Development of a Physics Experiment Guidebook Using a Smartphone Assisted by the *Phyphox* Application

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Abstract *- The purpose of this study was to determine how to create, evaluate, and implement a physics experiment manual for damped oscillatory motion using a smartphone and the Phyphox application. This study took place at the Integrated Science Laboratory of IKIP Muhammadiyah Maumere and involved 20 students from the second and fourth semesters of the Physics Education Study Program during the 2022/2023 academic year. The methodology used in this research was Research and Development (R&D), which followed the ADDIE development model consisting of five main stages: Analysis, Design, Development, Implementation, and Evaluation. The tools used in this study were expert validation sheets and student response questionnaires. Quantitative descriptive analysis techniques were used to calculate the proportion of expert validation scores and student response questionnaire results. Specialists in materials evaluated the physics experiment manual and gave it a rating of 94%. Meanwhile, media professionals evaluated the same manual and rated it 95%. The combined feedback from both groups indicates that the physics experiment handbook is very eligible to use. According to the student response questionnaire, the average score obtained by the students was 87%, which falls under the category of "very interested." This indicates that the physics experiment manual is highly suitable for learning physics.*

Keywords*: Phyphox; Damped Oscillatory Motion; R&D; Guidebook*

INTRODUCTION

The progress of a country is heavily dependent on its educational system, as it has a ripple effect on other sectors of the economy. With scientific and technological advancements, demands on education are increasing. Therefore, the education sector needs to be able to adapt to new changes and circumstances to improve student ability and quality in achieving educational goals (Syaripudin et al., 2023). The use of online and distance learning has become common in Indonesia's education system (Fitriyani et al., 2020).

The eight-month online programme that ran from August 2020 to March 2021 was not very successful due to a number of factors, including an unstable network, a lack of subject-matter focus by students, and a lack of student interest in the programme. Therefore, despite its difficulty, face-to-face instruction is still necessary. This was stated in the Joint Decree (SKB) of 4 Ministers consisting of the Minister of Home Affairs, Minister of Religion, Minister of Health, and Minister of Education and Culture, No. 737 of 2020, pertaining to face-to-face learning that is not yet mandatory (limited). The policies implemented to transition from online learning to limited face-to-face learning are one of the reasons why students perform fewer laboratory experiments (Theasy et al., 2021).

Physics is one of the sciences that teaches about the human-nature relationship and serves as the foundation for all advanced technology. Physics is a scientific discipline that promotes critical thinking, experimentation, and observation in order to analyse everything that has a connection to the outside world (Jufriansah et al., 2022). It is anticipated that students who study physics will be able to comprehend the principles of physics and use scientifically-based methods that are consistent with scientifically-based knowledge to solve everyday problems (Wati et al., 2021).

Educators frequently employ conventional teaching methods for physics courses, which only emphasize theory and mastery of the material rather than encouraging students to comprehend it (Martanti et al., 2021). This makes it challenging for students to improve their ability to solve physics problems. In physics, educators must be able to employ methods that are reliable and consistent with the material's characteristics. Experimentation is one approach that can be used (Martanti et al., 2021). Similarly, Damped Oscillatory Motion requires experimental activities to enhance students' comprehension of the material. The material for Damped Oscillatory Motion necessitates experimental planning to aid students' comprehension.

Experimental activities are used less frequently due to the perception that they require a considerable amount of time and retard the acquisition of content (Elvina et al., 2022). Therefore, it is necessary to have a learning experiment or exercise with a specific objective so that students can practice what they have learned without spending a great deal of time preparing the necessary materials (Nurfadilah et al., 2019). Due to the availability of experimental guides, students are better able to conduct physics experiments independently, as determined by research findings and conclusions (Sari, 2021).

Basic physics and mechanics courses, according to the Physics Education Study Programme at IKIP Muhammadiyah Maumere, have utilized the Phyphox application to enhance students' comprehension of the learning process. In practice, students are less focused on conducting experiments due to the absence of a textbook, namely an experiment manual.

