Development of Simple Teaching Aid on Resonance Topic Using Audacity Software as Learning Media

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Abstract. This study aims to develop a simple prop of resonance topic using audacity software. The research was conducted based on the model from Borg and Gall, which involved only five main steps: analyzing the developed product, developing the initial product, expert validation and revision, small-scale field trials and revisions, and large-scale trials and final products. The small-scale and large-scale feasibility tests were given to 29 students of SMAN 5 Palu Class XI IPA6. The product quality data obtained were analyzed using a descriptive analysis from quantitative data into qualitative, then the average quality score was processed using category criteria. In the analysis results, the overall average score of media experts is 2.97, categorized as "Good". The overall average score from material experts was 3.33, categorized as "Very Good". While the average analysis result of the overall small-scale trials was 3.35, categorized as "Very Good", and the result of the overall large-scale trials was 3.39, categorized as "Very Good". The overall average score obtained in the transformation in table 2 shows that the simple teaching aid on resonance topic using the Audacity software developed by the researcher was feasible to be used as a medium for learning physics in the classroom.

1. Introduction

Physics is the most fundamental science because it deals with the behaviour and structure of objects [1]. In addition, Physics is a challenging and less interesting subject [2]. Many students have difficulty in learning and understanding physics concepts [3]. The process of teaching and learning physics is often confronted with abstract material [4]. Moreover, in learning activities, students are generally given the lecture method of learning [5]. With this method, students only get spoken and written words called the Verbal Method, which makes students not interested or feel compelled to study physics [6].

One suitable method for teaching physics is through demonstration [7]. It can also provide direct experience in learning [8]. The demonstration method is a teaching method by demonstrating items, events, rules, and sequences of activities, either directly or through teaching media relevant to the subject or material being presented [9,10]. The use of media (to demonstrate) is expected to play a critical role in enhancing academic performance [11].

One of the media that can be used in physics learning is teaching aid. Teaching aids are valuable instructional tools that can help make effective and interesting learning [12,13].
According to the observations made by researchers at one of the schools in Palu, namely SMAN 5 Palu, the learning process in class about resonance events was taught without any evidence to understand the resonance topic. So the researchers developed a simple teaching aid for resonance topics using Audacity software as a learning medium in SMAN 5 Palu.

Previously, a similar study was conducted by Haisy [14], who developed a resonance and doppler effect based on a PC/laptop sound card to increase high school students' motivation to learn physics. The resonance tube used was a thick, U-shaped pyrex glass tube equipped with a piston. The sound source was speakers, and Audacity software was used to show changes in amplitude when resonance occurred. Meanwhile, this study was made simpler, in which the Audacity software-assisted resonance teaching aid was used as a learning medium. The resonance tube used was a 90 cm long scrap iron pipe equipped with a scale piston. Researchers used speakers, but the sound was controlled with a frequency generator application on an Android cellphone.

The benefit of this research in the education field is that it can produce learning media. Learning media in the form of teaching aids can help teachers make the teaching and learning process more effective and efficient in the classroom.

2. Method
2.1. Research Design
The type of research used in this research was Research and Development (R&D). This research was conducted based on the developmental research model from Borg and Gall, involving only five main steps: analyzing the to-be-developed product, developing the initial product, expert validation and revision, small-scale field trials and revisions, and large-scale trials and final product. Tools and materials used for this research were provided in Table 1, while the design was presented in Figure 1.

| Tools                        | Explanation and Function                                                                 |
|------------------------------|------------------------------------------------------------------------------------------|
| Scrap iron pipe              | This 90 cm long iron pipe was found in the wreck and functions as a resonance tube.       |
| Used board                   | The used board here was the leftover board from a carpenter that was no longer used, and its function was to make a resonant tube holder and a speaker holder. |
| Used sandals                 | Its function was to make rubber from the piston.                                           |
| Piston                       | Its function was to adjust the length of the air column.                                   |
| Speaker                      | It served as a sound/sound source.                                                        |
| An android phone equipped with the Frequency Generator application | The frequency Generator only produces tones between 1 Hz-22000 Hz, and this application was used as a sound source controller. |
| Laptop with Audacity Software | It was used to analyze sound frequency.                                                    |

![Figure 1. Resonance props scheme](image-url)
This research was conducted in SMAN 5 Palu at Class XI IPA6, amounting to 29 people, five students became small-scale respondents, and 24 students became large-scale respondents. The type of data consisted of quantitative and qualitative data. Quantitative data was in the form of product assessment scores and the feasibility of simple resonance teaching aids using Audacity software based on the results of a validity test questionnaire with a Likert scale in numbers 1, 2, 3, and 4. Qualitative data was the evaluation from the validator (responses, input, suggestions and criticisms) listed in the questionnaire or directly used as a consideration in revising the simple resonance teaching aids.

