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Development of a Problem-Based Learning–Based Nearpod Learning Medium for Renewable Energy Topics

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Abstract

Physics learning requires active student engagement and strong conceptual understanding, particularly for topics related to real-life phenomena such as renewable energy. However, classroom instruction remains largely conventional and has yet to fully utilize interactive technologies. To address this issue, a Nearpod-based learning medium integrated with the Problem-Based Learning (PBL) model was developed as a solution to enhance student engagement, activeness, and conceptual comprehension. This study employed a Research and Development (R&D) approach using the ASSURE instructional design model, which includes six stages: analyzing learner characteristics, stating learning objectives, selecting methods and media, utilizing media and materials, requiring learner participation, and conducting evaluation and revision. The participants were tenth-grade students from SMA Negeri 1 Kabila. Research instruments included expert validation sheets for content and media, student activity observation sheets, student response questionnaires, and learning outcome tests (pre-test and post-test). The results showed that the Nearpod media was categorized as highly feasible, with validation scores from content and media experts exceeding the established eligibility standards. Regarding practicality, all indicators of instructional implementation during both sessions reached 100%, indicating that every step of the PBL learning syntax was executed effectively. Student activity observations revealed high engagement levels, ranging from 64% to 100%, while student responses were highly positive in terms of visual design, ease of use, and interactivity. In terms of effectiveness, all students achieved post-test scores above the school's Minimum Mastery Criteria (KKTP), showing a significant improvement compared to the pre-test results. These findings demonstrate that the Nearpod media successfully increases student engagement, facilitates interactive learning, and supports better understanding of renewable energy concepts through a problem-based approach.

Keywords: Nearpod; Problem-based learning; Research and development; Renewable energy; Physics learning media

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INTRODUCTION

Education is a fundamental aspect of human life as it plays a critical role in developing individual potential and enabling people to adapt to the changing times. It is regarded as a lifelong process that continuously evolves in response to the needs of modern society (Yayan et al., 2019; Pristiwanti et al., 2022). In line with the rapid advancement of science and technology, the field of education is increasingly expected to integrate digital media to make learning more effective, interactive, and engaging (Fareza et al., 2023; Pratiwi et al., 2024; Adam, 2023). Teachers are therefore expected not only to deliver instructional content but also to create learning environments that foster interest, motivation, and active student participation.

Despite these expectations, physics instruction in secondary schools continues to be dominated by traditional, teacher-centered lectures. This approach often

results in passive learning, low student motivation, and suboptimal learning outcomes (Hernawati, 2018; Nurrita, 2018). Observations conducted at SMA Negeri 1 Kabila revealed that students' lack of interest and poor conceptual understanding—especially regarding renewable energy topics—stem from the use of limited and non-interactive instructional media that do not match students' characteristics. These findings are consistent with earlier research (Pd et al., 2014), which showed that conventional media tends to reduce student engagement during the learning process.

To address this issue, there is a growing need for innovative instructional media that can enhance student participation and engagement. One promising solution is the use of Nearpod, a web-based digital learning platform that offers a variety of interactive features such as quizzes, polls, simulations, videos, and online collaboration tools (Az-Zahro & Panduwinata, 2023; Nurhamidah, 2021; Purwaningsih et al., 2023). Several studies have demonstrated the effectiveness of Nearpod in improving learning outcomes. Kanaya (2024) reported a significant increase in student achievement following the implementation of Nearpod, while Susanto (2021) found that a Discovery Learning-based Nearpod module improved elementary students' critical thinking skills.

In addition to selecting appropriate media, the choice of instructional model is equally vital in determining the quality of the learning process. Problem-Based Learning (PBL) is a pedagogical model that employs real-world problems as a stimulus to develop students' critical thinking, analytical, and problem-solving skills (Anwar & Jurotun, 2019; Ardianti et al., 2022). Research conducted by Fitriani and Jusra (2024) demonstrated that PBL, when combined with audiovisual media, can enhance students' mathematical creativity. Similarly, Oktavianah and Nurfalah (2023) found that animated learning media based on PBL were feasible, practical, and effective. These findings indicate that the integration of PBL with digital media can significantly improve the quality of classroom instruction.

