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Development of PBL-Based Sound Wave Interactive Multimedia Using Lumi for Class XI High School Students

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Abstract: This study aims to describe the development, feasibility, and practicality of PBL-based sound wave interactive multimedia using Lumi. The research method used is research and development. The model used is an Instructional Design type ADDIE which consists of 5 stages namely Analyze, Design, Development, Implementation, and Evaluate. The results showed that PBL-based sound wave interactive multimedia using Lumi was declared feasible by the validator with an average Aiken validity index of 0.86 (very high). The teacher as a practitioner states that practical interactive multimedia is used in learning physics with an average value of 93.30 (very practical). Students also stated that practical interactive multimedia was used in learning physics with an average value of 90.46 (very practical). Based on the results of the study, it can be concluded that PBL-based interactive multimedia using Lumi is declared feasible and practical for use in the physics learning process, especially in sound wave material.

Keywords: Development; Interactive Multimedia; Lumi; PBL; Sound Wave

Introduction

Quality human resources is one of the pillars that determine the welfare of a nation (Suprapto et al., 2021). The achievement of quality human resources is certainly not obtained instantly but through a series of training and teaching processes known as education (Pratikno et al., 2022). Education is part of a conscious and planned effort by the government to advance the nation's civilization and is contained in RI Law Number 20 of 2003 concerning the National Education System (Falaq, 2020). This is also in line with one of the goals of the Indonesian nation which is contained in the 4th paragraph of the Preamble to the 1945 Constitution, namely the intellectual life of the nation (Maulida et al., 2018).

Over time, globalization has indirectly changed the life of human civilization. The rapid development of science and technology is part of the impact of globalization (Priya et al., 2021). Teacher skills such as creative and innovative attitudes are certainly very much needed in adapting to the use of ICT (Information and Communication Technology) in the field of education (Gómez-Galán, 2020; Permatasari & Marwoto, 2018; Saadah & Hasanah, 2023). This proves that education must be dynamic so that the goals of the Indonesian nation in terms of educating the nation's life can be properly realized (Riyadi, 2014).

Physics is a branch of science that contains natural phenomena and their interactions based on a series of mathematical processes and scientific activities that can be proven empirically (Favela, 2020; Irrgang et al., 2021; Maulida et al., 2018). Based on the physical characteristics that are identical to the discovery process, learning activities should provide direct experience to students such as scientifically exploring the surrounding environment to achieve the desired competence (Duda et al., 2019; Hartini, 2017; Saiful et al., 2020).

There is no ivory that is not cracked in fact experienced by the learning process of physics. There are still many problems that hinder the course of teaching and learning activities. After the Covid-19 pandemic, students were used to the online system, causing them to feel lazy in learning (Hidayat & Nisa, 2022). Therefore,

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researchers conducted surveys and initial ability tests to strengthen evidence related to problems during the physics learning process.

The initial survey was conducted via a Google form which was filled in by 7 physics teachers and 147 high school students or the equivalent in Riau-Kepri. The survey results stated that sound waves are one of the physics materials that are difficult for students to understand. The difficulties experienced by students are supported by the use of learning resources and the application of methods in the physics learning process. This is evidenced by the survey results which stated that as many as 71.4% of 7 high school physics teachers or the equivalent in Riau-Kepri still had difficulty making or displaying simulations related to physics materials such as waves; 85.7% of 7 high school physics teachers or equivalent in Riau-Kepri still apply the question and answer method as a method commonly used in every physics learning process; 54% of the 50 students of SMA Negeri 5 Pekanbaru rarely do experiments; and 71.4% of 7 high school physics teachers or the equivalent in Riau-Kepri rarely direct students to conduct virtual experiments.

The right solution is the key to overcoming any learning problems. Learning media is considered as a supporting factor in realizing better learning (Panjaitan et al., 2020). The results of other studies also state that learning media in the form of interactive multimedia can improve student learning outcomes such as in the aspect of science process skills (Khery & Khaeruman, 2018; Sujarwanto, 2019). The use of learning media can also increase student motivation in each learning process (Syarifah & Sumardi, 2015).

Learning media in the form of interactive multimedia can be developed from applications such as Lumi. Lumi is an application that provides more than 60 types of digital content that are interactive and freely chosen for free by users such as teachers. In addition to producing learning media in the form of interactive multimedia, Lumi also makes it easier for teachers to share interactive multimedia with students in the form of HTML files (H5P packages) that can be accessed online or offline.