The use of smartphone applications as learning media is becoming increasingly pervasive, with educators and students extensively employing them to support learning activities. However, smartphone applications and sensors have not been extensively utilized in the field of education, particularly in science, in this case, learning physics. Whereas previous research demonstrated that smartphone applications and sensors can be used as an experimental instrument for learning physics in Damped Oscillatory Motion material (MSi, 2021).

Aachen University has developed Phyphox, an electronic practicum application for smartphones that facilitates students in conducting physics experiments (Novitasari et al., 2021). This application measures experimental outcomes primarily through the use of multiple types of smartphone and computer sensors (Bura et al., 2022). The read sensor display is presented in graphical form and contains a number of intriguing features, making it an excellent tool for enhancing students understanding of physics (Kristiyani et al., 2020). The purpose of this study was to determine how to develop a guidebook, the content of the guidebook, and student responses to a physics experiment guidebook using a smartphone and the Phyphox application

Using the development of physics experiment guides, this research will provide benefits as an alternative to classroom learning innovations and an engaging independent learning tool.

RESEARCH METHODS

This research is Research and Development (R&D) with a product as its end result (Nurfadilah et al., 2019). The model used is the ADDIE development model, which consists of five main stages: Analysis, Design, Develop, Implement, and Evaluate (Feedback).

This study focused on a physics experiment manual that was validated by material and media specialists. Experts in the subject matter examine and determine the veracity of the content based on the learning aspects and the content itself. Experts in the media analyses and study the guide's graphic feasibility, usability, grammar, and comprehensiveness. The students were requested to view the finished products and provide feedback.

This research employs expert validators' validation documents and student response questionnaires to collect data. The validation sheet for material specialists addresses the relationship between the physics experiment manual and the material, specifically the learning aspects and the accuracy of the content. The validation document for media experts includes aspects of the guide's graphic feasibility, usability, grammar, and completeness. The student response questionnaire was used to determine student responses or reactions to the developed physics experiment manual.

Expert validation analysis and student response questionnaire analysis are among the data analysis methods utilized. Expert validation analysis was conducted by calculating the average score for each criterion evaluated by the equation:

$$\bar{X} = \frac{\sum X}{Y} \qquad (1)$$

with $\bar{X}$ being the average score of the assessment by experts, $\sum X$ the number of scores obtained by experts, and Y is number of questions.

Table 1. Criteria for the Quality of the Physics Experiment Manual

No.	Value	Criteria
1.	$81.25 < x \leq 100$	Very Eligible (SL)
2.	$62.50 < x \leq 81.25$	Decent (L)
3.	$43.75 < x \leq 62.50$	Less Eligible (KL)
5.	$25.00 < x \leq 43.75$	Not Eligible (TL)

Student response questionnaire analysis calculates the percentage with the equation:

$$P = \frac{\sum_{i=1}^{n} x_i}{\sum_{i=1}^{n} y_i} \qquad (2)$$

with x_i being the number of assessment answers from the validator for the i aspect, y_i the total maximum score for the i aspect, P the percentage of overall ratings, and $n = 1, 2, 3, \ldots$, n (the number of aspects assessed.

Table 2. Student Response Criteria

Value	Criteria	Decision
$81.25 < x \leq 100$	Very Eligible (SL)	4
$62.50 < x \leq 81.25$	Decent (L)	3
$43.75 < x \leq 62.50$	Less Eligible (KL)	2
$25.00 < x \leq 43.75$	Not Eligible (TL)	1

RESULTS AND DISCUSSION

Results

The experimental guide includes procedures for preparation, implementation, data analysis, and report writing. In physics classes, the presence of an experimental guide is crucial. This is due to the fact that experimental manuals enable students to conduct laboratory experiments in a systematic manner.

