

Developing Nearpod-based interactive learning media on the topic of algebra to improve critical thinking ability

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Received: 12 June 2024 / Accepted: 25 December 2025 / Published Online: 12 June 2026

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Abstract

Interactive learning has become a necessity in the modern educational era, particularly for facilitating students' understanding of abstract mathematical concepts such as algebra. Difficulties in comprehending algebraic concepts often hinder the development of students' critical thinking skills, which are essential for solving problems and making logical decisions. This study aimed to develop Nearpod-assisted interactive learning media and examine its effectiveness in enhancing students' critical thinking skills in algebra. The study employed the Thiagarajan (4-D) development model, consisting of four stages, namely define, design, develop, and disseminate. The research subjects were selected through purposive sampling and consisted of 31 seventh-grade students (16 females and 15 males) from Class VII G of State Junior High School 4 Jember, Indonesia, who demonstrated low levels of critical thinking skills based on the results of an initial assessment. Data were collected through classroom observations, critical thinking tests, and student response questionnaires. The effectiveness of the developed media was evaluated by testing the research hypothesis regarding the impact of Nearpod-assisted learning on students' critical thinking skills. Data were analyzed using a paired-samples t-test and N-Gain analysis. The t-test results showed a significance value (Sig. 2-tailed) of 0.000 (< 0.05), indicating a significant difference between the mean pre-test and post-test scores. Furthermore, the N-Gain percentage reached 80.19%, indicating a high level of improvement. These findings suggest that Nearpod-assisted interactive learning media is effective in improving students' critical thinking skills in algebra and positively contributes to their learning outcomes at State Junior High School 4 Jember.

Keywords: Algebra, Interactive, Critical Thinking Skills, Nearpod

How to Cite: Kurniati, D., Setiawati, S., Jatmiko, D.D.H., Kristiana, A.I., & Prihandini, R.M. (2026). Developing Nearpod-based interactive learning media on the topic of algebra to improve critical thinking ability. *AXIOM : Jurnal Pendidikan dan Matematika*, 15(1), 1-14. <https://doi.org/10.30821/axiom.v15i1.20543>

Introduction

Mathematics instruction plays an essential role in fostering students' critical, analytical, and logical thinking skills (Sa'adilla et al., 2022). As a universal discipline, mathematics supports students' mastery of various other fields of science (Gunawan et al., 2023; Umami et al., 2023). In practice, however, many students perceive mathematics as a difficult and abstract subject, particularly in the context of algebraic material (Clove et al., 2023). These difficulties can be mitigated through the use of appropriate learning media (Fadilah et al., 2023).



Learning media play a crucial role in creating interactive and engaging learning environments (Chairunnas et al., 2022; Wisada et al., 2019). In mathematics learning, instructional media function to transform abstract concepts into more concrete representations, thereby facilitating students' understanding of the material (Yuliyanti et al., 2021). Interactive learning media can increase students' engagement during the learning process, provide meaningful learning experiences, and motivate them to develop their mathematical abilities (Wisada et al., 2019; Wulandari et al., 2023). Furthermore, the integration of technology-based media has been proven to enhance students' critical thinking skills by offering more appealing and enjoyable learning approaches (Hakami, 2020).

One of the most important mathematical competencies is critical thinking ability (Koto & Priyanda, 2021). Critical thinking enables students to analyze problems, evaluate information, and construct logical solutions (Facione, 1998). In mathematics learning, critical thinking plays a significant role in helping students understand more complex concepts and apply them across various contexts (Facione, 1998; Karim & Normaya, 2015). However, existing studies indicate that Indonesian students' critical thinking skills remain low, particularly in algebra (Mursidah et al., 2023). Previous research has also shown that students often face difficulties in interpreting problems that connect algebraic concepts to real-world contexts, which restricts their ability to carry out in-depth analytical reasoning (Baidoo & Ali, 2023).

At present, most mathematical learning media used in schools remain conventional, including textbooks, student worksheets, and PowerPoint presentations. (Prihandini & Siswati, 2022) emphasized that the development of learning media should align with technological advancements. Nonetheless, the use of interactive, technology-based media remains limited (Hendi et al., 2020). In fact, prior studies have demonstrated that the use of technology-enhanced learning media, such as animated videos and learning applications, can significantly improve students' understanding of mathematical concepts (Febrita & Ulfah, 2019; Saputra et al., 2022).