In addition to learning media packaged in the form of interactive multimedia, the problem-based learning (PBL) model can be an appropriate learning model in overcoming problems in physics learning (Jannati & Milana, 2017). Not only that, the PBL model can also increase motivation and curiosity so that students can play an active role in the physics learning process (Jannati & Milana, 2017).

Based on the description above, it is necessary to do proper handling in overcoming the existing problems. Therefore, this research will develop PBL-based interactive multimedia sound waves using lumi for class XI high school students.

Method

The type of research used is research and development. The model used is an ADDIE-type Instructional Design which consists of 5 stages, namely Analyze, Design, Development, Implementation, and Evaluate. The research and development procedure for PBL-based sound wave interactive multimedia using Lumi is shown in Figure 1.

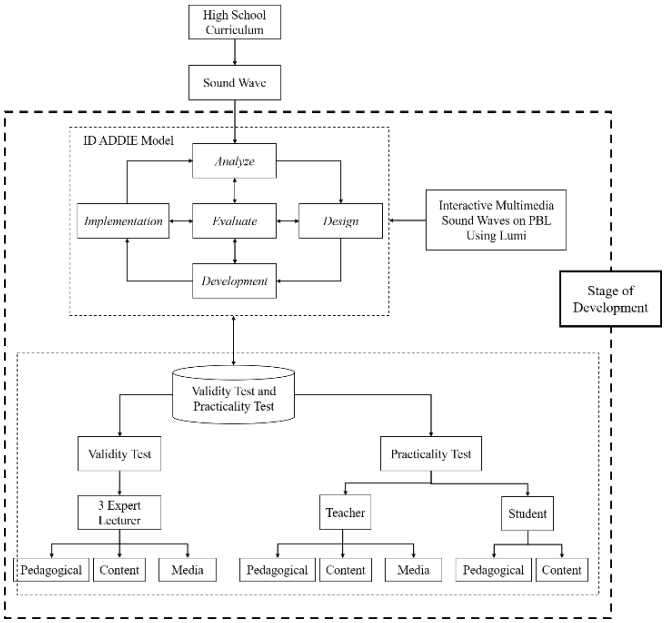

Figure 1. Research Procedure

Analyze

The analysis phase in this study consisted of needs analysis and material analysis (Tegeh et al., 2014). Needs analysis aims to find out the methods and models commonly used in the learning process and to find out the needs of teachers and students for learning media, especially interactive multimedia related to sound waves. Needs analysis was carried out by distributing a questionnaire using Google Form and filled in by 147 students and 7 physics teachers at high school level or equivalent spread across Riau-Kepri. The researcher also conducted a literature study as a basis for developing and strengthening arguments regarding the need for sound wave interactive multimedia as a learning medium.

The material analysis aims to determine the competencies that must be achieved by students and the depth of the material in accordance with the demands of competence in the learning process (Simamora et al., 2020). The material analysis also comes from various

teaching materials such as books, modules, articles, and learning videos related to sound waves for class XI SMA.

Design

The design phase consists of a PBL-based wave interactive multimedia design using Lumi and the preparation of PBL-based wave interactive multimedia development instruments using Lumi. The interactive multimedia design process is based on making history boards and storyboards. The history board includes various pages and a main menu. The storyboard contains a description of each interactive multimedia scene that is adapted to the characteristics or syntax of the PBL model (Arief et al., 2023). Researchers also develop and adapt the necessary instruments in the development of PBL-based interactive multimedia sound waves using Lumi. The types of instruments consist of interactive multimedia validity assessment sheets, interactive multimedia practicality assessment sheets.

Development

The development stage is carried out based on the history boards and storyboards that have been available at the design stage. The development stage is the process of making sound wave-based interactive multimedia using Lumi. The type of content created is in the form of a branching scenario that contains a branching question feature. Researchers also combine various content templates in developing this interactive multimedia such as presentation courses, image hotspots, and videos.

Implementation

The implementation phase is a product trial independent of researchers. Researchers also ensure that each button and content contained in interactive multimedia can function properly and match the characteristics or syntax of the PBL model.