Drawing from this literature, the integration of Nearpod and Problem-Based Learning is believed to foster a more interactive, engaging, and meaningful physics learning experience. Although numerous studies have explored the use of Nearpod and PBL independently, there is still a lack of research focusing specifically on the development of PBL-based Nearpod media for teaching renewable energy topics at the senior high school level using the ASSURE instructional design model. This is particularly important given that renewable energy is a critical topic, closely linked to environmental issues, energy sustainability, and the promotion of scientific literacy among students (Pd et al., 2014).

Therefore, the present study focuses on developing a Problem-Based Learning-oriented Nearpod learning medium for renewable energy topics. The objective is to produce a learning tool that is valid, practical, and effective in enhancing students' understanding and learning outcomes while contributing to innovation in secondary school physics education.

METHOD

This study employed a Research and Development (R & D) methodology using the ASSURE instructional design model developed by Heinich, Molenda, Russell, and Smaldino (1999). The ASSURE model consists of six systematic stages: (1) Analyze Learners, which involves identifying the characteristics of the learners; (2)

State Objectives, to define specific learning goals; (3) Select Methods, Media, and Materials, where appropriate instructional strategies and media are chosen; (4) Utilize Media and Materials, which focuses on the actual implementation of the selected tools; (5) Require Learner Participation, aimed at ensuring active student engagement; and (6) Evaluate and Revise, which includes assessing the effectiveness of the instruction and refining it as needed (Rustandi, 2022).

The study was conducted at SMA Negeri 1 Kabila, located in Bone Bolango Regency, during the second semester of the 2024/2025 academic year. The participants were tenth-grade students. The main product developed in this study was a Nearpod-based learning medium integrated with the Problem-Based Learning (PBL) model, specifically designed for the topic of Renewable Energy.

The research instruments comprised: (1) expert validation sheets to assess the validity of the learning media, (2) observation sheets to evaluate the implementation of the learning process, and student questionnaires to measure practicality, and (3) learning outcome tests and student activity observation sheets to assess the effectiveness of the developed product. Validity assessments were carried out by subject matter experts and media experts, while a limited trial was conducted in one tenth-grade class to gather data on the practicality and effectiveness of the media.

Data collection techniques included observations, questionnaires, expert validations, and learning outcome tests. The data were analyzed descriptively, focusing on three key dimensions: (1) validity, based on expert evaluations of the content, language, and visual design of the media (Amanda et al., 2019; Prilianti et al., 2018); (2) practicality, determined by the extent to which the learning process was implemented as planned and student responses (Mustami, 2017; Yakop et al., 2024); and (3) effectiveness, assessed through student learning activities and the achievement of learning outcomes (Hanafi, 2018).

The criteria for validity, practicality, and effectiveness were established using average scores obtained from experts, teachers, and students, following established guidelines from previous studies. Thus, the quality of the Nearpod learning media developed in this study was comprehensively measured across all three dimensions.

RESULTS AND DISCUSSION

Results

The effectiveness of the Nearpod learning media integrated with the Problem-Based Learning (PBL) model for the topic of Renewable Energy was assessed through student activity observations and analysis of learning outcomes over the course of two learning sessions.

Observation results indicated that students were actively engaged throughout all phases of the learning process. During the introductory phase, students responded positively to the teacher, began the lesson with a prayer, listened attentively to the learning objectives, paid attention to the apperception, and followed the teacher's instructions on how to use the Nearpod media.

In the core learning activities, students concentrated on the material delivered via Nearpod, completed interactive tasks such as quizzes, polls, and matching exercises, responded to questions, and received feedback from the teacher. They also actively participated in group discussions, connected the content to real-life contexts, and demonstrated discipline in managing their learning time.

During the closing activities, students collaborated with the teacher to formulate conclusions, responded to reflective questions using Nearpod features, accepted follow-up assignments, and concluded the lesson with a prayer.

Overall, the observation results suggest that student activity was categorized as excellent, as nearly all engagement indicators were achieved. These findings indicate that the developed Nearpod media successfully fostered an interactive and supportive learning environment, thereby enhancing the effectiveness of the Problem-Based Learning approach.

