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Development of Android-Assisted Sound Wave Experiment Devices as an Effort to Improve High School Students' Motivation and Physics Learning Outcomes

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A B S T R A C T

The experimental device of sound wave in high school rarely available. This study conducted to develop a android-assisted sound wave experiment device. The experiment consist of four type of activities such as linear and circular motion effect dopler, interference and resonance. The study utilized the developmental research design by applying the ADDIE Model. The developed experiment device validity obtained from the expert while its practicality conducted by students and physics teacher consist of 10 students and 2 physics teacher. Based on the results of the effectiveness test on students stated that the android-assisted sound wave experimental device was declared effective in increasing motivation and learning outcomes. With an average evaluation of the motivation of the experimental class 85.56 higher than the control class with an average of 76. The average evaluation of the learning outcomes of the experimental class is 85.07 higher than the control class with a value of 75.22. Thus the developed android-assisted sound wave experimental device has been declared valid, practical and effective for use as a learning medium in teaching and learning activities in the classroom to increase learning motivation and student learning outcomes.

1. Introduction

The implementation of the learning process desired by the 2013 Curriculum is student-centered learning and minimizing the lecture method (Perdana et al., 2019). Along with the development of increasingly modern times, we must be able to present physics in a modern and fun way. Especially in sound wave material which includes extensive material but very few practical activities. Learning through practical activities is considered to improve student learning outcomes and not only cognitive aspects are achieved but affective and motor

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aspects are also fulfilled. (Fidiana et al., 2012). In addition, the application of experimental methods on sound waves material is expected to create an effective and fun learning process so that the boring impression in learning can be overcome. This can be realised because students are able to participate directly in the learning process so that it can affect the improvement of science process skills and student learning outcomes. (Wahyu et al., 2021).

Based on the results of interviews with teachers and students for the initial needs analysis of the research, 57% of 7 teachers said that there was a Learning Loss after the end of the pandemic which resulted in all three aspects of learning such as cognitive, affective and psychomotor aspects going down. 85% of them agreed that practicum activities would help to improve student motivation and learning outcomes. The disadvantages of practicum activities are only that these activities require facilities and infrastructure in the form of practical tools, substances and also experimental devices whose prices are often not cheap. Some tools, besides having a high price, are prone to damage and also require routine and expensive maintenance so that teachers are reluctant and students are afraid to carry out experiments. (Ilhamdi et al., 2020).

One of the physical phenomena that is considered abstract is sound waves, because sound cannot be seen directly by the eye but can only be heard. In the concept of sound waves, the most commonly encountered examples are the flight event, the doppler effect and also resonance. For example, the doppler effect is used in radar to calculate the speed of moving objects and in astronomy to determine frequency changes in electromagnetic waves. (Gómez-Tejedor et al,. 2014). These events really help students understand the concept of sound waves if students can experience these events directly. So we really need practical tools to better understand sound waves. (Rustana & Indrasari, 2020).

Android phones are widely used as learning media, this can be seen from the many research developments that use Android phones as the main media. Physics material, especially sound waves, requires the ability to read graphs, determine frequency, determine sound intensity and others. All of that can be done easily through applications on Android phones. Sound wave research with Android phones was conducted by Suryaningtyas et al., (2020) who developed an Android-based e-Module that can be accessed easily using a mobile phone. The development of this e-Module aims to improve students' process skills in learning sound waves.

In the resonance practical activity, the tubes are made of glass, although the aim is to be easy to see, but they are prone to breakage. The doppler effect and drift labs rarely have the equipment. For the doppler effect and drift, what is analysed is the frequency captured by the sensor, but the sensor does not only capture the frequency of the sound coming from the source. The sensor also captures the frequencies of the surrounding sounds that interfere with the frequency readings obtained. (Sriyansyah & Anwar, 2021). There are several researchers who have developed practicum tools or practicum devices for sound wave events such as those done by Muhammad Caisar Haisy & I Made Astra, (2015) who developed

teaching aids for resonance events and doppler effects using soundcards and PCs, these teaching aids are able to increase student learning motivation, these teaching aids use PCs and soundcards as well as Audacity software to process sound frequencies. Research by Arifin et al,. (2019) who developed a lab tool for levitation and the doppler effect. This lab tool uses a condenser microphone and a microcontroller. The advantage of a condenser microphone is its sensitivity in capturing sound waves. This practical tool is made with a dynamic train driven by a DC motor placed on a 1m - 2m long optical rail.

The development of doppler effect teaching aids using digital oscilloscopes and speakers was conducted by Karimah et al,. (2019) However, there is still noise around the sensor so that the waves displayed on the digital oscilloscope are not correct. In order not to be disturbed by noise or unexpected sounds, researchers Dias et al,. (2016) took recordings from several sources such as Formula 1 Racing videos and several other videos to analyse the frequency of the doppler effect in Audacity software to get the speed of the sound source or the speed of the F1 car in the video.