The objective of the development of a physics experiment guide using the ADDIE model is to determine how to develop a guidebook, the quality of the guidebook, and student responses to the physics experiment guidebook using a smartphone and the Phyphox application on damped oscillatory motion material.

The ADDIE model research phases consist of:

1. Analysis

At the analysis stage, the researcher conducted interviews with Physics Education students at the Muhammadiyah Maumere Teachers' Training College to make initial observations on the learning activities. Based on the interviews, it was determined that students encountered difficulties when conducting independent experiments during lectures. This occurred because the experiment was conducted without a physics experiment manual. Therefore, students require guidance from lecturers supporting the subject in question. Therefore, researchers have compiled a physics experiment manual to aid lecturers during the lecture process, particularly when conducting laboratory experiments.

2. Design

During the design phase, the researcher conducted an evaluation of the material and then gathered data by evaluating the processes for creating media. Several components must be considered when presenting this physics experiment manual, including the manual's title, instructions for conducting the experiment, and its contents (Nuniati et al., 2021).

3. Development

During the development phase, the researcher created a manual for physics experiments that had been designed beforehand. The components of the physics experiment manual are outlined in the flowchart below.

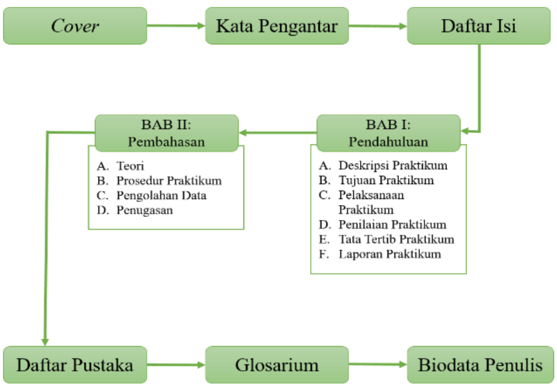

Figure 1. Flowchart of the Physics Experiment Guidebook

The physics experiment manual can be seen in the following figure:

Figure 2. Display of the Physics Experiment Guidebook Cover

4. Implementation

The physics experiment manual developed in earlier phases will be evaluated by two expert validators, namely material specialists and media specialists. In addition, product distribution and student surveys were conducted to determine the quality of the developed physics experiment manual and student feedback. Figure 3 depicts the outcomes of two expert validators' evaluations.

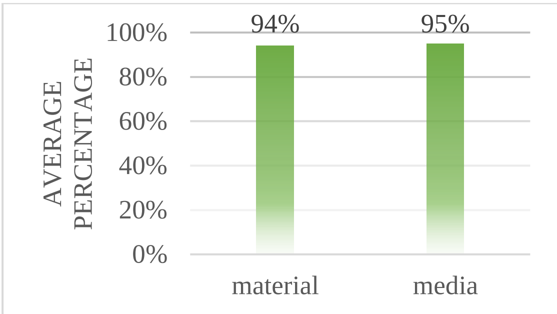

Figure 3. Graph of Assessment by Expert Validators

The Very Eligible (SL) category has been assigned to the Physics Experiment Manual as a result of an evaluation of the data obtained from material experts and media design experts. The aggregate value of all aspects demonstrates this, as the percentage of eligible material is 94% and the percentage of eligible media design is 95%. The researchers' created Physics Experiment Guidebook is highly usable, according to evaluations made by material experts and media design experts.