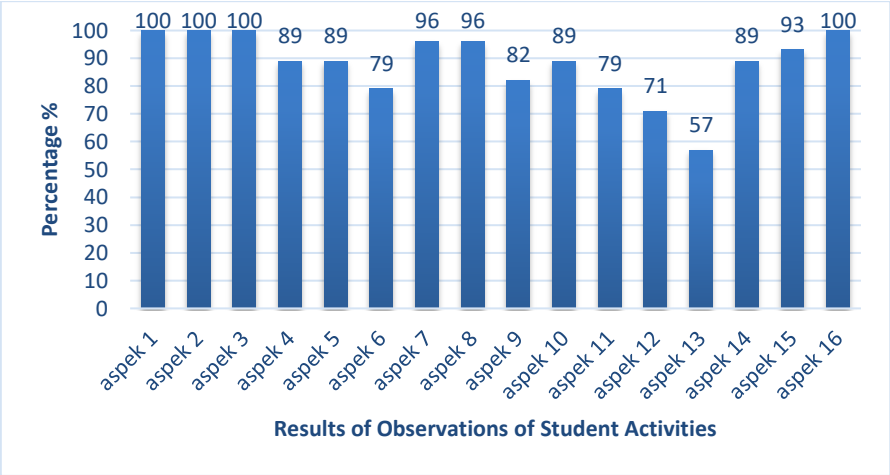

Figure 1. Results of observations of student activities at meeting 1

Based on Figure 1, which presents the results of student activity observations during the first meeting, it was found that student engagement across nearly all indicators was categorized as high. In the introductory phase (aspects 1 to 4), students demonstrated excellent participation, with engagement percentages of 96%, 100%, and 100% for the first three aspects, and 93% for the fourth.

During the core learning phase, student engagement ranged between 64% and 96%. The highest engagement was recorded for aspects 7 and 8, both reaching 96%, while the lowest was found in aspect 13, with a score of 64%. Other indicators—such as attention to the material, participation in Nearpod activities, group discussions, responsiveness to teacher feedback, and relating the content to real-life contexts—ranged between 75% and 89%. These figures suggest that the majority of students were actively involved in the learning process.

In the closing phase, aspects 14 through 16 also demonstrated high engagement, with scores of 89%, 93%, and 100%, respectively. Overall, the results illustrate that students were able to engage effectively with the Nearpod-based learning environment. However, certain aspects, such as time management and engagement in reflective activities, still require improvement to maximize the learning experience.

Based on Figure 2, the results of student activity observations during the second meeting show that overall student engagement remained high across nearly all aspects. In the introductory phase, the first three aspects continued to demonstrate excellent engagement levels, with percentages of 96%, 100%, and 100%, respectively. The fourth aspect also remained high at 93%.

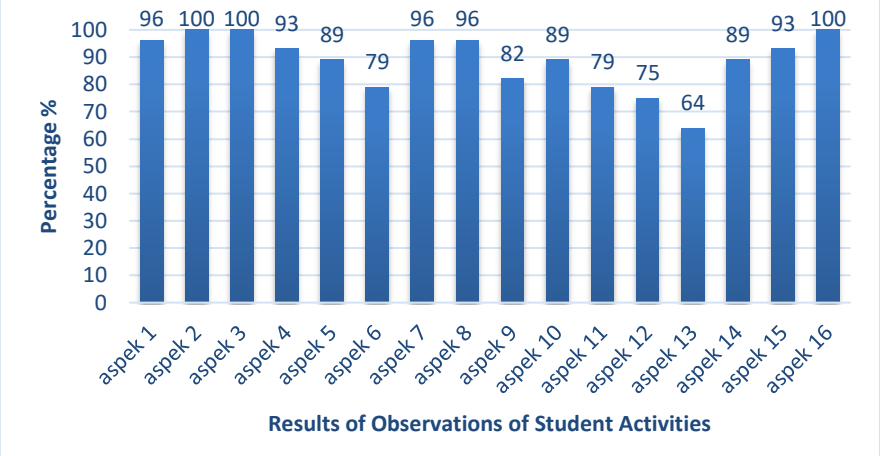

Figure 2. Results of observations of student activities at meeting 2

During the core learning phase, student engagement varied but remained within the good to excellent categories. Attention to the material reached 89%, while engagement in using the Nearpod media stood at 79%. The highest engagement scores were recorded for active participation and responsiveness to teacher feedback, both at 96%. Engagement in group discussions also remained relatively strong, with scores of 82% and 79%.

However, some aspects showed lower levels of engagement. Time management discipline was recorded at 75%, and engagement in reflective learning was the lowest, at 64%. Despite this, the majority of other indicators ranged between 89% and 93%, including closing activities such as drawing conclusions and accepting follow-up tasks. The final aspect of the closing phase once again reached 100%.