Findings from the preliminary study also indicate that students' critical thinking abilities in algebra are relatively low. Most students are only able to identify basic information without being able to solve the given problems (Rahayu et al., 2022). Other studies similarly report that students frequently struggle to relate algebraic concepts to real-life situations, which contributes to their limited ability to evaluate and analyze mathematical problems (Rangkuti, 2022).

As a solution, this study developed a Nearpod based interactive learning medium designed to enhance students' critical thinking skills on algebraic topics. This medium integrates animated videos, interactive quizzes, and evaluative features specifically designed to cultivate critical thinking skills (Nisa, 2023). Nearpod was selected due to its diverse features that enable students to learn independently and interactively (Chairunnas et al., 2022).

Previous studies by (Nisa, 2023; Suprapti, 2024; Susanto, 2021) have shown that Nearpod-based learning media are effective in improving students' critical thinking skills, demonstrating the platform's strong educational potential. However, the present study offers novelty by integrating animated instructional videos created using the Plotagon Studio application into Nearpod, in which the material is presented through characters and interactive narrative storytelling. This aligns with the findings of (Saputra et al., 2022), who demonstrated that

animated visualization of abstract mathematical concepts can significantly enhance students' conceptual understanding.

The purpose of this study is to examine the validity, practicality, and effectiveness of the Nearpod based interactive learning medium in improving the critical thinking skills of Class VII-G (equivalent to Grade 7) students at State Junior High School 4 Jember, Indonesia. Through this approach, students are expected to develop a deeper understanding of algebraic concepts and demonstrate significant improvements in their critical thinking abilities.

Methods

This study employed a research and development (R&D) design using the 4-D development model proposed by (Thiagarajan & Sivasailam, 1974). The model was selected because it offers a systematic sequence of stages namely Define, Design, Develop, and Disseminate which comprehensively cover needs analysis, product design, product development, and product distribution. These stages ensure that the instructional media produced are valid, practical, and effective for classroom use (Zamsiswaya et al., 2024). Compared to other development models such as ADDIE, PLOMP, or ASSURE, the 4-D model places greater emphasis on continuous product validation at each stage of development, making it appropriate for this study, which aims to produce a new form of instructional media. The 4-D model has been widely implemented in the development of interactive learning media (Suprapti, 2024), demonstrating its flexibility and effectiveness in producing learning tools that enhance students' abilities, including critical thinking skills. In this study, the product developed was assessed in terms of its validity, practicality, and effectiveness.

The research subjects consisted of 31 seventh-grade students of State Junior High School 4 Jember in the 2023/2024 academic year, comprising 16 female and 15 male students from Class VII(G). The subjects were selected through purposive sampling based on their low critical thinking performance, as identified through teacher interviews and an initial diagnostic test. Research data were obtained from one mathematics teacher and the participating students.

Referring to the stages proposed by (Thiagarajan & Sivasailam, 1974), the procedures of this study were carried out as Figure 1. In the Define stage, problems were identified through teacher interviews and diagnostic tests, which indicated that students demonstrated low critical thinking skills in algebra. The needs analysis revealed the necessity for interactive learning media to enhance student engagement and improve critical thinking skills. In the Design stage, Nearpod-based interactive learning media were designed, incorporating animated videos, interactive quizzes, and built-in evaluation features. The media were developed in HTML format to enable online accessibility. A test blueprint was constructed to measure critical thinking indicators, including interpretation, analysis, evaluation, and inference. In the Develop stage, the media prototype was evaluated by expert validators, and revisions were made based on their feedback. A pre-test and post-test were administered to measure the effectiveness of the developed media. Finally, in the Disseminate stage, the finalized media were distributed offline at the school and online through platforms such as Instagram and YouTube to ensure broader accessibility.