Evaluate

The evaluation stage is carried out by observing deficiencies found in sound wave-based interactive multimedia PBL uses Lumi. The evaluation process addressed to each expert in order to obtain data at each stage to improve the development of interactive multimedia (Tegeh et al., 2014).

After the 5 stages contained in the ADDIE-type Instructional Design model have been completed, a validity test and a practicality test are carried out on sound wave interactive multimedia. The validity test was carried out by 3 expert lecturers using an assessment sheet consisting of aspects of pedagogy, materials, and media. Data from the validity test results of PBL-based interactive multimedia sound waves using Lumi were analyzed by looking at the qualitative assessment criteria for each aspect which contains several indicators. The qualitative data that has been obtained is converted into quantitative data and presented on a Likert scale, namely 1-5. The conversion of a qualitative scale to a quantitative scale is stated in Table 1.

Table 1. Convert Qualitative Scale to Quantitative Scale

Criteria	Score
Very Agree	5
Agree	4
Doubtful	3
Disagree	2
Very Disagree	1

Source: (Sugiyono, 2019)

Each assessment indicator on the validation sheet is declared valid if it has a value of ≥ 3. If there is an indicator that has a value of < 3, it is necessary to make improvements or revisions to each product according to suggestions or input on the indicator in question. The validity value is obtained by using Aiken's V formula (Yani et al., 2022) in equation (1), then interpreted descriptively based on Table 2.

$$V = \frac{\sum s}{n(c-1)} \quad (1)$$

Where, V = validity score; s = the number given by the validator is reduced by the minimum score; n = number of validators; and c = maximum score.

Table 2. Interpretation of Aiken's V Coefficient

Score Average Interval	Criteria
$0.80 < V \leq 1.00$	Very High
$0.60 < V \leq 0.80$	High
$0.40 < V \leq 0.60$	Enough
$0.20 < V \leq 0.40$	Low
$0.00 < V \leq 0.20$	Very Low

Source: (Azwar, 2012)

The practicality test was carried out by 3 physics teachers using an assessment sheet consisting of pedagogical, material, and media aspects, as well as responses from 20 students of SMA Negeri 5 Pekanbaru using an assessment sheet consisting of pedagogical and media aspects. Data from the practicality test results of wave interactive multimedia using Lumi were analyzed by looking at the qualitative assessment criteria for each aspect which contains several indicators. The qualitative data that has been obtained is converted into quantitative data and presented on a Likert scale, namely 1-5 (Safitri et al., 2023). The practicality value is obtained by using equation (2), then interpreted descriptively based on Table 3.

$$\text{Practicality} = \frac{\text{Total score}}{\text{Maximum score}} \times 100 \quad (2)$$

Table 3. Practicality Assessment Criteria

Practicality Score (P)	Criteria
$P \leq 20$	Not Practice
$20 < P \leq 40$	Less Practical
$40 < P \leq 60$	Enough
$60 < P \leq 80$	Practice
$80 < P \leq 100$	Very Practice

Source: (Riduwan, 2011)

Result and Discussion

The analysis phase states that physics material such as sound waves is considered learning that is difficult for students to understand. This problem is triggered by the use of inappropriate methods and models and learning resources, especially in explaining sound wave material. This is evidenced by the results of a needs analysis which stated that 85.7% of 7 high school physics teachers or equivalent in Riau-Kepri were dominant in applying the question and answer method and 59.2% of 147 high school or equivalent students in Riau-Kepri were dominant in using books or e-Book in learning physics.

The application of learning resources in the form of books or e-books is caused by 71.4% of 7 high school physics teachers or the equivalent in Riau-Kepri still having difficulty in making or displaying simulations related to physics materials such as waves. The question and answer method that is often used in the physics learning process makes 54% of the 50 students of SMA Negeri 5 Pekanbaru rarely conduct experiments and 71.4% of the 7 high school physics teachers or the equivalent in Riau-Kepri rarely direct students to conduct virtual experiments. This shows that the PBL model, especially at SMA Negeri 5 Pekanbaru, has not been implemented optimally, especially in the 3rd syntax, namely guiding individual and group investigations. Since 87.8% of the 147 high school or equivalent students in Riau-Kepri are allowed to use cellphones and laptops during learning, PBL-based interactive multimedia sound waves using Lumi are needed to overcome problems in the physics learning process.