The effectiveness of the Nearpod media integrated with Problem-Based Learning was also evaluated based on students' learning outcomes. The success criteria were based on the Learning Objectives Mastery Criteria (*Kriteria Ketercapaian Tujuan Pembelajaran* - KKTP) used at SMA Negeri 1 Kabila, which set the minimum mastery threshold at a score of 75. A student was considered to have mastered the material if their score met or exceeded this standard.

Test results revealed that during the pre-test phase, most students had not yet met the KKTP standard, with average scores falling below the required threshold. However, following the implementation of the Nearpod-based PBL instruction, post-test results showed a significant improvement. All students achieved scores above the KKTP standard, and the class average increased substantially compared to the pre-test results.

These findings indicate that the Nearpod media integrated with the Problem-Based Learning model is effective in enhancing students' conceptual understanding of renewable energy topics. The improvement from pre-test to post-test confirms that the use of interactive media combined with a problem-based approach successfully enhances student engagement and yields positive impacts on learning outcomes.

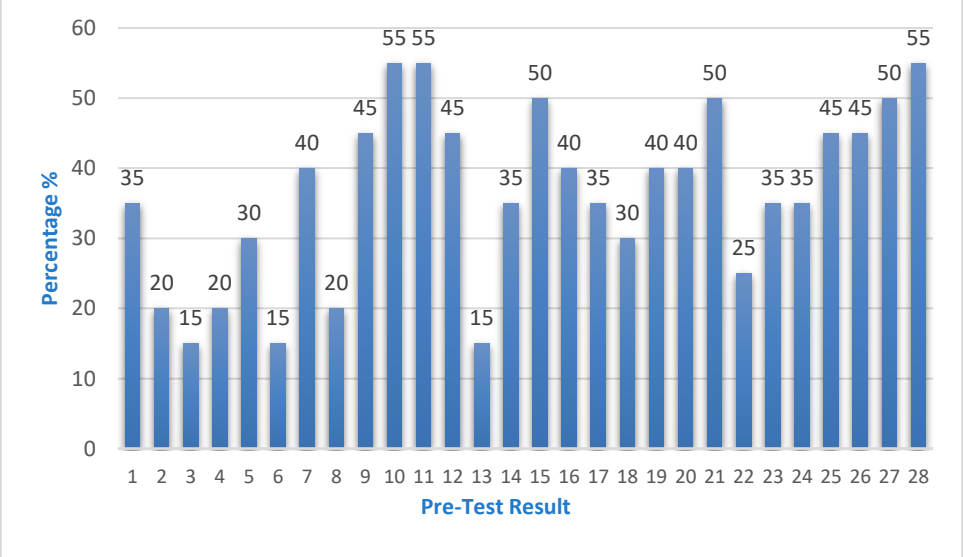

Figure 3. The pre-test results

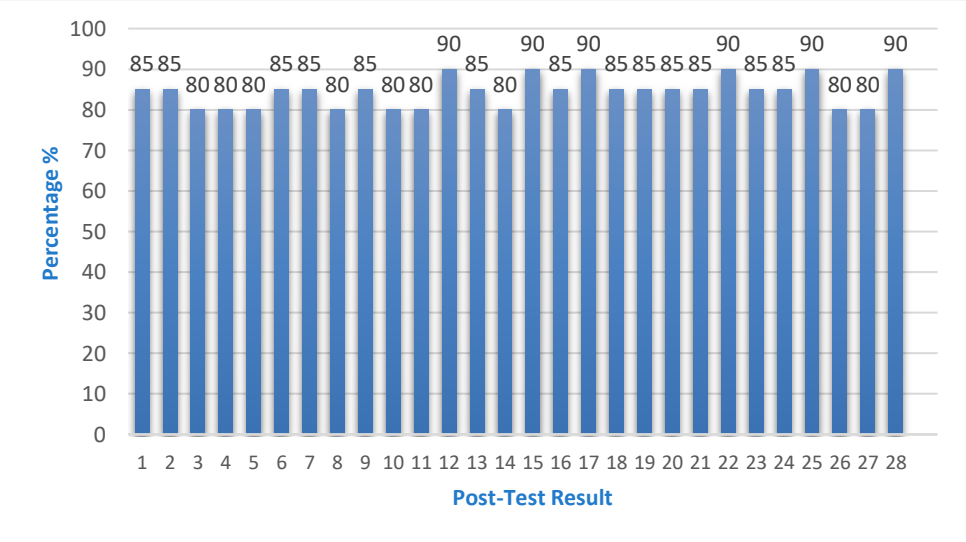

Figure 4. The post-test results

Based on the data presented in Figures 3 and 4, there was a significant difference between students' Pre-Test and Post-Test scores. During the Pre-Test phase, the percentage of correct answers was relatively low, ranging from 15% to 55%. Most students scored between 20% and 40%, with only a few achieving scores above 50%. This suggests that prior to the implementation of the Nearpod media integrated with the Problem-Based Learning (PBL) model, students' understanding of the renewable energy topic was still limited. This condition may have been influenced by a lack of prior learning experience and the unavailability of engaging and interactive learning media.

Following the implementation of the learning intervention, Post-Test results showed a substantial improvement. All students achieved high scores, ranging from 80% to 90%. Nearly all students obtained a minimum score of 80%, with several students—specifically numbers 11, 14, 20, 27, and 28—scoring as high as 90%. These

results indicate that all students successfully exceeded the school's mastery criterion (KKTP), which was set at 75%.

Discussion

During the first meeting, observations of student activity revealed a high level of engagement across all phases of the lesson. In the introductory phase, nearly all students responded to the teacher, listened to the learning objectives, paid attention to the apperception, and followed the explanation regarding the use of the Nearpod media, with participation levels ranging from 96% to 100%. These findings align with the study by Puspita Yasa (2024), which highlights that the implementation of Problem-Based Learning supported by interactive media can enhance students' readiness and engagement at the start of the learning process.

In the core activities, student engagement ranged from 64% to 96%. Aspects such as listening to the material, participating in Nearpod features, actively engaging, responding to feedback, and joining discussions demonstrated strong performance. The highest percentage (96%) was observed in students' responsiveness to teacher feedback and their effort to revise answers, while the lowest score (64%) was related to time management. These results are consistent with findings by Hasan et al. (2024), which suggest that interactive learning media improves both student participation and the quality of learning interactions.

