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Development of Nearpod-based Interactive Media on Microplastic Material to Improve Students' Critical Thinking Skills in P5P2RA Activities

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Abstract

Microplastic particles have widely polluted the environment, including water, soil, and air, and can enter the human food chain, potentially causing health problems. Therefore, effective and engaging teaching of microplastic material is crucial to enhance students' understanding, motivation, and critical thinking skills, preparing them to face complex problems in everyday life. This study aims to develop interactive learning media based on Nearpod with microplastic material to improve students' critical thinking skills in P5P2RA activities in madrasas. The research method used is research and Development (R&D) with the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The subjects of the study were 32 of 7th grade students at one of the MTs in Jakarta. The results showed that the critical thinking ability instrument had a validity score of 3.1, a practicality level with an average score of 2.8 (good category), an average n-gain of critical thinking skills of 0.6 (moderate category), and student response assessments with an average percentage of 77% (good category). The paired t-test results showed a p-value of 0.0007, indicating that the intervention was effective in improving students' critical thinking ability scores. Thus, interactive teaching materials based on Nearpod can be used as an effective alternative learning media, especially for microplastic material, in improving students' critical thinking skills.

Keywords: critical thinking, interactive learning, nearpod, P5P2RA

Introduction

Plastic was produced worldwide around 368 million metric tons (MMT) in 2019, and half of it was produced in Asia (Tiseo, 2021). Meanwhile, the production of plastic waste entering the ocean is estimated to be between 4.8 and 12.7 million metric tons (MMT) (Jambeck et al., 2015). By 2050, it is estimated that around 12 billion metric tons of plastic waste will be in landfills which will affect natural habitats, which is 60% of all plastic products produced in 2015 (Geyer et al., 2017). The increasing human need for the use of plastic products has led to the continued increase in plastic production. Plastic waste has resistance and properties, low recovery rates cause an increase in the number of plastic fragments along the coastline, water surface, water depth, and sediment (Barnes et al., 2009).

Plastic waste cannot be decomposed biologically. Over time, plastic waste will disintegrate into very small pieces measuring micro to nano (Allan et al., 2021; Hartmann et al., 2019). All plastic materials that enter the environment as waste can become microplastics and nanoplastics through several processes including physical, chemical, and biological (Galgani, 2015). There are several characteristics of microplastics found in the environment that vary in terms of shape, size, colour, and type of polymer (Browne et al., 2011).

Microplastics are found in various ecosystems, including oceans, rivers, and even the atmosphere. Microplastic particles will accumulate in the food chain, starting from plankton to top predators, including humans. Microplastics contain hazardous chemicals such as pesticides and heavy metals that can cause various health problems when consumed by humans. Based on research findings, exposure to microplastics can cause inflammation and tissue damage in marine organisms. When humans consume microplastics through seafood, it may lead to hormonal disorders, reproductive disorders, and other chronic diseases (Aulia et al., 2023).

Currently, there are several steps to reduce the impact of microplastics such as a ban on the use of very thin plastic products, plastic shopping bags with a thickness of less than 40 microns, and an efficient recycling system for all plastic products. Other steps, such as enforcing laws against the misuse of plastic products, developing bioplastics, and discovering microbial enzymes that can degrade plastic, can be implemented to minimize microplastic pollution in the environment. Adequately designed studies are needed to prove the effects of microplastic exposure on humans and their impacts on health. Efforts to raise awareness through education in schools, universities, government, and non-government organizations are urgently needed to highlight the chronic impacts of microplastics. Counselling programmes and campaigns through education provide education to foster a responsible attitude of individuals in minimizing plastic use through rejection, reduction, reuse, and recycling programs will help reduce microplastic pollution (Lamichhane et al., 2023).

Microplastics are major threats to the environment and human health; therefore, educating students about this threat is very important. With proper knowledge, students can understand the sources, impacts, and effects of microplastics pollution in the environment. This will increase motivation and sense of responsibility to take appropriate action to contribute in reducing microplastic pollution (Raab & Bogner, 2020). The results of the study showed that microplastics have been found in the bodies of aquatic biota and indicate potential risks to the ecosystem and human health (Wisnu & Radityaningrum, 2021).