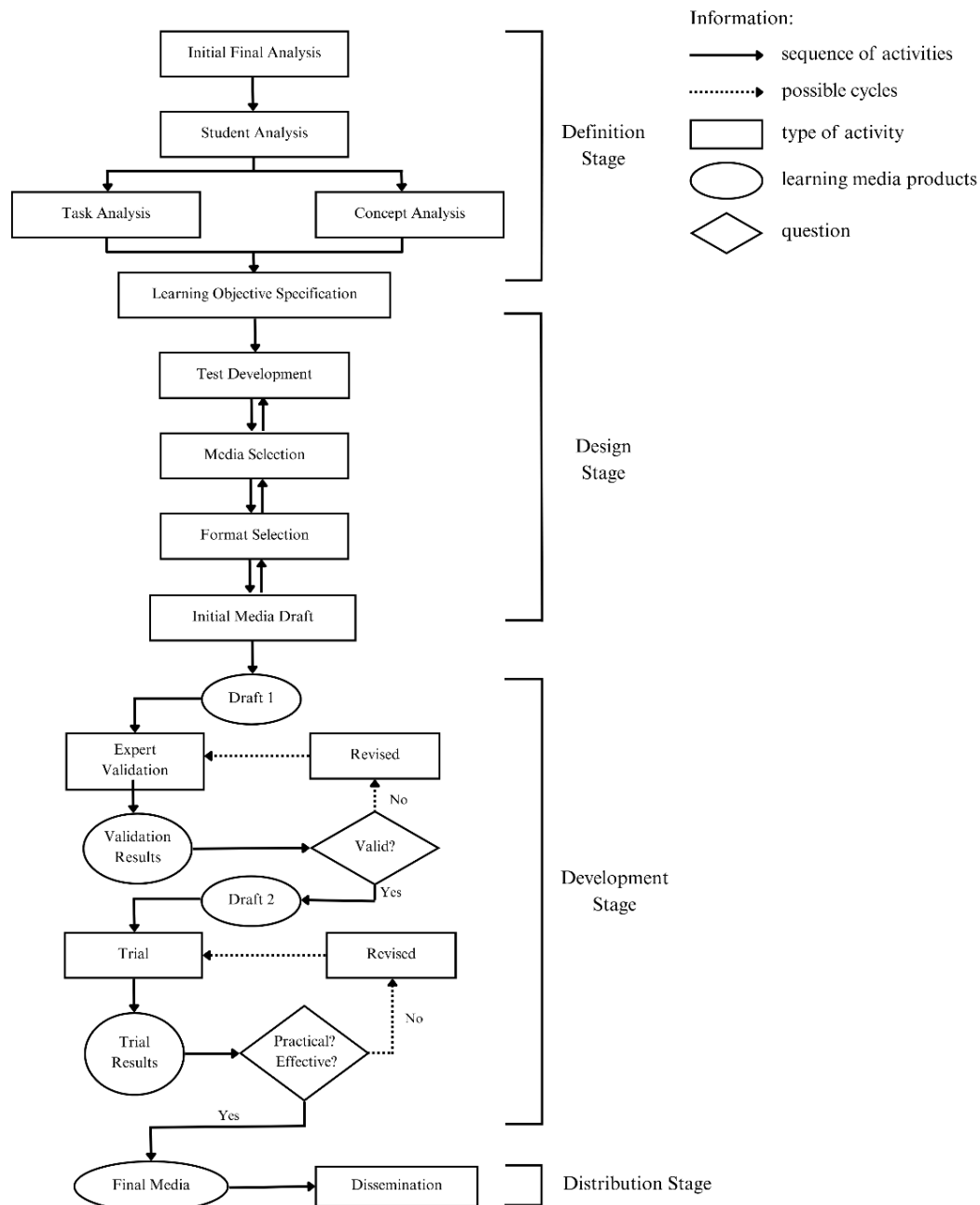


Figure 1. Development Stages of the Learning Media

Data collection involved expert validation of the learning media, followed by testing the media's effectiveness through a comparison of pre-test and post-test scores. The practicality of the learning media was assessed through user response questionnaires completed by the students. Instrument validity was considered fulfilled when validity scores met the criteria of valid $3 \leq V_a < 4$ or very valid $V_a = 4$. If the scores did not meet these criteria, revisions were required based on validator recommendations (Ratumanan & Laurens, 2003). The practicality of the learning media was determined using the results of user response questionnaires. According to (Nieveen, 1999), practicality is achieved if the obtained percentage score falls into the good category $80 \leq P < 95$ or very good category $P \geq 95$.

