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Development of video podcast-based learning media for secondary physics on renewable energy topics

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Abstract
The lack of engaging learning media and limited classroom time make it difficult for students to understand the concept of renewable energy in physics lessons. To address this issue, this study aims to develop podcast-based learning media on renewable energy issues in the context of the environment, as an alternative medium that is engaging, flexible, and contextual. The development was conducted using the ADDIE model (Analyze, Design, Development, Implementation, and Evaluation), but was limited to the development stage. A limited pilot test was conducted with 2 physics teachers and 26 students from class X-E4 at SMAN 1 Ingin Jaya in the 2025/2026 academic year. The validation results indicate that the podcast media falls into the highly valid category with Aiken's V values of 0.909 (media), 0.85 (content), and 0.925 (instructional design). Teachers' responses were very good (93.3%), and students' responses were also very good (91.5%). The effectiveness test showed an increase in student learning outcomes, with an average N-gain of 0.51 (moderate), indicating that podcast use can improve students' understanding and learning outcomes. Therefore, the developed podcast media is suitable for use in Physics education as an innovative medium that supports active student engagement. In conclusion, the developed podcast-based learning media is valid, practical, and moderately effective in improving students' understanding of renewable energy concepts. In practice, this media can be used by physics teachers as an alternative learning resource to enhance student engagement, support flexible learning, and facilitate deeper conceptual understanding in physics.

Keywords: Environment, Learning media, Podcast, Renewable energy

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I. Introduction

Learning media plays a crucial role in supporting the success of the learning process. Learning media come in various forms, such as visual, audio, audio-visual, and music, which serve as intermediaries between teachers and students, ensuring effective, easy-to-understand delivery of material [1]. In the era of Society 5.0, the integration of digital technology in learning media is becoming increasingly important, particularly in physics education. Therefore, teachers are required to be more creative and innovative in selecting appropriate learning media to increase student interest and motivation [2].

However, despite the importance of integrating digital learning media, actual school conditions do not always reflect these expectations. Observations at SMAN 1 Ingin Jaya on November 14, 2024, found that approximately 70% of students had not achieved the Minimum Passing Criteria for renewable energy, with a passing score of 80. This indicates that the learning process is not yet fully effective. Further interviews

revealed that most students prefer audio-visual learning media. However, the media currently used in schools is still limited to PowerPoint (PPT), which tends to be static, focuses primarily on visual aspects, and lacks interactivity. As a result, students tend to be passive, have difficulty connecting concepts to real-life situations, and are unable to review the material flexibly outside of class.

Renewable energy is an important topic because it is closely related to everyday life and global environmental issues. However, its abstract nature requires learning media that can present real-world phenomena through visualizations such as images, animations, and demonstrations [3]. Therefore, innovative learning media are needed to provide a more contextual learning experience. EFL students showed a positive response to podcast-based learning on the issue of arrival [4]. In this context, the role of an expert as a resource person in podcast learning media is very important, as it can provide access to practical knowledge through interview sessions. Efforts to present resource persons directly in class can be overcome by utilizing video podcasts, so that students can still hear facts, discussions, and opinions from experts in their fields [5].

One potential medium that can address this issue is podcasts. Podcasts are a digital medium that is easily accessible, flexible, and popular among students [5], [6]. In recent years, podcasts have evolved from an audio-only format to video podcasts that combine audio and visual elements, making them more engaging and effective for learning. This development allows learning materials to be presented through discussions or interviews with expert sources without requiring their physical presence in class. Furthermore, podcasts can support self-directed learning, as students can access the material anytime, anywhere, as needed [7]. Podcasts typically last 10-15 minutes [8]. In the context of podcast-based learning, it is important to consider the duration of content delivery to avoid boredom and maintain student focus throughout the learning process [9].

However, the use of podcasts in physics learning remains limited, particularly on topics such as renewable energy and environmental issues. Most existing podcasts lack visual support, such as animation or video, which can make them less engaging for students [10]. Therefore, it is necessary to develop video-based podcast learning media that combine audio and visuals to make them more engaging, relevant, and effective in helping students better understand renewable energy concepts. Based on the background above, the researcher wants to conduct a study on the development of podcast learning media on renewable energy issues in the environment for high school physics learning.

II. Methods

This research uses the research and development (R&D) method, with the ADDIE model comprising five stages: analysis, design, development, implementation, and evaluation. This research is limited to 3 stages, namely: analysis, design, and development.

The population in this study consisted of all students in class X IPA at SMA Negeri 1 Ingin Jaya. While the sampling technique was non-probability sampling, the subjects in this study, with a limited sample, were students of class X IPA 4 at SMA 1 Ingin Jaya, Aceh Besar.