The development of microplastics research has been quite advanced in Indonesia but still finds challenges in identifying and managing the risks of microplastics to the environment and human health. The importance of collaboration between institutions and researchers is needed to accelerate the development of microplastic research in Indonesia (Alam & Rachmawati, 2020). Experts believe that effective action is needed to reduce microplastic pollution, although there are still challenges in determining the most effective and practical solutions (Grünzner et al., 2023). Environmental education in schools should be able to play an important role in shaping students' awareness of environmental issues. An integrated curriculum and interactive learning can help students understand the impacts of harmful human activities on the environment, the importance of maintaining ecosystem balance, and ultimately motivate them to take proactive action in finding solutions. Participation in science project activities, environmental campaigns, and direct real activities in the environment can strengthen students' understanding and commitment to environmental sustainability. Research shows that students involved in environmental education activities tend to develop positive attitudes and behaviors toward the environment. They are also more likely to be pro-environmental and influence their communities to care about environmental issues (Ilham et al., 2023).

Based on research, interactive learning using e-modules and multimedia can improve critical thinking skills since it makes students more active in learning (Robbani, 2023). Critical thinking skills can also be achieved by using interactive learning media and *Google Classroom* (Arif et al., 2020). Active participation and collaboration in groups will develop problem-solving and critical thinking skills because of exploration activities and finding solutions (Ulviah, 2024).

Interactive learning using Nearpod allows teachers to create and share learning content that actively involves students since it contains various types of media such as text, images, videos, quizzes, virtual reality experiences, etc. All of which can be integrated into one presentation. On Nearpod, teachers can monitor student participation and understanding in real-time, so that they can create dynamic and responsive interactions during learning. Interactive and engaging learning increases students' interest and motivation, leading to significant improvements in conceptual understanding and learning engagement (Delacruz, 2023).

Student involvement in the learning process through interactive learning makes the learning experience more engaging and enjoyable, helping students focus more and understand the material well. Nearpod media also facilitates engaging visual learning and enriches learning materials with images, sounds, and videos, helping students with visual and auditory learning styles understand complex lesson concepts (Putra & Salsabila, 2021).

The problem-based learning model with interactive peer feedback activities in discussion forums has been shown to improve critical thinking skills, as it encourages students to get used to using logical reasoning. This also helps students to express opinions with clear and specific reasons, using common sense and data to support arguments (Winarti et al., 2018).

Critical thinking requires the ability to manage information including identifying problems, thinking logically, assessing the effects of an event, determining solutions, and drawing conclusions. There are five indicators of critical thinking skills, namely basic clarification, providing reasons, concluding, further clarification, and guessing and integration (Ennis, 1995). Critical thinking involves the ability to analyse, connect, evaluate, create solutions, and conclude from existing problem situations (Facione, 2020). With critical thinking skills, students will be ready to face complex problems in everyday life, by distinguishing relevant information from unimportant information and finding facts objectively, thereby improving their problem-solving skills (King & Kitchener, 2012). Active learning and critical thinking by emphasizing project-based activities are designed so that students can identify problems, formulate solutions, and evaluate results (Mallewai, 2023). The P5P2RA activity (Strengthening the Pancasila Student Profile Project and the Rahmatan Lil 'Alamin Student Profile) is part of the project-based Merdeka Curriculum activities designed to strengthen students' competencies and character (Idayanti, 2023). The purpose of the P5P2RA activity is to observe and solve problems based on students' potential. One of which is by developing critical and creative reasoning attitudes and behaviors (Irawati, 2024).

The limitations of structured teaching materials related to microplastic material and the lack of teacher training in teaching microplastic topics hinder teachers' ability to deliver the material in an interesting and understandable way. The use of technological potential in teaching microplastics to make learning interactive and interesting is also still lacking (Utami & Permana, 2021). Effective and engaging teaching of microplastic material is very important, as it can enhance students' understanding and motivation to participate in learning. Interesting teaching methods with the use of interactive teaching technology can help students visualize the impact of microplastics and understand the importance of reducing microplastic pollution.

