendly access across various devices and supports both online and in-person learning environments (Lees et al., 2022). Furthermore, it provides educators with the flexibility to alternate between lecture-based instruction and individual or collaborative learning activities. As noted by Banjarnahor & Tarigan (2023), Nearpod is specifically designed to promote interactive learning experiences.

Nearpod also has advantages, such as being able to connect to Zoom meetings and YouTube. The connection of Nearpod media with

Zoom Meeting aims to engage students effectively in synchronized online classes (Wang & Chia, 2022). YouTube makes learning more flexible. Teachers can easily use Nearpod media to facilitate student learning.

In addition, the connection to YouTube makes it easier for teachers to find additional video resources that support learning. This is consistent with research (Arnesen et al., 2025) showing variation in the use of YouTube for mathematics learning. Teachers may also use interactive exercises and polls at the end of a session to encourage active participation and gather real-time feedback on students' understanding (Burton, 2019). Polls can further be used to explore students' perspectives on the lesson. Hence, Nearpod serves as a supportive instructional medium that can enhance students' critical thinking abilities.

## ■ CONCLUSION

Based on the findings and discussion regarding the influence of Nearpod media on students' mathematical critical thinking skills, it can be concluded that Nearpod has a significant positive effect on improving these skills. Furthermore, Nearpod shows potential as an effective learning tool, enabling teachers to create more interactive and engaging instructional experiences that enhance students' motivation and participation in learning.

However, this study has limitations, particularly the relatively small sample size and the effect size value, which falls within the medium category ( $d = 0.50$ ). These limitations suggest that although the impact of Nearpod is evident, further research with larger, more diverse samples is needed to strengthen the generalizability of the findings.

Additionally, research can be conducted with a larger sample size and include additional variables, and it can be detailed for each indicator of critical thinking ability.

## ■ REFERENCES

- Abachi, H. R., & Muhammad, G. (2014). The impact of m-learning technology on students and educators. *Computers in Human Behavior*, *30*, 491–496. <https://doi.org/10.1016/j.chb.2013.06.018>
- Aktoprak, A., & Hursen, C. (2022). A bibliometric and content analysis of critical thinking in primary education. *Thinking Skills and Creativity*, *44*, Article 101029. <https://doi.org/10.1016/j.tsc.2022.101029>
- Apriliana, L. P., Handayani, I., & Awalludin, S. A. (2019). The effect of problem-centered learning on students' mathematical critical thinking. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, *4*(2), 124–133. <https://doi.org/10.23917/jramathedu.v4i2.8386>
- Arnesen, K. K., Valenta, A., & Radmehr, F. (2025). Mathematical learning opportunities in YouTube resources: An investigation of content creators' positioning and discourse. *Educational Studies in Mathematics*. Advance online publication. <https://doi.org/10.1007/s10649-025-10453-6>
- Banjarnahor, Y. D. M., & Tarigan, D. (2023). Nearpod-based interactive learning media in improving learning outcomes of class V elementary school students. *Indonesian Journal of Advanced Research*, *2*(6), 767–778. <https://doi.org/10.55927/ijar.v2i6.4554>
- Bredberg, J. (2020). The role of mathematics and thinking for democracy in the digital society. *Policy Futures in Education*, *18*(4), 517–530. <https://doi.org/10.1177/1478210319899242>
- Burton, R. (2019). A review of Nearpod: An interactive tool for student engagement. *Journal of Applied Learning & Teaching*, *2*(2), 95–97. <https://doi.org/>

- 10.37074/jalt.2019.2.2.13
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.
- Darhim, Prabawanto, S., & Susilo, B. E. (2020). The effect of problem-based learning and mathematical problem posing in improving students' critical thinking skills. *International Journal of Instruction*, *13*(4), 103–116. <https://doi.org/10.29333/iji.2020.1347a>
- Delacruz, S. (2014). Using Nearpod in elementary guided reading groups. *TechTrends*, *58*(5), 62–69. <https://doi.org/10.1007/s11528-014-0787-9>
- Drijvers, P., & Sinclair, N. (2024). The role of digital technologies in mathematics education: Purposes and perspectives. *ZDM—Mathematics Education*, *56*(2), 239–248. <https://doi.org/10.1007/s11858-023-01535-x>
- Hakami, M. (2020). Using Nearpod as a tool to promote active learning in higher education in a BYOD learning environment. *Journal of Education and Learning*, *9*(1), 119–126. <https://doi.org/10.5539/jel.v9n1p119>
- Halimatun Sa, L., Siahaan, P., Suhendi, E., Samsudin, A., Aminudin, A. H., Rais, A., Sari, I., & Rachmadtullah, R. (2020). Critical Thinking Instrument Test (CTIT): Developing and analyzing Sundanese students' critical thinking skills on physics concepts using Rasch analysis. *International Journal of Psychosocial Rehabilitation*, *24*(8), 2020–2032. <https://doi.org/10.37200/IJPR/V24I8/PR281423>
- Jarrah, A. M., Wardat, Y., Fidalgo, P., & Ali, N. (2025). Gamifying mathematics education through Kahoot: Fostering motivation and achievement in the classroom. *Research and Practice in Technology Enhanced Learning*, *20*, Article 10. <https://doi.org/10.58459/rptel.2025.20010>
- Khusna, A. H., Siswono, T. Y. E., & Wijayanti, P. (2024). Research trends in critical thinking skills in mathematics: A bibliometric study. *International Journal of Evaluation and Research in Education*, *13*(1), 18–30. <https://doi.org/10.11591/ijere.v13i1.26013>
- Kuncoro, K. S., Zakkia, A., Sulistyowati, F., & Kusumaningrum, B. (2021). Students' mathematical critical thinking based on self-esteem through problem-based learning in geometry. *Southeast Asian Mathematics Education Journal*, *11*(1), 41–52. <https://doi.org/10.46517/seamej.v11i1.122>
- Malik, S. (2015). Undergraduates' statistics anxiety: A phenomenological study. *The Qualitative Report*, *20*(2), 120–133.
- Mangarin, R. A., & Caballes, D. O. (2006). Difficulties in learning mathematics: A systematic review. *Revista de Neurología*, *42*(Suppl. 2), 401–405. <https://doi.org/10.33588/rn.42s02.2005787>
- Minalti, M. P., & Erita, Y. (2021). *Penggunaan aplikasi Nearpod untuk bahan ajar pembelajaran tematik terpadu tema 8 subtema 1 pembelajaran 3 kelas IV sekolah dasar* [The use of the Nearpod application for integrated thematic learning materials for theme 8 subtheme 1 learning 3 for grade IV elementary school]. *Journal of Basic Education Studies*, *4*(1), 2231–2246.
- Munthe, A. P. B., Andini, R. T., Humayra, L., & Harahap, M. R. H. (2023). *Analisis kesulitan siswa SMA terhadap materi statistika* [Analysis of high school students' difficulties with statistics material]. *Jurnal Pendidikan Matematika*, *4*(1), 54–61.
- Naumoska, A., Rusevska, K., Blazhevskaja, A., & Stojanovska, M. (2022). Nearpod as a tool for increasing students' motivation for learning chemistry. *International*