Research data collected during validity testing consisted of responses and suggestions, which served as the basis for revising the initial product or prototype. The data obtained after the expert validation process was then discussed to obtain clear information on the product validation results. Afterward, the expert test data was processed using the following formula proposed by Aiken:

$$V = \frac{\sum s}{\left[n(c-1)\right]} \tag{1}$$

Based on the results of the Aiken V calculation, the product's validity can be categorized. The product validity categories are as follows.

Table 1. Product validity categories [11]

Level of achievement	Category
$0.8 \leq V \leq 1.0$	Very valid
$0.4 < V \leq 0.8$	Quite valid
$0 < V \leq 0.4$	Less valid

Next, the practicality test, the response questionnaire that has been filled out by teachers and students with the assigned assessment score, is then calculated using the following percentage formula:

$$P = \frac{f}{N} \times 100\% \quad (2)$$

Once the calculation results are expressed as percentages of teacher or student responses, a final score is obtained for each assessed aspect. These final scores are then averaged to determine the overall result. This average score will then be compared with the assessment criteria in Table 2.

Table 2. Questionnaire assessment criteria [11]

Mark	Criteria
81 – 100	Very good
61 – 80	Good
41 – 60	Enough
21 – 40	Not enough
0 – 20	Very not good

After conducting the practicality test, the next stage involved a limited implementation test to evaluate the effectiveness of the developed learning media. The effectiveness test involved test data in the form of pretests and posttests, as well as non-test data in the form of observations of the implementation of learning using the developed media. The test data were analyzed using the N-gain formula to determine the level of improvement in student learning outcomes, as shown in Equation 3.

$$\text{N-Gain} = \frac{\text{Postest} - \text{Pretest}}{\text{Maximum Score} - \text{Pretest}} \quad (3)$$

N-gain values can be classified according to the categories in Table 3 [12].

Table 3. Criteria for N-gain values

Gain value (g)	Criteria
$g \geq$	Tall
$0.3 \leq g < 0.7$	Currently
$g < 0.3$	Low

From the non–t-test data using simple statistics, applying Equation (2), with criteria as shown in Table 4.

Table 4. Criteria evaluation non-t tests [11]

Mark	Criteria
81 – 100	Very good
61 – 80	Good
41 – 60	Enough
21 – 40	Not enough
0 – 20	Very Bad

III. Results and discussion

The development of this learning media used the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) [13]. However, due to time constraints in the research process, it could only be carried out up to the development stage.

Analysis

In the analysis stage, this study conducted a needs analysis, curriculum analysis, and learning media analysis through observations and interviews with teachers and several 10th-grade students at SMA 1 Ingin Jaya. The interview results showed that approximately 70% of students had not met the Minimum Completion Criteria for renewable energy materials. Students also struggled to understand abstract physics concepts and tended to rely on teacher explanations. In addition, the learning media used in class remained limited to PowerPoint presentations, which were less interactive and did not support active student involvement. Students also preferred audiovisual-based learning media, which were more interesting and easier to understand.

Design

After getting the results from the needs analysis process, the next stage in developing this learning media is the design stage. At this stage, the design process is carried out through six main steps, namely: (1) determining the name of the podcast media, (2) determining the podcast format, (3) compiling the podcast script (scriptwriting), (4) compiling the initial design, (5) compiling the design of the display flow or storyboard, and (6) uploading the podcast to the platform.

In this process, each video is provided with a title, description, tags, and a corresponding thumbnail. This strategy not only makes it easier for students to find the content but also increases its visibility, making it accessible anytime, anywhere. The resulting media design is shown in Figure 1.

Figure 1. Media developed by researchers

Development

This stage includes activities aimed at realizing the learning media design, with evaluation at each stage. The developed podcast learning media was then validated by experts: media experts, content experts, and learning design experts, consisting of three experts per group. The expert validation results indicated that the media still had many shortcomings in various aspects. Therefore, before proceeding to the next stage, the researchers made improvements to the media in accordance with the validator's instructions.

The validation results were conducted by three expert validators, namely three media experts. The data obtained are the results of expert validation of the developed media. The results of the expert/specialist validity test are shown in Table 4.