Methods

The research on the development of teaching materials using Nearpod microplastic materials uses the ADDIE model (Analyse, Design, Development, Implementation, Evaluation). This model is used due to its stages, which describe a systematic approach to instructional development. The product development procedure in this model can be seen in Figure 1.

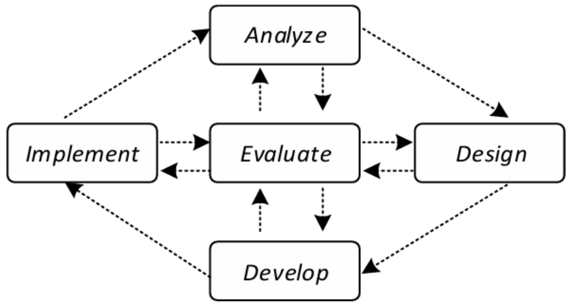

Figure 1. Stages of the ADDIE model

Several stages of the ADDIE approach are as follows:

1. Analyze
   At this stage, two things are done, including,
   a. Analysis of problems and content needs based on the independent curriculum structure.
   b. Analysis of application needs, which aims to obtain the right application to be able to display interesting and interactive learning media.
2. Design
   The design stage aims to obtain a product overview according to the results of the needs analysis. There are several steps in this stage, namely identifying researcher's innovations in the terms of content, questions, and media appearance, as well as designing product layout.
3. Development
   The development stages consist of making products based on the completed designs, followed by validation or feasibility assessment by content and media experts. The validation results include content feasibility test scores, learning media feasibility test scores, as well as suggestions, comments, and input used to revise the developed product. Revisions are made after the validation process to obtain a product suitable for limited testing.
4. Implementation
   This stage is conducted by applying the developed product to a sample group used for testing. Additionally, the activities take place after the limited trial stage. The test group uses digital devices such as smartphones, notebooks, or laptops.
5. Evaluation
   At the evaluation stage, the final product is expected to be improved based on the students' feedback collected during the implementation stage. Measurements of students' critical thinking improvement are also conducted using the results of the pre-tests and post-tests during the implementation stage. Additionally, formative evaluation and student opinion surveys are carried out to collect data on the media's effectiveness and efficiency in achieving the stated goals.

This research was conducted at one of the state junior high schools in South Jakarta from August to October 2024. The population of this study was all 7th grade students at MTsN 32 Jakarta. The sample was taken using the cluster random sampling technique; thus, 32 students in grades 7-3 were selected as the model testing group in this study. This study involved 2 experts who tested the content of the material, learning media, and instrument validation.

The research instruments used in the study include instrument validation sheets, media validity sheets, material content validity sheets, critical thinking skills instruments, and student response questionnaires. The validation sheet was developed as a guideline for validators to assess the validity of critical thinking skills instruments. It consists of several aspects including alignment with learning objectives, clarity and readability, relevance and accuracy, content validity, reliability, suitability to cognitive levels, involvement and motivation, and quality of feedback and assessment. The media feasibility sheet was developed theoretically as a guideline for validators to assess the quality of Nearpod-based interactive teaching materials, which consist of several aspects including material suitability, interactivity quality, design and navigation, learning effectiveness, visual and audio quality, involvement and motivation, technology suitability, feedback and assessment, and sustainability and development. The student response questionnaire was prepared to determine students' assessments of the media, which consist of several aspects including involvement and interactivity, understanding of the material, development of critical thinking skills, ease of use, and learning effectiveness. The student response questionnaire uses a range of 1 to 5, with a score of 1 = not good, 2 = less good, 3 = quite good, 4 = good, and 5 = very good. The critical thinking skills instrument consists of 10 essay questions. The research instrument was validated by 2 experts.

Data analysis in this study includes analysis of validity, practicality, and effectiveness of Nearpod-based interactive teaching materials. This includes the validity of both Nearpod-based interactive teaching materials and the critical thinking skills instrument. Expert validation is analysed using criteria (Ratumanan & Laurens, 2011) as follows: 3.25 < score < 4.00 is considered very valid, meaning it can be used without revision; 2.50 < score < 3.25 is considered valid, meaning it can be used with slight revision; 1.70 < score < 2.50 is considered less valid, meaning it can be used with some revisions; and 1.00 < score < 1.75 is considered invalid, meaning the teaching materials cannot be used at all.