To evaluate the media's effectiveness, the improvement between pre-test and post-test scores was analyzed. A paired-sample t-test was conducted to examine whether the use of the

learning media significantly influenced students' critical thinking skills. The study tested two hypotheses: H_0 , indicating no significant difference between the mean pre-test and post-test scores; and H_1 : indicating a significant difference between the mean scores. If a significant effect was found, N-Gain analysis was performed to classify the level of improvement in students' critical thinking skills before and after using the media. The N-Gain classification used in this study refers to (Hake, 1999), as presented in Table 1.

Table 1. Classification of N-Gain values

Value g	Classification
$g > 0,70$	High
$0,30 \leq g \leq 0,70$	Moderate
$g < 0,30$	Low

Furthermore, the interpretation of the media's overall effectiveness was determined based on the classification of the N-Gain scores. The learning media was considered effective if more than 75% of students achieved N-Gain values falling within the moderate or high improvement categories.

Result

Define Stage

The first step in the define stage was to identify problems encountered in mathematics instruction, particularly in the algebra topic taught at State Junior High School 4 Jember, Indonesia. This identification process aimed to analyze students' needs, the learning context, and instructional challenges. The analysis was conducted based on teacher interviews, school environment observations, and the availability of supporting facilities. The results of this analysis served as the foundation for determining the objectives of the learning media to be developed.

Findings from the teacher interview indicated that conventional teaching methods remain dominant in mathematics instruction. Learning media are limited to textbooks, student worksheets, PowerPoint presentations, and YouTube videos. In contrast, the school already provides Wi-Fi access and computer laboratory facilities that could support more engaging instruction and foster greater student interactivity.

Students expressed high interest in video-based learning delivered through a projector. Several students even requested that videos be replayed to ensure a better understanding of the content. However, many students quickly forgot the material because their learning was limited to direct instruction within class time. Results from assignments and tests further revealed that students struggled to understand contextual problems, particularly in algebra. A preliminary test integrating contextual problems with critical thinking indicators also showed that students could only identify the given information without being able to solve the provided tasks.

The learning material presented in the media focuses on algebra, including algebraic expressions, components of algebra, and operations such as addition, subtraction, multiplication, and division. The learning objective refers to students' ability to represent situations using algebraic expressions. Based on a review of the learning objectives, specific learning outcomes were formulated for the media being developed. Two branched open-ended

questions were administered before and after the implementation of the media to measure improvements in students' critical thinking skills in algebra.

The analysis of students' critical thinking development refers to the critical thinking indicators proposed by Facione, as adapted by (Karim & Normaya, 2015). These indicators include: 1) Interpretation, in which students are expected to restate the problem by identifying the given and required information clearly and accurately, 2) Analysis, where students are expected to determine relationships among statements, questions, or concepts by constructing appropriate mathematical models and providing accurate explanations, 3) Evaluation, in which students are expected to apply suitable strategies to solve the problems and perform complete and accurate calculations; and, 4) Inference, where students are expected to draw appropriate and logical conclusions.