Table 4. Results of expert validity tests

Expert	Statement Items	validator			V	Note
		I	II	III		
Media	Items 1-12	56	55	56	0.909	Very Valid
Material	Items 1-10	43	44	45	0.850	Very Valid
Learning Design	Items 1-10	48	48	45	0.925	Very Valid

Based on the results presented in Table 4, expert validation indicates that the developed learning media meet the criteria for high validity. Validation was conducted on three aspects: media, content, and learning design. The media aspect was assessed using 12 statement items, while the content and learning design aspects

were each evaluated using 10. The results showed that the media aspect obtained an Aiken's V score of 0.909, the content aspect 0.85, and the learning design aspect 0.925. All of these values fall within the highly valid category, indicating that the developed learning media are suitable for use in the next stage.
In addition, the assessments from each validator showed a high level of consistency, where the scores for the media aspect were 56, 55, and 56, for the content aspect 43, 44, and 45, and for the learning design aspect 48, 48, and 45, reflecting minimal variation and strong agreement between validators. Despite slight differences in scores, Aiken's V scores across all aspects remained high, indicating that the developed media met the required standards for content quality, presentation, and learning design principles. After revisions were made based on the validators' suggestions, a practicality test was conducted through a limited implementation involving two physics teachers and 25 students of class X E-4. Practicality data were collected using a response questionnaire, and the results of teacher and student responses are presented in the following figure.

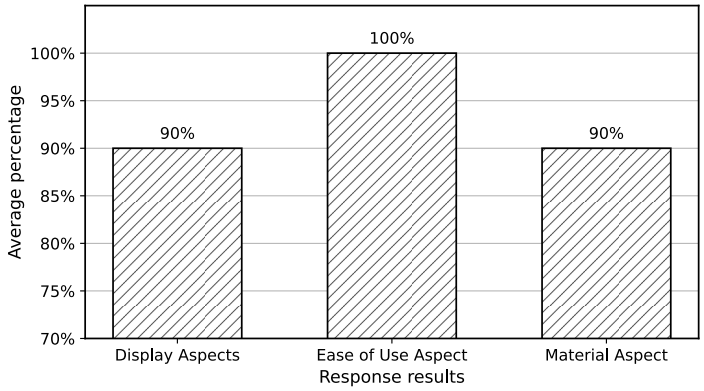

Figure 2. Teacher response results

Based on Figure 2, the average results of teacher responses to the developed learning media were obtained. The assessment conducted by two teachers covers three aspects: appearance, ease of use, and presentation materials. In the aspect display, the obtained presentation is 90%, indicating that the media display meets very good criteria. This shows that the media has an attractive, neat visual design and is easy for users to understand. Furthermore, in the aspect of convenience usage, media obtained the highest percentage, namely by 100%. This shows that the media is considered very easy to use, good in terms of navigation and channel presentation, which can support effective learning. As for the presentation aspect, the presentation was 90% effective, indicating that the material was delivered in a clear, coherent, and appropriate way, with objective learning. Overall, the teacher's response indicates that the developed learning media falls into the very good category and supports the learning process in schools.

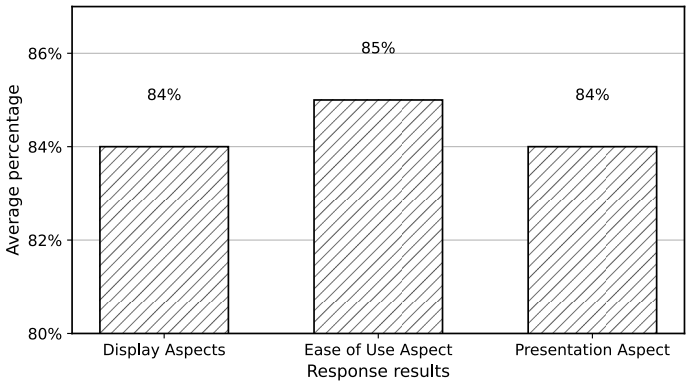

Figure 3. Student response results

Figure 3 shows the researchers' average percentage of students' responses to the media. The display aspect showed a score of 83.65% with very good criteria; the ease of use aspect obtained a score of 95% with very good criteria; and the presentation aspect obtained a score of 94% with very good criteria.

This media has also been tested for effectiveness through pretests and posttests for students and observational assessments of implementation conducted by teachers as observers. The pretest and posttest

results were used to determine whether student improvement was achieved using N-gain. Student improvement was not optimal, as evidenced by the average score of 0.51, which is considered moderate. The improvement in students' performance is evident in the N-gain results. The N-gain results are shown in Figure 4.