- Journal of Education and Learning*, 4(1), 89–99. <https://doi.org/10.31763/ijele.v4i1.616>
- Oktafiani, O., & Mujazi, M. (2022). *Pengaruh media pembelajaran Nearpod terhadap motivasi belajar pada mata pelajaran matematika* [The influence of Nearpod learning media on learning motivation in mathematics subjects]. *JPGI (Jurnal Penelitian Guru Indonesia)*, 7(1), 124–130. <https://doi.org/10.29210/022033jpgi0005>
- Pérez, J. E. (2017). Nearpod. *Journal of the Medical Library Association*, 105(1), 108–110. <https://doi.org/10.5195/jmla.2017.121>
- Popova, Y., Abduliyeva, M., Torebek, Y., & Saidakhmetov, P. (2024). Factors propelling mathematics learning: Insights from a quantitative empirical study. *International Journal of Evaluation and Research in Education*, 13(2), 1159–1172. <https://doi.org/10.11591/ijere.v13i2.27322>
- Ratnawati, D., Handayani, I., & Hadi, W. (2020). *Pengaruh model pembelajaran problem-based learning berbantu question card terhadap kemampuan berpikir kritis matematis siswa SMP* [The influence of the problem-based learning model assisted by question cards on the mathematical critical thinking skills of junior high school students]. *Edumatica: Jurnal Pendidikan Matematika*, 10(1), 44–51. <https://doi.org/10.22437/edumatica.v10i01.7683>
- Salsabila, U. H., Habiba, I. S., Amanah, I. L., Istiqomah, N. A., & Difany, S. (2020). *Pemanfaatan aplikasi Quizizz sebagai media pembelajaran di tengah pandemi pada siswa SMA* [Utilization of the Quizizz application as a learning medium during the pandemic for high school students]. *Jurnal Ilmiah Ilmu Terapan Universitas Jambi*, 4(2), 163–173. <https://doi.org/10.22437/jiituj.v4i2.11605>
- Shehata, N., Mitry, C., Shawki, M., & El-Helaly, M. (2020). Incorporating Nearpod in undergraduate financial accounting classes in Egypt. *Accounting Education*, 29(2), 137–152. <https://doi.org/10.1080/09639284.2019.1704806>
- Sriraman, B., & English, L. D. (2005). Theories of mathematics education: A global survey of theoretical frameworks and trends in mathematics education research. *ZDM—International Journal on Mathematics Education*, 37(6), 450–456. <https://doi.org/10.1007/BF02655853>
- Suliani, M., & Saputri, R. A. (2021). *Analisis kesulitan guru dan siswa pada materi statistika di SMA Advent Purwodadi* [Analysis of teacher and student difficulties in statistics material at Purwodadi Adventist High School]. *Mandalika Mathematics and Educations Journal*, 3(1), 40–51. <https://doi.org/10.29303/jm.v3i1.2673>
- Syaiful, S., Mukminin, A., & Puspayanti, P. (2025). Using APOS theory in learning basic mathematics to promote students' mathematical critical thinking skills. *Discover Education*, 4(1). <https://doi.org/10.1007/s44217-025-00863-2>
- Trisnani, N., Retnawati, H., & Wuryandani, W. (2024). Challenges of Indonesian elementary school mathematics teachers in integrating critical thinking into the classroom. *Journal on Mathematics Education*, 15(3), 905–924. <https://doi.org/10.22342/jme.v15i3.pp905-924>
- Veng, S. (2023). Using an online student response system to promote student engagement in critical thinking classes. *International Journal of TESOL Studies*, 5(1), 69–86. <https://doi.org/10.58304/ijts.20230106>
- Wagner, D., Prediger, S., Artigue, M., Bikner-

- Ahsbabs, A., Fitzsimons, G., Meaney, T., Mesa, V., Pitta-Pantazi, D., Radford, L., & Tabach, M. (2023). The field of mathematics education research and its boundaries. *Educational Studies in Mathematics*, 114(3), 367–369. <https://doi.org/10.1007/s10649-023-10270-9>
- Wang, J., & Chia, I. (2022). Engaging students via Nearpod® in synchronous online teaching. *Management Teaching Review*, 7(3), 245–253. <https://doi.org/10.1177/2379298120974959>