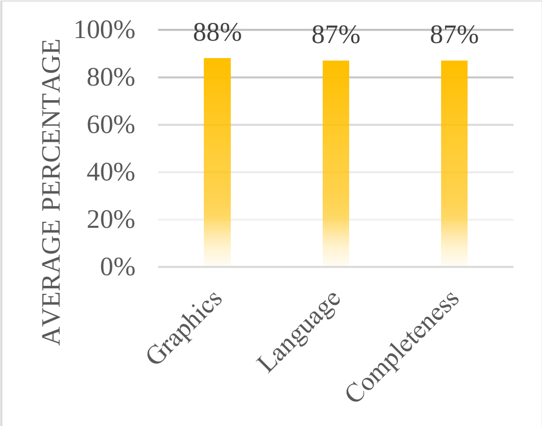

Figure 4. Graph of Student Response Questionnaire Assessment

Based on Figure 4, it can be seen that 87% of the average student response falls into the category of "very interested." Students are very interested in learning to use a physics experiment manual on damped oscillatory motion material using a smartphone and the Phyphox application. Aside from that, this Physics Experiment Guidebook has received overwhelmingly positive feedback and has met all of the necessary criteria to be distributed to students for conducting experiments.

5. Evaluate (Feedback)

The feasibility of the first Physics Experiment Guidebook was determined based on the validation outcomes, which included validation by material substance experts and media substance experts. Based on the results of the comprehensive validation of the Physics Experiment Guidebook, the average from the Very Eligible (SL) category is utilized. Student responses are then utilized to evaluate the Physics Experiment Guidebook's practicability. After using the Physics Experiment Guidebook, it was distributed to the Very Interested category of students.

Discussion

Two physics instructors conducted an evaluation of the Physics Experiment Guidebook. Experts in media design awarded the creation of the Physics Experiment Guidebook 20 points. For material substance specialists, the development of the Physics Experiment Guidebook is evaluated using 12 criteria. The Physics Experiment Guidebook assessment results include data in the form of scores that are converted into four categories: Very Eligible (SL), Eligible (L), Less Eligible (KL), and Not Eligible (TK). The score obtained is also converted into a percentage for eligibility requirements (Fransiska et al., 2021).

The Very Eligible (SL) category has been assigned to the Physics Experiment Manual as a result of an evaluation of the data obtained from material experts and media design experts. As shown in Figure 3, the aggregate value of all aspects demonstrates this, specifically, the percentage of material feasibility at 94% and the percentage of eligibility for media design at 95%. Based on the evaluations of material experts and media design experts regarding the practicability of the researcher's Physics Experiment Guidebook, it is evident that The Physics Experiment Guidebook is highly applicable.

The results of the student response questionnaire indicated a favorable reaction to the physics experiment manual utilizing a smartphone and the Phyphox application to study damped oscillatory motion material. Figure 4 reveals that the majority of students firmly agree that the Physics Experiment Guidebook should be utilized in the lecture process, as determined by the results of the survey distribution. The outcomes of the response analysis revealed that an average of 87 percent of student responses fell into the category of "very interested."

The physics experiment manual using a smartphone and the Phyphox application on damped oscillatory motion material is highly feasible and effective for laboratory physics experiments, according to the analysis of data from material experts, media design experts, and the results of student response questionnaires. The aforementioned is supported by the research of Nurfadilah et al. (Nurfadilah et al., 2019) with the title "Development of a Physics Experiment Guide Using a Smartphone with the Phyphox Application on Collision Material", which concludes that the developed experimental guide can be deemed effective and practicable for use on the identified concepts. The findings of this study have a positive impact on the current development of science and technology. According to Nurhidayah and Wangid (2020) and Bura et al. (2022), creating engaging instructional materials is an effective way to help students learn science concepts.

CONCLUSION

The development of the Physics Experiment Guidebook Using a Smartphone and the Phyphox Application for Damped Oscillatory Motion materials use the ADDIE Model. Analyse (analysis), Design (design), Develop (development), Implement (implementation), and Evaluate (feedback) are the phases of the development research.

The creation of a physics experiment manual using a smartphone and the Phyphox application for the material damped oscillatory motion are deemed Very Feasible (SL) in physics learning, according to material experts with a 94% feasibility rate and media design experts with a 95% feasibility rate.

The average number of student responses indicates that 87 percent of students are extremely intrigued. Students are very interested in learning to use a physics experiment manual on damped oscillatory motion material using a smartphone and the Phyphox application.

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