The reliability of the results of the Nearpod-based interactive media validity assessment is calculated based on the following percentage of agreement formula:

$$\text{Percentage of Agreement (R)} = \left[1 - \frac{A-B}{A+B}\right] \times 100\% \quad (1)$$

Description:
R: Coefficient of agreement between observers.
A: Assessment of validators who give high scores.
B: Assessment of validators who give low scores.

The results of the assessment of the validity of Nearpod-based interactive media are said to be reliable if the percentage of agreement is ≥ 75%. The practicality of Nearpod-based interactive media is a measure of the feasibility of learning obtained from observers by giving an interval score of 1 to 5. The assessment criteria are obtained by calculating the average assessment score given by each observer with the criteria (Ratumanan & Laurens, 2011) as follows: 3.25 < score < 4.00 is considered very valid, 2.50 < score < 3.25 is considered valid, 1.70 < score < 2.50 is considered less valid, and 1.00 < score < 1.75 is considered invalid.

The analysis of the effectiveness of Nearpod-based interactive teaching materials was obtained from the analysis of critical thinking skills data and student responses. The normalized gain (n-gain) criteria, according to Meltzer (2002), are as follows: 0.70 < n-gain is considered high criteria, 0.30 ≤ n-gain ≤ 0.70 is considered medium criteria, and n-gain < 0.30 is considered low criteria. The level of improvement in critical thinking skills is calculated using the normalized gain (n-gain) from the pre-test and post-test with the following formula:

$$\text{n} - \text{gain} = \frac{\text{final test score} - \text{initial test score}}{\text{maximum score} - \text{initial test score}} \quad (2)$$

To determine whether there was a difference in pre-test and post-test scores after using Nearpod-based interactive teaching materials, a paired sample t-test was used. The difference in pre-test and post-test scores on critical thinking skills was used to describe a significant influence on the application of Nearpod-based interactive teaching materials. Data on student responses were obtained from student response questionnaires regarding the learning activities and were analysed using quantitative and qualitative descriptive. The student response questionnaire data used a Likert scale in the form of positive questions.

The percentage of student response scores was calculated using the following formula:

$$P = \frac{\Sigma K}{\Sigma N} \times 100\% \quad (3)$$

Description:
P : percentage of student response scores
∑R : the number of scores achieved by students
∑N : the highest possible score a student can achieve

Meanwhile, the percentage categories of student responses (Saleh & Bista, 2017) are as follows: 0%–20% indicates a very bad category, 21%–40% indicates a bad category, 41%–60% indicates a moderate category, 61%–80% indicates a good category, and 81%–100% indicates a very good category.

Results and Discussion

1. Interactive teaching materials based on Nearpod

Interactive teaching materials based on Nearpod for microplastic material were developed using the ADDIE model, one of the learning device development models that consists of the following five stages:

a. Analysis

Literature review related to the use of interactive teaching materials draws on sources from both national and international journals. Nearpod-based interactive teaching materials use technology that allows students to access learning resources without limitations of place and time. These teaching materials will increase student involvement and participation in the learning process, ultimately encouraging students to think critically. Research shows that technology supports learning by helping students develop critical thinking skills through the measurable Socratic method (Le, 2019).

Nearpod-based teaching materials can also encourage students to be able to learn independently since they can access information and learning resources independently; hence, students can evaluate and analyse information critically. Based on research, immersive digital technology can improve independent learning and critical thinking through in-depth learning experiences (Tang, 2024).

Nearpod-based learning materials allow students to collaborate, thereby enriching discussion topics and enhancing critical problem solving. Based on research, a learning environment that facilitates student involvement can influence the learning process and foster critical thinking skills (Carini et al., 2006). Nearpod-based learning materials help students develop digital skills and critical thinking skills that are important for their future (Waldrop et al., 2019).