Assessing the feasibility of a product can be seen from the feasibility indicators. Media expert assessors, material experts and students have their respective eligibility indicators. The indicators for the feasibility of media consist of attractiveness, placement suitability of tools and materials, ease of use, teaching aids can run well, ease of transfer, ease of storage, facilitation to teaching and learning activities, increase of student knowledge, and the durability of the teaching aids. The material expert's eligibility indicators consist of showing a clear resonance event, showing changes in amplitude when resonance occurs, measuring the resonance frequency, students easily understanding resonance events, the suitability of teaching aids in learning, and increasing students' competence. The feasibility indicators for students are attractiveness, proper shape and location of tools and materials, ease of understanding resonance events, emerging enthusiasm in learning, ease of operation, facilitation to understand resonance, the durability of props, simplicity, and ease of management.

Arikunto [15] stated that finding out the final score rating on each item of the assessment questionnaire was divided by the total score obtained was divided by the number of respondents who answered the assessment questionnaire. Then, the average score obtained was transformed in Table 2 to see the feasibility of a product.

| Achievement percentage | Average score | Interpretation   |
|------------------------|--------------|-----------------|
| 76% – 100%             | 4            | Very decent     |
| 51% – 75%              | 3            | Decent          |
| 26% – 50%              | 2            | Decent enough   |
| 0% – 25%               | 1            | Less decent     |

2.2. Working Principle of Props

The working principle of this teaching aid is, first, open the Audacity software, then turn on the speaker (which is set by the generator frequency) and place it at the end of the first tube. The resonance tube is equipped with a piston placed at the end of the second tube, where the piston is pulled slowly after recording on audacity begins. Then, there will be a sound getting louder and louder, and the loudest sound is the first resonance event. Measuring sound frequency can be analyzed with audacity software by selecting the spectrum of the sound signal using the selection tool. Then on the menu bar, select "Analyze" and press "Spectrum Plot". After that, take the highest peak in the "Frequency Analysis” picture, the first basic tone or resonance.
The illustration of the displayed results can be seen in Figure 3. Determine the wavelength, the speed of wave propagation and the value of the frequency of sound using the following formula.

\[ f_{hp} \text{ (Generator Frequency)} = 250 \text{ Hz} \]
\[ L = 33 \text{ cm} = 0.33 \text{ m} \]

\[ \lambda = \frac{4L}{n} = \frac{4(0.33 \text{ m})}{1} = 1.32 \text{ m} \]
\[ \nu = f_{hp} \cdot \lambda = 250 \times 1.32 = 330 \text{ m/s} \]
\[ f = \frac{\nu}{\lambda} = \frac{330 \text{ m/s}}{1.32 \text{ m}} = 250 \text{ Hz} \]

![Figure 3. Display frequency analysis](image)

3. Result and Discussion

In operating this simple resonant material prop, using constant motion is a must. Pulling or pushing the piston should be done slowly. Observers of resonance events on props must have good hearing and be careful. Therefore, the frequency value calculated by the formula is the same as the source frequency value in the Generator Frequency application.

Resonance events are commonly used to determine the speed of sound in the air. The theoretical value of the speed of sound in the air is 340 m/s. In comparison, the value obtained using a simple resonance topic was 330 m/s at a frequency of 250 Hz. It means that the value was close to or almost the same. In line with research conducted by Agustina [16], the value of the speed of sound in the air obtained was close to the theoretical value. The results of measurements using simple props on resonance topics can be seen in Table 3.

| \( f_{hp} \) (Hz) | Number of Resonance \((n=1,3,5,...N)\) | \( L \) (m) | \( f_A \) (Hz) | \( f_h \) (Hz) | \( \lambda \) (m) | \( \nu \) (m/s) |
|-----------------|-------------------------------------|-------|----------|--------|---------|--------|
| 250             | 1                                   | 33    | 254      | 250    | 1.32    | 330    |
| 550             | 1                                   | 47    | 551      | 551    | 1.88    | 1034   |
|                 | 2                                   | 79    | 551      | 550    | 1.05    | 577.5  |
| 750             | 1                                   | 32    | 745      | 750    | 1.28    | 960    |
|                 | 2                                   | 65    | 746      | 746    | 0.87    | 652.5  |
|                 | 3                                   | 80    | 746      | 746    | 0.62    | 480    |