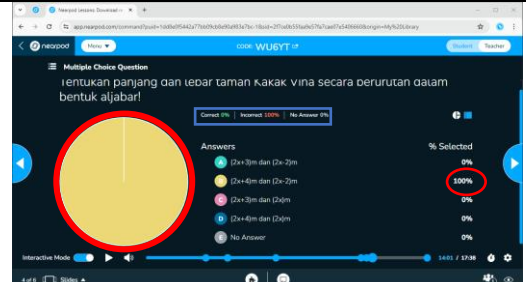
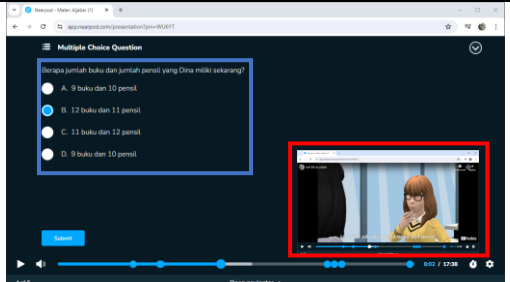
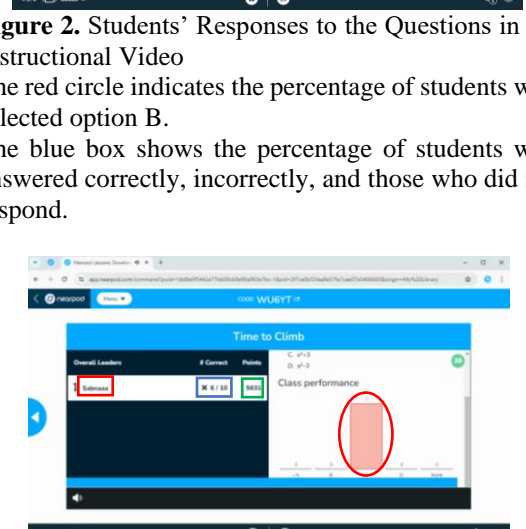
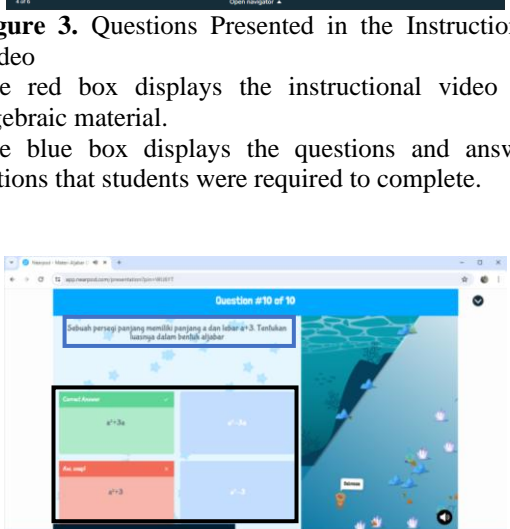
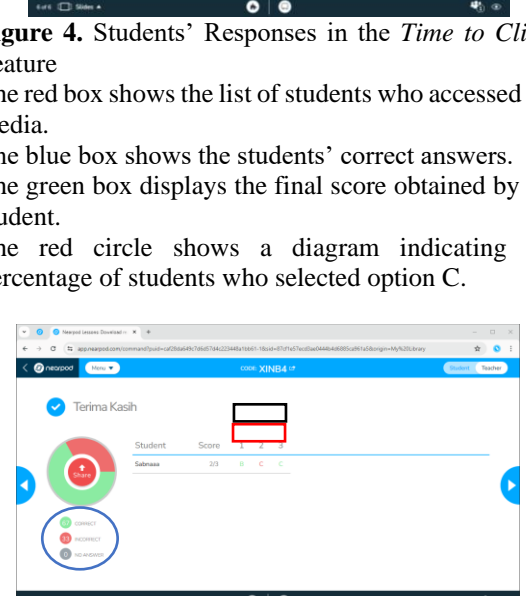
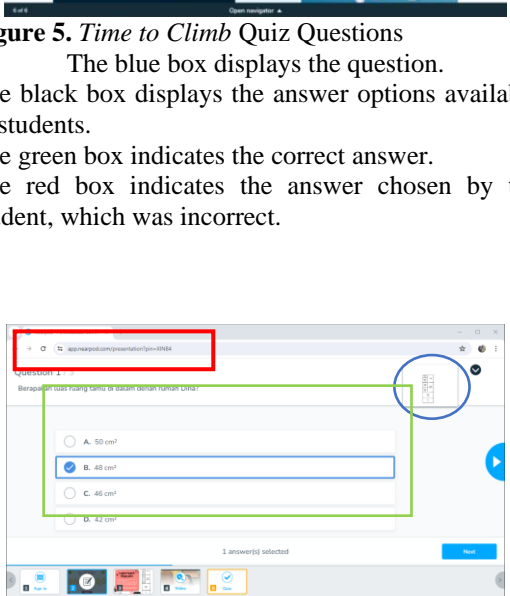
Design Stage

In the design stage, several activities were undertaken, including constructing the test blueprint, selecting the media, determining the format, and developing the initial media prototype. The critical thinking test consisted of two branched open-ended questions that students were required to complete within 60 minutes. The selection of learning media was based on the analysis conducted during the define stage. Considering students' preferences, the learning material was presented in the form of animated videos created using the Plotagon application. Plotagon was chosen because it provides customizable settings, characters, and animations, enabling the researcher to produce engaging instructional videos. Students accessed these videos through the Nearpod platform developed for this study. Nearpod was selected due to its variety of interactive features that support student engagement.