Based on the results of the analysis of various journal reviews, it was found that interactive teaching materials are needed to provide education for students about the dangers of microplastics. These materials aim to increase environmental awareness (Cordier et al., 2021), raise awareness of the danger of microplastics to human health (Mahalingaiah, 2023), encourage more environmentally friendly behaviours (National Oceanic and Atmospheric Administration (National Oceanic and Atmospheric Administration [NOAA], 2024), and help students understand the scientific concept of how plastics break down into microplastics and affect both marine and terrestrial ecosystems (Thompson et al., 2024).

b. Design

At the design stage, the initial design of interactive teaching materials was designed based on consideration of several factors including the curriculum used in schools, the selection of P5P2RA activity themes, the exploration of Nearpod teaching material creation applications, and the preparation of microplastic materials that can train students' critical thinking skills.

c. Development

At this stage, several activities are involved, including creating a Nearpod account, starting to create learning media by selecting the "create" and "lesson" buttons.

To design the slides that will be displayed, Canva can be used to make them more visually appealing. Afterwards, the "slides" option is selected from the activity selector. The slide editor can be used to create slide content with various templates and layout features available. Text, images, GIFs, and audio are added to enrich the slide. Interactive media and activities can be utilized by selecting "add new", which allows to add dynamic elements such as 3D objects, simulations, and VR field trips. Interactive activities such as Time to Climb, Draw It, Open-Ended Questions, and Collaborate Boards can also be incorporated. Relevant titles, descriptions, and tags are provided by selecting "lesson details," so that the teaching materials with various themes can be searched and accessed by other educators. If the teaching materials are ready to use, display them in "live participation" or "student-paced" mode. "Live participation" mode will allow teachers to control the lesson directly, while "student-paced" mode allows students to learn at their own pace. Teachers can monitor student progress and evaluate learning effectiveness by using the report feature on Nearpod. The prototype development stage of Nearpod-based teaching materials is shown in Figure 2.

Figure 2. Prototype development stage of Nearpod-based teaching materials

d. Implentation

In the implementation stage, teachers are trained to use the learning media to understand its objectives, content, and operation, including the features available in the Nearpod application and how these can be integrated into teaching. Students who will use this teaching material are also involved in an orientation session to introduce the Nearpod platform in accessing and how they can participate in interactive activities. Students are also ensured to have access to devices and a stable internet connection and are helped to understand how to use it. After all preparations are complete, the teaching materials begin to be used in learning activities. Teachers guide students in using learning media and utilizing interactive features to increase engagement and students' critical thinking skills. Feedback from students is collected during implementation and teachers identify areas that need improvement. The learning process is monitored to ensure that learning objectives are achieved.

Figure 3. Implementation stage

e. Evaluation

The evaluation stage is carried out during the process of developing teaching materials to identify and correct deficiencies in teaching materials before they are widely used. In testing the improvement of students' critical thinking skills, a pre-test is carried out before students are given interactive teaching materials based on Nearpod; furthermore, a post-test is carried out after students are given interactive teaching materials based on Nearpod. The critical thinking ability instrument is first validated by experts from various aspects. The t-test is carried out to be able to assess the pre-test and post-test data obtained, in order to determine whether the treatment of interactive teaching materials based on Nearpod can improve students' thinking skills.

Evaluation is also carried out to assess the overall effectiveness and its impact on students' critical thinking skills. Measurement of student reactions to teaching materials is carried out by a student response survey to determine the quality of the interactivity of the teaching materials. In the learning process to measure students' understanding and active involvement, interactive quizzes are used such as 'time to climb.' Changes in student behavior in applying critical thinking skills to microplastic material are assessed by making essay projects and craft products from used plastic bags. Evaluation of understanding, student involvement, and project assignments were also conducted; however, this study was limited to measuring the improvement of critical thinking skills, the feasibility of teaching materials through validity assessments from experts, and the practicality of teaching materials in their use through student opinion surveys.