The doppler effect is usually only demonstrated in linear trajectories, but some researchers have begun to develop models of the doppler effect with circularly moving sources such as research conducted by Ma & Zhang, (2020), They researched how the doppler effect on circular moving objects such as windmills, the aim of their research was to identify the source of rotating sound.

Based on previous research in developing sound wave experimental devices or sound wave learning media to increase motivation and learning outcomes of high school physics students, no one has developed an android-assisted sound wave experimental device that includes linear and rotational doppler effect experiments, levitation and resonance.

2. Methodology

This research will be conducted in the Laboratory of Physics Education Study Programme, Faculty of Teacher Training and Education, Riau University and SMAN 10 Mandau, Bengkalis Regency, Riau Province. This research is a type of research and development (Research And Development) or R&D type of research is to use the ADDIE model steps adapted from the ADDIE model by Tegeh et al., (2015).

In the analysis stage, researchers take data to analyse, the data taken is the initial data in the form of material analysis data and learning media needs analysis data. From the material analysis data, the Learning Implementation Plan (RPP), LKPD and guidebook for the use of the sound wave experimental device will be designed. From the data analysis of learning media needs, a survey has been conducted on students and physics teachers in several regions of Riau which if the results are a lot of decreased motivation and learning outcomes occur in students,

it will be high media needs that can increase student motivation and learning outcomes.

In the design stage, researchers will design the sound wave experimental device according to the results of the initial analysis. For all the materials, researchers use materials that are cheap and also not easily broken such as glass in resonance experiments, for example, resonance tubes which are usually made of glass will be made with paralon rods. To process and analyse the wave frequency, the researcher used the frequency generator and spectriod application in the android play store because most students have android phones and this application is free and can be used directly.

At the develop stage, if the design of the sound wave device has been completed and is appropriate, the researcher will develop the sound wave device according to the design and will be validated by an expert. In this stage also began to develop LKPD and also the instruction manual for using the sound wave experimental device. At the implementation stage, the sound wave experimental device has been declared valid by experts and is ready to be tested on students and teachers in a limited trial to test its level of practicality. After the practicality test, the sound wave experimental device can be used in experiments to determine the effectiveness of the sound wave experimental device in increasing motivation and learning outcomes.

The evaluation stage is the stage for analysing the data obtained previously. The data that has been analysed will be categorised according to the instructions and made research results. In this study, the sampling method used purposive sampling technique. This technique is used because this research is a Quasi Experiment research (pseudo experiment).(Lenaini, 2021). This technique is used to determine the sample based on the subject matter. The research subjects that will be involved in the development of the sound wave experimental device are 10 students from class XII MIPA for the practicality trial and 54 students from class XI MIPA 1 and XI MIPA 2 SMA Negeri 10 Mandau in the 2022/2023 academic year as the experimental class and control class to test the effectiveness of the sound wave experimental device on motivation and learning outcomes.

Data on the effectiveness of the sound wave experimental device to increase learning motivation will be taken from data sources that have previously been tested for normality and homogeneity of the two classes. With an instrument in the form of a learning motivation questionnaire adapted from Tuan et al., (2016). The form of quasi-experimental design used is Nonequivalent Group posttest only design (NGPO) which is carried out in the experimental class and control class. (Abdussamad, Z. 2022). The implementation of this experiment compares the data from the analysis of motivation and posttest learning outcomes after the experimental class uses the sound wave experimental device and the control class learns conventionally.

3. Results and Discussion

The products produced from this research are in the form of andoid-assisted sound wave experimental devices with four materials, namely linear doppler effect material, rotational doppler effect, drifting and resonance. The experimental device produced is an improvement and innovation from several studies that have been carried out by several previous researchers.

3.1. Desain

The design stage is carried out designing experimental devices based on the results of the analysis that has been done before, but there are some modifications to the tools and materials used. The design carried out on this sound wave experimental device can be divided into five, namely the design of the rotational Doppler effect sound wave experimental device, linear Doppler effect, resonance, levitation and use guide book. The design of the sound wave device can be seen in Figure 1.