The learning media were developed in HTML format and made accessible through the Nearpod website (<https://nearpod.com>). The link can be opened using browsers such as Google Chrome, Microsoft Edge, or Mozilla Firefox. The media can only be accessed online using an internet connection. Within the learning media, animated videos present contextual problems experienced by the characters. Indicators of critical thinking skills were embedded in each step of the problem-solving process within the interactive instructional videos. The first media presentation introduces Algebraic Concepts, while the second focuses on Contextual Problems in Algebra. Before accessing the material, students are required to enter their full names on an initial slide. They are then provided with learning instructions and several short interactive quizzes, such as interactive videos, Time to Climb activities, and multiple-choice questions.

A key advantage of Nearpod in designing the learning media is its availability of integrated quiz features, including score display, answer review, downloadable reports, and other instructional tools. Additionally, Nearpod provides an option to prevent users from skipping slides, ensuring that students engage with the learning content sequentially from beginning to end. The appearance of the developed media is presented in Table 2.

Table 2. Learning Media Display

Teacher Display	Student Display
 <p>Figure 2. Students' Responses to the Questions in the Instructional Video The red circle indicates the percentage of students who selected option B. The blue box shows the percentage of students who answered correctly, incorrectly, and those who did not respond.</p>	 <p>Figure 3. Questions Presented in the Instructional Video The red box displays the instructional video on algebraic material. The blue box displays the questions and answer options that students were required to complete.</p>
 <p>Figure 4. Students' Responses in the Time to Climb Feature The red box shows the list of students who accessed the media. The blue box shows the students' correct answers. The green box displays the final score obtained by the student. The red circle shows a diagram indicating the percentage of students who selected option C.</p>	 <p>Figure 5. Time to Climb Quiz Questions The blue box displays the question. The black box displays the answer options available to students. The green box indicates the correct answer. The red box indicates the answer chosen by the student, which was incorrect.</p>
 <p>Figure 6. Students' Responses in the Quiz Feature The black box displays the question number. The red box shows the answer choice selected by the student. The blue circle indicates the percentage score obtained by the student.</p>	 <p>Figure 7. Questions in the Quiz Feature The red box displays the question. The green box shows the answer options available to students. The blue circle displays the house layout image presented in the question.</p>

Development Stage

During the development stage, several activities were carried out, including testing, evaluation, and revision. The validation process was conducted by expert validators (a lecturer

and a mathematics teacher). After the validation, revisions were made based on the validators' suggestions, followed by the calculation of the media's validity score. In addition, students were asked to complete a response questionnaire to assess the practicality of the developed learning media. Subsequently, the researcher administered evaluation tests consisting of a pre-test and a post-test. The students' test scores were then analyzed using the assessment rubric to determine the effectiveness of the media.

The analysis of the validation results for the Nearpod based interactive learning media is presented in Table 3. Based on the established validity criteria, the findings indicate that the developed media fall into the valid category, with an average total score (V_a) of 3.8. Although the media were categorized as valid, the validators provided revision notes related to navigation features. Nevertheless, because the Nearpod platform does not allow additional custom navigation settings, the researcher employed only the default navigation buttons provided within the platform.

Table 3. Data Analysis of Media Validation Results

No.	Aspects Assessed	A_i
1	Ease of navigation	3.75
2	Cognition content	3.8
3	Presentation Information	3.78
4	Media Integration	4
5	Artistic and Aesthetic	3.83
6	Overall Function	3.67
Total Average Value (V_a)		3.8

The analysis of the practicality level, assessed based on the established practicality criteria and the results of the user response questionnaire validation, indicates that the Nearpod-based learning media meet the criteria for practicality. The media were categorized as practical with a good classification, obtaining an average total score (V_a) of 3.89 and a percentage score of 84.89%.

Table 4. Data Analysis of User Response Questionnaire Results

No.	Aspects Assessed	A_i
1	Format	4
2	Content	4
3	Language Quality	3.67
Total Average Value (V_a)		3.89

The effectiveness analysis was determined based on the learning outcome tests administered to 31 students of Class VII-G at State Junior High School 4 Jember, Indonesia, who served as the research subjects. The effectiveness results were obtained from the pre-test and post-test scores, which were subsequently analyzed using a Paired Sample t-test and N-Gain. The Paired Sample t-test was conducted to assess the impact of the learning media on students' critical thinking skills by examining whether a significant difference existed between the mean pre-test and post-test scores. The output of the Paired Sample t-test is presented in Table 5.