2. Validity

The results of the validator's assessment showed that the validity score of the critical thinking ability instrument was 3.1 (from a score range of 1-5), which was in the valid criteria. The reliability coefficient in the aspect of the instrument validity assessment was 90%. Based on interobserver agreement, the reliability coefficient of the critical thinking ability instrument was above 75%, indicating that it met the reliable criteria. The instrument was also revised based on suggestions from the validator, including in terms of the writing, the presentation of case studies in questions, and the adjustment of questions to learning objectives. Based on the writing aspect, revisions were made to address the use of capital letters and typographical errors. The presentation aspect in the questions is connecting students' daily attitudes with efforts to reduce plastic use, while adjustment of questions to learning objectives includes adjusting words to the abilities to be achieved. This study shows that the critical thinking ability instrument developed has a high level of validity. This shows that the instrument can be used to measure students' critical thinking abilities, as well as the results of research stating that the level of instrument validity can provide good results in assessing the improvement of students' critical thinking abilities (Wahyuni & Budiarso, 2023). Instrument validity data are presented in Table 1 as follows:

Table 1. Validity of critical thinking instruments

Aspects of Instrument	Validity		Reliability	
	Score	Criteria	R (%)	Criteria
1. Alignment with learning objectives	3,2	Valid	100	Reliable
2. Clarity and readability	3,6	Very valid	90	Reliable
3. Relevance and accuracy	3,2	Valid	100	Reliable
4. Content validity	2,8	Valid	86	Reliable
5. Reliability	2,6	Valid	86	Reliable
6. Conformity to the cognitive level	2,8	Valid	86	Reliable
7. Engagement and motivation	3,8	Very valid	86	Reliable
8. feedback	2,6	Valid	86	Reliable
Average	**3,1**	**Valid**	**90**	**Reliable**

3. Practicality

The practicality of Nearpod-based interactive teaching materials illustrates the feasibility of the teaching material content and the feasibility of the learning media, as observed during the learning process. The assessment of practicality through a feasibility test was obtained from the assessment of two experts. The results of the study showed that the Nearpod-based interactive media that was developed had a good level of practicality. Based on the results of the feasibility test of the teaching material content and learning media by experts, the teaching material obtained an average score of 2.8, which is classified as good category.

The results of the study showed that Nearpod-based interactive teaching materials have a good level of practicality in improving students' critical thinking skills. One type of teaching material technology innovation that can be used in schools is interactive teaching materials. Interactive teaching materials contain a series of learning experiences that are planned and designed systematically to help students achieve learning objectives. The practical value of Nearpod-based interactive teaching materials in improving students' thinking skills is the same as other interactive teaching materials such as Augmented Reality-Based Interactive Multimedia (Syawaludin et al., 2019) and Edmodo-Based Interactive Teaching (Wahyuni et al., 2020). Interactive learning using Nearpod on other materials can also improve students' critical thinking skills such as in science learning materials (Nisa et al., 2023; Wahyuni & Budiarso, 2023) and Physics Learning (Puspitasari, 2024). Practicality data is shown in Table 2 as follows:

Table 2. Level of practicality of teaching materials

Aspects of the Feasibility Test		Score	Criteria
Assess the feasibility of material content	a. Compatibility with the Curriculum	2,9	Good
	b. Depth and Breadth of Material	2,7	Good
	c. Scientific Accuracy	2,7	Good
	d. Relevance to Real Life	2,7	Good
	e. Critical Thinking Skills Development	2,7	Good
	f. Clarity and Readability	2,9	Good
	g. Visual Quality and Supporting Media	3,3	Very good
	h. Interactivity and Engagement	2,7	Good
	i. Feedback and Ratings	2,7	Good
Learning Media Feasibility Test	a. Material Suitability	2,9	Good
	b. Quality of Interactivity	2,7	Good
	c. Design and Navigation	2,4	Good
	d. Learning Effectiveness	2,5	Good
	e. Visual and Audio Quality	2,7	Good
	f. Engagement and Motivation	3,1	Good
	g. Technology Suitability	2,7	Good
	h. Feedback and Ratings	2,7	Good
	i. Sustainability and Development	2,7	Good
	Average	**2,8**	**Good**

4. Effectiveness

The effectiveness of Nearpod-based interactive teaching materials illustrates the impact of implementing teaching materials developed to improve students' critical thinking skills. Data on the effectiveness of

Nearpod-based interactive teaching materials are in terms of improving critical thinking skills and student responses. Data on critical thinking skills from the pre-test and post-test results are presented in Table 3 as follows:

The data in Table 3 shows that the average n-gain of critical thinking skills in teaching and learning activities by implementing Nearpod-based interactive teaching materials is 0.6 with moderate criteria. This shows that Nearpod-based interactive teaching materials on microplastic material can be used in learning, especially in improving students' critical thinking skills since interactive teaching materials leave concrete messages on students (Afify, 2019).