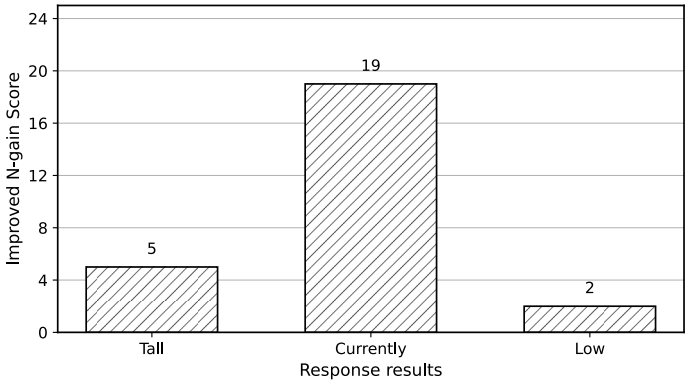

Figure 4. N-gain test results diagram

Validation results indicate that the developed podcast learning media is highly valid across media, materials, and learning design. This confirms that the media is suitable for use because it has been designed to align with core competencies and learning objectives and can present material in an attractive, easy-to-understand manner. Another advantage is the flexibility of access through platforms like Spotify and YouTube, which allows students to learn anytime, anywhere, thereby supporting independent learning. Interactive and easily accessible media can foster independent learning in students [14].

The practicality test showed excellent results with an average score of 91.82%. This high score indicates that the media is easy to use for both teachers and students. The approximately 5-minute video podcast, accompanied by relevant visual illustrations, was deemed effective in capturing students' attention. Student enthusiasm was evident in their focus while watching and responding to teacher questions, and questionnaire results showed that 84% of students rated the visual aspect positively. However, the visual aspect still needs improvement, particularly the font type and size, and the color contrast, which affect reading comfort. The quality of media displays significantly impacts learning effectiveness [15].

The effectiveness test results showed an increase in student understanding with an average N-gain value of 0.51, which is considered moderate. Although the increase is not optimal, these results indicate that podcasts are effective in improving student learning outcomes. The use of podcasts as a learning medium significantly improves student learning outcomes. This improvement occurred because the podcast media developed combined audio, visual, and animation elements, thus helping students understand abstract renewable energy concepts more concretely. The visualization of real-world phenomena presented in the podcast provides a more contextual learning experience, making it easier for students to relate the material to everyday life [16]. In addition, during learning, students are more focused on the material presented in the podcast, making it easier to grasp and understand. Video podcasts have the advantage of presenting visual elements that clarify the material, making it easier for the audience to understand [17]. Audio-visual media, such as videos, animations, and audio recordings, enable teachers to explain complex concepts more clearly and more easily [18]. Visualization can clarify concepts and increase learning effectiveness [19], [20].

IV. Conclusions

The pretest results showed that students' initial critical thinking skills were relatively comparable, with an average score of 32.2. After treatment using podcast learning media on renewable energy material, posttest scores increased significantly, with an average score of 67. The n-gain results showed an increase in students' critical thinking skills with an average score of 0.5111, which is included in the moderate category. This indicates an increase in student understanding after using podcast media, although not optimal. Based on the results of expert validation, the developed podcast learning media have met the criteria of being very valid in three aspects, namely the media aspect (Aiken's v = 0.909), the material aspect (Aiken's v = 0.86), and the learning design aspect (Aiken's v = 0.925). Validation was carried out by three experts in the fields of media,

materials, and learning design. Suggestions from the validators were used to refine the media before the trial, including improving font type and size, adjusting video duration, adding text, and adding animation.

The media's practicality test showed that teachers and students rated the podcast learning media highly. Teacher responses to aspects of appearance, ease of use, and material presentation were 90%, 100%, and 90%, respectively. Meanwhile, student responses showed 83.65% for appearance, 95% for ease of use, and 94% for material presentation. Minor improvements were made to the appearance to make it more appealing, such as video lighting and adding animation to the background. The results of the observation of the implementation of learning showed that learning activities using podcast media can run well, with an average percentage of implementation of 86%. Podcast media can improve students' understanding across several material indicators, especially the indicator of factors that influence the efficiency of electricity production in wind power generation systems, which increased from 44.9% in the pretest to 93.6% in the posttest. Although the increases in several other indicators are still moderate, podcast media is effective in improving student learning outcomes.

This study has several limitations. First, the research was limited to the development stage and did not proceed to the full implementation and evaluation phases of the ADDIE model. Second, the sample size was relatively small and limited to a single class in a single school, limiting the generalizability of the findings. Third, the media's effectiveness was measured using a simple experimental design without a more robust statistical analysis, which may affect the robustness of the conclusions. Based on these limitations, future research is recommended to involve a larger and more diverse sample to improve the generalizability of the results. Further studies should also implement the full ADDIE cycle, including broader implementation and evaluation stages, to better assess the media's long-term impact. In addition, integrating more interactive features and improving visual design elements are suggested to enhance the effectiveness of podcast-based learning media in physics education.

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