Table 5. Result of Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	6.7097	31	1.65718	0.29764
	Posttest	26.9677	31	2.27279	0.40821

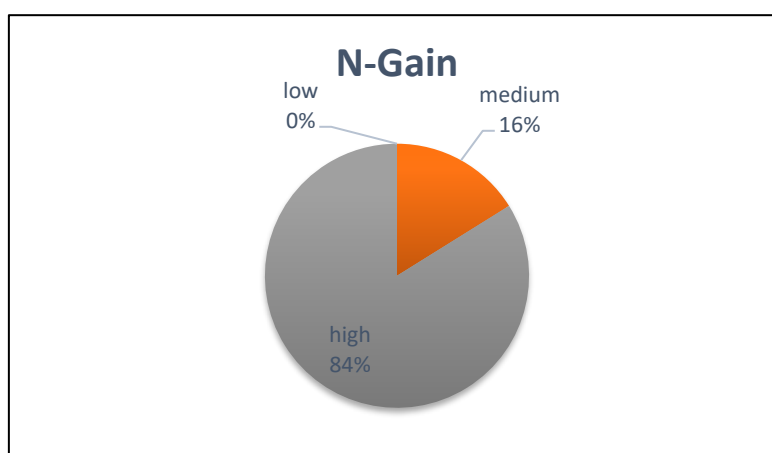
Based on Table 5, the average pre-test score was 6.71, whereas the average post-test score was 26.96, with a total of 31 student participants. Since the average pre-test score of 6.71 was lower than the Post-Test score of 26.96, the implementation of the learning media resulted in a significant difference between the pre-test and post-test mean scores. The results of the Paired Samples t-test are presented in Table 6 below.

Table 6. Results of the Paired Samples t-Test

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	pretest-posttest	-20.26	2.38	0.43	-21.13	-19.39	-47.39	30	0.000

The interpretation was based on the Paired Samples t-test, specifically the Sig. (2-tailed) value. As shown in Table 6, the obtained Sig. (2-tailed) value was 0.000, which is lower than 0.05. Therefore, a significant difference exists between the mean pre-test and post-test scores. It can thus be concluded that the use of the learning media had a positive effect on improving students' critical thinking skills.

After confirming that the learning media produced a significant improvement in students' critical thinking skills aligned with the objectives of this study the N-Gain analysis was subsequently conducted. The results are presented in the following graph.

**Graph 1.** N-Gain Analysis Results

Based on the graph, the results show that 26 students experienced a significant improvement in critical thinking skills, categorized as having a high N-Gain score, while 5 students obtained a moderate N-Gain score. The mean pre-test and post-test scores of the Class VII-G students were 6.71 and 26.96, respectively, with a maximum possible score of 32. The calculated N-Gain value was 0.80, with an N-Gain percentage of 80.19%. When interpreted

using the effectiveness criteria, this percentage indicates that the learning media is effective, as it exceeds the threshold of 75%.

Dissemination Stage

The dissemination stage was carried out to distribute the learning media that had been tested for its validity, effectiveness, and practicality. The dissemination was conducted offline at State Junior High School 4 Jember, Indonesia, which served as the trial location for this study. In addition, the media was disseminated online through Instagram under the username *virg.oandme* and via the following YouTube link: <https://www.youtube.com/watch?v=jVFTUg1Dq7k&list=PLrQ5Q1bZX-oOQkg0enPvOlgRwoCiKKe9G&pp=gAQBiAQB>

Discussion

The results of this study indicate that the Nearpod-based learning media was effective in improving students' critical thinking skills. This finding aligns with theories and previous studies emphasizing the importance of interactive learning media in enhancing learning outcomes and higher-order thinking skills (Akker et al., 2007). The media was intentionally designed to train students in interpretation, analysis, evaluation, and inference, which correspond to (Facione, 1998) critical thinking indicators. Through structured activities embedded in videos, quizzes, and discussion prompts, students were encouraged to engage actively with contextual algebra problems rather than passively receive information.