The design stage produces interactive multimedia designs in the form of history board and storyboards (Rosamsi et al., 2023). The results of the history board and storyboard design are outlined in the form of scenarios. Scenarios in interactive multimedia are created using the branching question feature. Branching questions consist of instructions (command sentences and interrogative sentences in operating interactive multimedia) as well as feedback expressions. Branching questions also contain various content templates such as presentation courses, image hotspots, and videos. The advanced branching option feature for each branching question is also regulated by the researcher so that it is connected to other branching questions. Scenario snippets using Branching Scenario are shown in Figure 2.

Figure 2. Scenario use *Branching Scenario*

Researchers also collect various media such as text, images, links, and videos. Texts on interactive multimedia include preface, instructions, competencies, learning, evaluation, references, and profiles. Images in interactive multimedia are mostly designed using the Canva and SuperMe applications. Links in interactive multimedia include links to student worksheet using Google Documents; student worksheet collection links and evaluation question links using Google Forms, as well as virtual laboratory links sourced from PhET, Olabs, and GoLabz. Video on interactive multimedia is a video discussing sample questions.

The results of the design stage are the basis for creating sound wave-based interactive multimedia using Lumi. There are several activities carried out in making interactive multimedia, namely setting up displays, creating scenarios, and incorporating various media or content into scenarios. The results of the development phase are shown in Figure 3 until Figure 11.