Table 3. Pre-test and Post-test Critical Thinking Skill Descriptions

Indicators of Critical Thinking Skills	Pre-test	Post-test	N-gain	Criteria
Actual	5	8	0,6	Moderate
Reason	4	6	0,3	Moderate
Argumentation	5	8	0,6	Moderate
Inference	4	8	0,7	Moderate
Implication	5	8	0,6	Moderate
		Average	0,6	Moderate

Nearpod-based interactive teaching materials can improve critical thinking skills as the presentation of information is concrete and attracts students' attention through technology. Learning becomes more structured and interactive; as a result, students find it easier to understand complex concepts. The use of Nearpod in teaching materials can significantly improve critical thinking skills (Fahrunnisa et al., 2023; Susanto, 2021) and student learning outcomes (Anggaretta et al., 2024; Banjarnahor & Tarigan, 2023).

The significance of pre-test and post-test data was tested using the paired sample t-test to determine whether there is an increase in students' critical thinking skills. The results are as shown in Table 4 as follows:

Table 4. Statistical Test Result on Critical Thinking Skills

Statistical Test	**t-statistic**	**p-value**
Pre-test -Post-test	-9.49	0,0007

The p-value of 0.0007 indicates that there is a significant difference between the pre-test and post-test scores, in order that the p-value is less than 0.05. Therefore, it can be concluded that the increase in scores from pre-test to post-test is statistically significant. These results indicate that the intervention or learning method used between the pre-test and post-test is effective in improving students' critical thinking ability scores. These results are in accordance with research in improving students' thinking skills as well as in other interactive teaching materials such as Augmented Reality-Based Interactive Multimedia (Syawaludin et al., 2019) and Edmodo-Based Interactive Teaching (Wahyuni et al., 2020).

At the end of the learning, students were asked to fill out a response questionnaire, which aims to determine students' responses to the Nearpod-based interactive teaching materials. This student response questionnaire is needed to determine students' responses in the field and to determine the strengths and weaknesses of the Nearpod-based interactive teaching materials from their perspective, even though the materials have been validated by experts. Based on table 5, the results of the student response assessment show that the average percentage obtained was 77% with good criteria. Good student responses to other interactive teaching materials were also obtained, such as in Augmented Reality-Based Interactive Multimedia learning (Syawaludin et al., 2019) and Edmodo-Based Interactive Teaching (Wahyuni et al., 2020). Further research could explore the long-term effects of interactive media use on students' critical thinking skills, as well as investigate other environmental topics that could be taught using similar methods.

Table 5. Student opinion survey result.

Aspects	Response	
	Percentage (%)	Category
Engagement and Interactivity	80	high
Understanding the Material	74	high
Critical Thinking Skills Development	77	high
Convenience of Use	75	high
Learning Effectiveness	78	high
Average	**77**	**high**

Conclusion

Based on the results of data analysis and discussion, it can be concluded that the validity of the critical thinking ability instrument of 3.1 is in the valid criteria. The reliability coefficient in the aspect of the instrument validity assessment is 90%; therefore, it is classified under the reliable criteria. This media has a good level of practicality. Based on the results of the feasibility test of the material and learning media content by experts, this teaching material obtained an average score of 2.8, which is categorised as good. The average n-gain of critical thinking skills in learning by implementing interactive teaching materials based on Nearpod is 0.6 with moderate criteria. This shows that interactive teaching materials based on Nearpod on microplastic material can be used in learning, especially in improving students' critical thinking skills. Meanwhile, the results of the student response assessment showed that the average percentage obtained was 77% with good criteria. The results of this study indicate that interactive teaching materials based on Nearpod can be implemented as an alternative learning media, especially microplastic material, in improving students' critical thinking skills. The integration of technology-based learning platforms, such as Nearpod into the curriculum, can significantly enhance students' critical thinking skills. This approach can also be adopted by other educational institutions to develop other 21st-century skills.

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