During the closing phase, student involvement in summarizing, completing reflection activities, and accepting follow-up assignments remained high, with scores of 89%, 93%, and 100%, respectively. This indicates that the integration of Nearpod and PBL significantly supports students' conceptual understanding and sustained engagement through to the end of the lesson.

In the second meeting, observations showed further improvement in most aspects of student activity. In the introductory phase, the first three aspects once again reached 96% to 100%, while the fourth remained high at 93%. This consistency reinforces Puspita Yasa's (2024) conclusion that interactive media helps maintain active engagement from the beginning of instruction.

In the core phase, several indicators showed positive trends, particularly in active participation, responsiveness to feedback, and engagement in discussions, with scores reaching 96% and 82%. Although time management and reflection remained among the lower scores (75% and 64%, respectively), they showed improvement from the previous meeting. These results correspond with Hasan et al. (2024), who emphasized that the use of interactive platforms such as Nearpod enhances collaboration, participation, and the quality of student responses.

In the closing phase, student engagement continued to rise, with all indicators scoring above 89%, and the final indicator reaching 100%. This improvement illustrates that consistent use of Nearpod helps students become more familiar with interactive features, thus enhancing their engagement from one session to the next.

CONCLUSION

This study resulted in the development of a Nearpod-based learning medium integrated with the Problem-Based Learning (PBL) model for the topic of Renewable Energy. The media was found to be valid, practical, and effective for use in physics instruction. Expert validation classified the media as highly feasible, implementation observations confirmed that both teacher and student activities were conducted

effectively, and student responses were categorized as positive. Learning outcome tests also showed a significant improvement, with all students exceeding the *Kriteria Ketercapaian Tujuan Pembelajaran* (KKTP) standard. Therefore, it can be concluded that the use of Nearpod integrated with Problem-Based Learning is effective in enhancing student engagement and learning outcomes among tenth-grade high school students on the topic of Renewable Energy.

RECOMMENDATION

Based on the results of this study, it is recommended that physics teachers utilize the Nearpod learning media integrated with the Problem-Based Learning model as an interactive instructional alternative to improve student engagement and learning outcomes, particularly for Renewable Energy topics. Future researchers are encouraged to develop similar media for other physics topics or to integrate Nearpod features with different learning models to broaden its effectiveness. Moreover, greater attention should be given to improving student reflection and time management in future implementations to further optimize the benefits of the Nearpod platform.

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