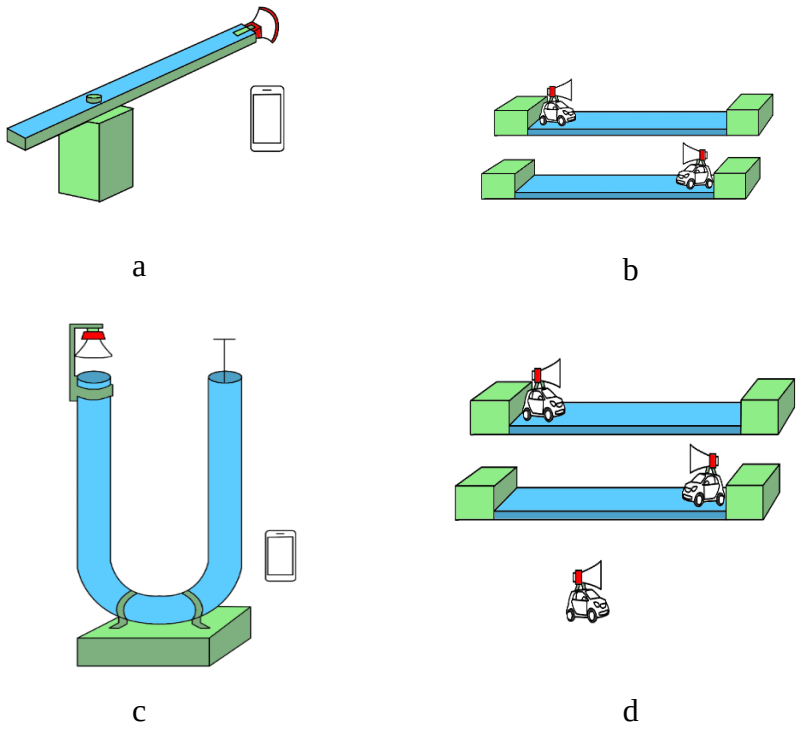


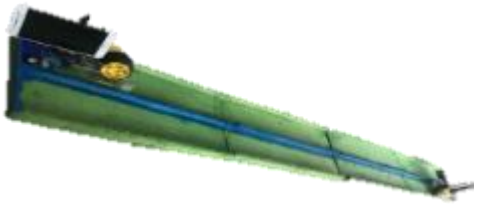
Figure 1. a. Design of the Rotational Dopler Effect Experiment Set, b. Linear Dopler Effect, c. Resonance, d. Drifting

3.2. Develop

The stage of this development is the manufacture of devices that have been designed. The manufacture of this device consists of the manufacture of experimental devices of sound waves rotational Doppler effect, linear Doppler effect, resonance, levitation and the development of an experimental guidebook.

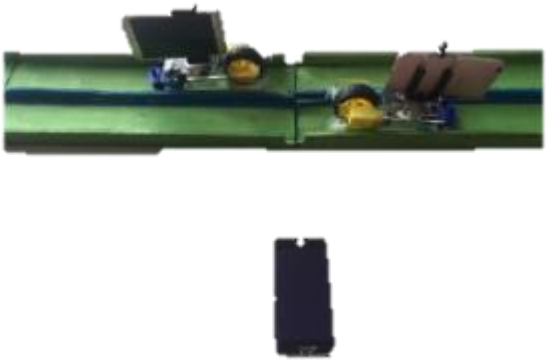
The experimental device products that have been developed can be seen in Figure 2.

a



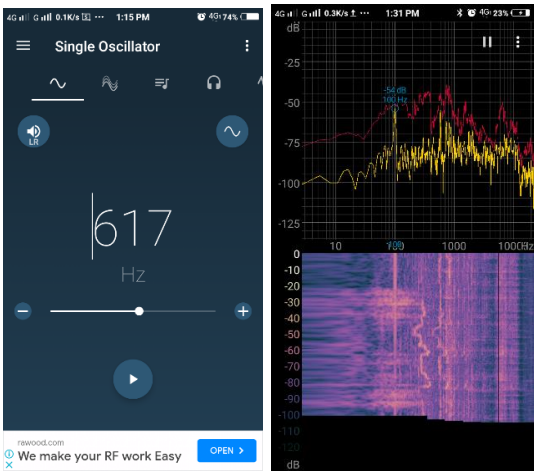
b

c



d

e



f

Figure 2. a. Rotational Dopler Effect Experiment Set, b. Linear Dopler Effect, c. Resonance, d. Drifting, e. Instruction Manual, f. Frequency Generator and Spectroid Application

3.3. Validation of Media

After making revisions, validation was carried out where there were responses, criticisms and suggestions from validators regarding several models and neatness improvements. The results of the validity assessment of the experimental device are listed in Table 1.

Table 1. Experimental Device Validity Assessment Results

Aspect	Average Score	Category
Media		
Rotational doppler effect	3,52	Very Valid
Linear doppler effect	3,47	Very Valid
Resonance	3,47	Very Valid
Flying	3,47	Very Valid
Guidebook	3,69	Very Valid
Material	3,42	Very Valid
Pedagogik	3,13	Valid

Based on the results of the validity assessment of the sound wave experimental device in table 1, it can be seen that the sound wave experimental device gets an average result above 3. The highest validity value is in the instruction manual while the lowest is in the pedagogical aspect. With this average value, the android-assisted sound wave experiment device is in the very valid and valid category so that it can be continued to the next stage, namely the practicality test by students and teachers.