It can be seen in Fig. 11 that the relationship between frequency and the number of observed resonance events is that the greater the frequency, the more resonance events are observed. Fig. 12 also shows that the relationship between frequency and the length of the air column is, the greater the frequency, the greater the length of the air column. Fig. 13 shows the difference between generator frequency, audacity frequency, and count frequency.
The analysis results of media experts obtained an average score of 2.97 for all aspects and were categorized as "Good" as in Table 4. For the material expert analysis results, the average score for all aspects was 3.33 and categorized as "Very Good". From the average score obtained, which was then transformed into Table 5, the achievement percentage was around 51%-75% with a "decent" interpretation. Hence, it can be stated that this simple resonance topic is very good and deserves to be tested in the field with revisions.
Table 4. Validation results by media experts

| No | Aspect                                | Average Score | Category     |
|----|---------------------------------------|---------------|--------------|
| 1  | Props design                          | 3.33          | Very Good    |
| 2  | Quality and effectiveness of props    | 3.50          | Very Good    |
| 3  | Operation and performance of props    | 3.00          | Good         |
| 4  | Clarity of usage instructions         | 2.00          | Less         |
| 5  | The ability of the media to increase knowledge | 3.00 | Good |
| 6  | Props resistance                      | 3.00          | Good         |
|    | Overall Average                       | 2.97          | Good         |

Table 5. Validation results by material experts

| No | Aspect                                | Average Score | Category     |
|----|---------------------------------------|---------------|--------------|
| 1  | The relationship between props and resonance topic | 3.50 | Very Good |
| 2  | Educational value                     | 3.50          | Very Good    |
| 3  | Physics content                       | 3.00          | Good         |
|    | Overall Average                       | 3.33          | Very Good    |

After doing the validation, the props that have been developed were tested on students. The results of the small-scale trial analysis obtained an overall average score of 3.35 in the "Very Good" category as in Table 6. Likewise, the analysis results on large-scale trials obtained an overall average score of 3.39 with the "Very Good" category as in Table 7. From the average score, which was then transformed into Table 2, the achievement percentage was around 51%-75%, with a proper interpretation. Therefore, it can be said that the simple resonance teaching aid that was developed is very good and suitable to be used as a medium for learning physics during the teaching and learning process in the classroom.

Table 6. The results of the analysis of the average small-scale student responses

| No | Aspect                                | Average Score | Category     |
|----|---------------------------------------|---------------|--------------|
| 1  | The physical appearance of props      | 3.5           | Very Good    |
| 2  | Motivation to learn by using props    | 3.4           | Very Good    |
| 3  | Aspects of the operation of the props | 3.2           | Good         |
| 4  | Props quality                         | 3.3           | Very Good    |
|    | Overall Average                       | 3.35          | Very Good    |

Table 7. The results of the analysis of the average large-scale student responses

| No | Aspect                                | Average Score | Category     |
|----|---------------------------------------|---------------|--------------|
| 1  | The physical appearance of props      | 3.34          | Very Good    |
| 2  | Motivation to learn by using props    | 3.40          | Very Good    |
| 3  | Aspects of the operation of the props | 3.44          | Very Good    |
| 4  | Props quality                         | 3.41          | Very Good    |
|    | Overall Average                       | 3.39          | Very Good    |

The teaching aid has advantages and disadvantages in the research development process to the field trial stage for sure. The advantages of these teaching aids include that the components are easy to find because they are commonly found in the surrounding environment, and we usually use them every day. In addition, in its use, this simple resonance visual aid can record and calculate the frequency automatically and see the frequency automatically through the analysis frequency graph, thus making it easier for students to understand the resonance event. The drawback of this teaching aid is that it cannot automatically calculate the sound speed in the air. In addition, to use this simple resonance topic prop, it must be done with two or three people, and the use of the audacity software must be in a quiet room so as not to be affected by other sound sources.
4. Conclusion
The simple teaching aid of resonance topic using audacity software that has been developed is overall good and suitable to be used as a physics learning medium during the teaching and learning process based on assessments by media experts, material experts and students. This simple resonance teaching aid makes it easier for students to understand the resonance topic taught by demonstrating it in front of the class.

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