The interpretation indicator was facilitated through guiding questions embedded in instructional videos, such as asking whether the information provided was sufficient to determine the area of rooms in a contextual scenario. Such questions required students to identify relevant information and examine the adequacy of given data, thereby fostering deeper conceptual understanding. The inclusion of immediate feedback after students submitted their responses further strengthened this process. According to (Hattie & Timperley, 2007), effective feedback plays a crucial role in improving student understanding by clarifying misconceptions and guiding future learning steps. The anti-skip feature in Nearpod also ensured that students followed the learning sequence systematically, promoting structured cognitive engagement.

The analysis and evaluation indicators were developed through problem-solving activities involving mathematical modeling and calculation tasks. For example, students modeled room dimensions using algebraic variables and applied formulas such as $2 \times (\text{length} + \text{width})$ to determine perimeters. These activities required students to connect abstract algebraic representations with real-life contexts, supporting findings by (Umami et al., 2023) that analytical skills in mathematics enhance the relationship between abstract concepts and practical applications. Furthermore, evaluation tasks encouraged students to review their solution steps and verify the accuracy of their results, which is consistent with (Rahayu et al., 2022), who emphasized evaluation as a key stage in developing reflective mathematical thinking.

The implementation of the media was conducted online using students' mobile devices due to limited school scheduling, which allowed only two research meetings. Although conducted remotely, this format enabled students to revisit learning materials at their convenience,

potentially strengthening content mastery. Nearpod was selected for its interactive features, including quizzes, videos, discussion prompts, automated analytics, and downloadable student reports. These features facilitated monitoring of student progress and participation (Chairunnas et al., 2022). However, certain technical limitations were identified. Essay responses were not automatically graded by the platform, and stable internet access was required. Some students experienced connectivity issues or browser incompatibility, which were addressed by recommending the use of Google Chrome and extending access time to refresh the learning code.

Quantitatively, the effectiveness of the media was reflected in the average N-Gain score of 0.80, which falls into the high category, indicating substantial improvement in students' critical thinking skills. This result supports previous findings by (Nisa, 2023; Susanto, 2021), which reported that Nearpod-based learning media significantly improve learning outcomes across various subjects, including mathematics. The consistent improvement suggests that the integration of interactive digital media with structured critical thinking indicators can meaningfully enhance students' cognitive development.

Despite these positive findings, this study has several limitations, particularly the absence of a small-group trial prior to large-group implementation. This limitation may have affected the refinement process of the media before broader application. Therefore, future research is recommended to incorporate a small-group trial phase to optimize product development and to further examine the effectiveness of Nearpod-based media across different topics and educational levels.

Conclusion

Based on the findings and discussion, it can be concluded that the Nearpod-based interactive learning media developed in this study met the criteria of validity, practicality, and effectiveness. The media obtained an average validity score of 3.89 and an average practicality score of 3.89, both categorized as valid and practical. Furthermore, the overall N-Gain score of 80.19% indicated a high level of improvement in students' critical thinking skills. These results demonstrate that the developed media is suitable for use in mathematics learning, particularly in algebra topics at the junior high school level.

However, this study has several limitations. First, the development process did not include a small-group trial prior to large-group implementation, which may have limited opportunities for further refinement of the media. Second, the research was conducted within a limited timeframe of only two meetings. Third, the implementation of the Nearpod-based media required a stable internet connection, which may present challenges for students in areas with limited network access.

Future research is recommended to conduct comparative studies between Nearpod-based learning and conventional instructional methods to examine their relative effectiveness in enhancing students' critical thinking skills. In addition, incorporating a small-group trial phase is suggested to optimize the development process before large-scale implementation. Further studies may also explore adaptations of the media for offline or low-connectivity environments, as well as its application in other subject areas or educational levels to broaden its impact.

Declarations

- Author Contribution : DK: Conceptualization, Methodology, Data Curation, Supervision, Project administration, Funding acquisition
 SS: Software, Formal analysis, Investigation, Visualization
 DDHJ: Validation, Writing – Review & Editing
 AIK: Validation, Resources, Writing – Review & Editing
 RMP: Validation, Resources, Writing – Review & Editing
- Funding Statement : This research was funded by "Hibah Percepatan Guru Besar-Universitas Jember Tahun 2025" No. 2765/UN25/KP/2025.
- Conflict of Interest : The authors declare no conflict of interest.
- Additional Information : No additional information is available for this paper.

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