3.4. Practicality of Media

After the validation test was carried out by experts and the sound wave experimental device was declared valid, a practicality test was carried out by students and teachers. This practicality test was conducted by 10 students of class XII Mipa and 2 physics teachers. The results of the practicality test can be seen in table 2.

Table 2. Practicality Test Results by Students and Teachers

Aspect	Average Score	Category
Student	3,60	Very Practical
Teacher	3,56	Very Practical

Based on the results of the practicality assessment by students and teachers in Table 2, it can be seen that the android-assisted sound wave experiment device gets an average result above 3. With this average value, the android-assisted sound wave experiment device can be categorised as very practical so that it can be continued to the next stage, namely the effectiveness test to increase the motivation and learning outcomes of high school students.

3.5. Effectiveness of Media

The evaluation consisted of analysing the motivation and learning outcomes of the experimental and control classes. The evaluation was conducted to see the role of the sound wave experimental device that aims to improve student motivation and learning outcomes.

3.5.1. Descriptive analysis

Descriptive analysis was conducted by comparing responses and learning outcomes between experimental and control class students. The experimental class studied the sound wave material using the sound wave experimental device while the control class studied conventionally. Data on the results of motivational responses and learning outcomes between the two classes can be seen in Table 3.

Table 3. Mean Value of Motivation Response and Student Learning Outcomes

Aspect	Average Score	
	Experiment Class	Control Class
Motivation	85,56	76
Learning Outcomes	85,07	75,22

Based on table 3, the average value of motivational responses and also the learning outcomes of students who use the sound wave experimental device is higher than the control class that uses conventional methods when learning sound wave material. this indicates that there is a difference between the experimental class and the control class. To determine the significance of the effectiveness of the sound wave experimental device, inferential analysis was carried out using the MANOVA test.

3.5.2. Inferential Analysis

The Manova test was conducted to test the hypothesis that there is a significant difference in motivation response and student learning outcomes between the experimental and control classes. Before conducting the Manova test, the normality and homogeneity of the two classes must be tested first. The results of the normality and homogeneity tests can be seen in table 4.

Table 4. Normality and Homogeneity Test

Test	Sig.	
	Motivation	Learning Outcome
Normalitas (Kolmogorov-Simirnov)	0,095	0,086
Homogenitas (Levene)	0,187	0,062

Based on table 4, it can be seen that the significance of normality for motivation is 0.095 > 0.05 and learning outcomes is 0.086 > 0.05, so the data on motivation

response and learning outcomes can be concluded that the data is normal data. The significance of homogeneity for the response to motivation and learning outcomes was found to be 0.187 > 0.05 and 0.062 > 0.05 so it can be concluded that the data on the response to motivation and learning outcomes are homogeneous. After the normality test and homogeneity test get normal and homogeneous results, the next MANOVA test is carried out.

Motivation data and learning outcomes between experimental and control classes have been normally distributed, so the next step is the multivariate analysis test, namely the MANOVA test. The results of the MANOVA test on the motivation and post-test results of experimental and control class students can be seen in Table 5.

Tabel 5. Manova Test

Test		Sig.
Box's M		0,287
Intercept	*Pillai's Trace*	0,000
	Wilks' Lambda	0,000
	Hotelling's Trace	0,000
	Roy's Largest Root	0,000
Test between subject effect		
	Motivation	0,000
	Learning Outcome	0,015

Based on the data in table 5, it can be seen that the sig value of Box's M is 0.287 > 0.05 so it can be concluded that the covariance matrix of variable Y (motivation and learning outcomes) is the same as the covariance matrix of variable X (experimental device). To determine whether the sound wave experimental device has the ability to influence the average score of motivation and post-test learning outcomes simultaneously or not, it can be done by comparing the Sig. values of Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root. The significance value obtained is 0.000, where 0.000 <0.05, which means that the independent variable (experimental device) affects the average score of the dependent variable (motivation and learning outcomes). Furthermore, from the MANOVA test results, it can be seen the test results of the effects of the two independent variables on the dependent variable. Test Results of Between Subjects Effects.

Based on Table 5, the significant value of learning outcomes shows a value of 0.015 <0.05, and the significance value of learning motivation is 0.000 <0.05, so it can be concluded that variable X (experimental device) affects the average score of the experimental class Y (learning outcomes and learning motivation). This shows that learning by applying the learning media of sound waves experimental device can improve learning outcomes and motivation in sound waves material.

4. Conclusion

Android-assisted sound wave experimental devices have been successfully developed and have been tested for validity, practicality and effectiveness on the motivation and learning outcomes of high school students. Android-assisted sound wave experimental devices get valid, practical and effective categories in increasing the motivation and learning outcomes of high school students on sound waves. Based on the results of the development of experimental devices consisting of experimental devices and tool usage manuals.

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