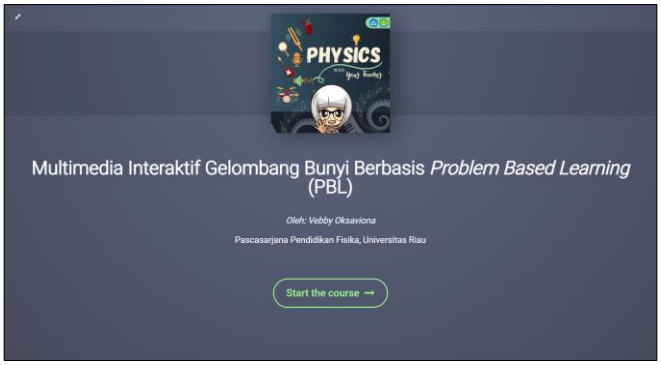

Figure 3. Start the Course

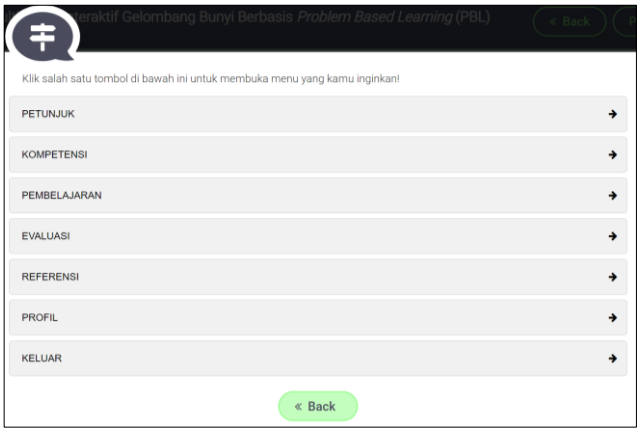

Figure 4. Main Menu

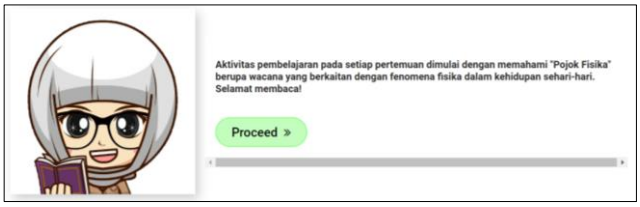

Figure 5. Feedback

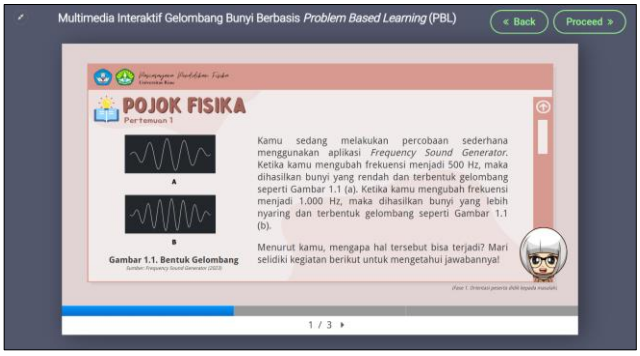

Figure 6. Presentation of Material

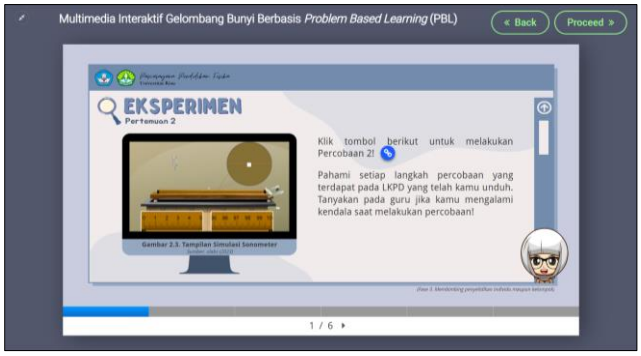

Figure 7. Experiment

Figure 8. Material

Figure 9. Video Sample Questions

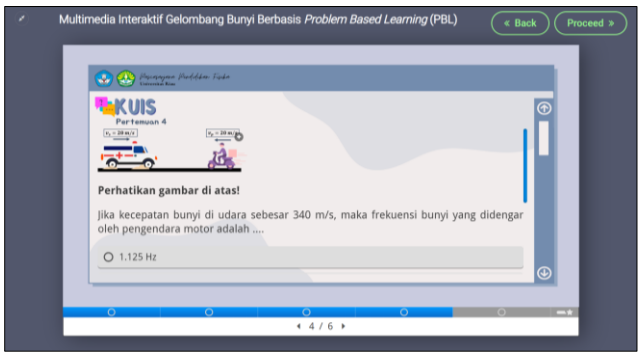

Figure 10. Quiz

Figure 11. Profile of learning media developer

Interactive multimedia that has been made is then tested for feasibility and practicality based on the assessment sheet that has been prepared by the researcher. The results of the validity test and practicality test are explained as follows.

Validity test results

The validity test was carried out by providing validity assessment sheets to 3 validators (Walad et al., 2019). The validator conducted 2 assessments of sound wave-based interactive multimedia using Lumi based on the aspects provided on the validity assessment sheet. Each validator in validity test 1 states that there are several items in each aspect of the assessment that do not meet the appropriate criteria. Therefore, researchers must make improvements according to the suggestions given by the validator. The results of the improvement on validity test 1 were then reassessed by each validator. The final validity test results are shown in Table 4.

Table 4. Interactive Multimedia Validity Test Results

Aspect	V	Criteria
Pedagogy	0.84	Very High
Material	0.84	Very High
Media	0.90	Very High
Average	0.86	Very High

Based on Table 4, the results of the interactive multimedia validity test by 3 validators obtained an average Aiken validity index of 0.86 with very high criteria. Since the average value of validity is already at very high criteria and there are no more suggestions from each validator, the interactive multimedia as a whole is declared feasible to be used in the physics learning process.

Practicality test results

The practicality test is carried out by providing practicality assessment sheets to users (teachers and students). The results of practicality tests by teachers and students are shown in Table 5 and Table 6 respectively.

Table 5. Interactive Multimedia Practicality Test Results by Teachers

Aspect	P	Criteria
Pedagogy	92.83	Very Practice
Materi	90.17	Very Practice
Media	96.91	Very Practice
Average	93.30	Very Practice

Table 6. Interactive Multimedia Practicality Test Results by Students

Aspect	P	Criteria
Pedagogy	90.00	Very Practice
Media	90.91	Very Practice
Average	90.46	Very Practice

Based on Table 5, the results of the interactive multimedia practicality test by 3 physics teachers obtained an average score of 93.30 with very practical criteria. Table 6 also states that the average value of interactive multimedia practicality carried out by 20 students is 90.46 with very practical criteria. Since the average value of practicality is already in the very practical criteria and there is no suggestion from any teachers or students, interactive multimedia as a whole is stated to be practical for use in the physics learning process.

Conclusion

The results of the study can be concluded that the sound wave-based interactive multimedia PBL using Lumi has been developed with the ADDIE type Instructional Design research procedure which consists of 5 stages namely analyze, design, development, implementation, and evaluate. The analyze stage shows that interactive multimedia needs to be developed for class XI high school students, especially in sound wave metry. In the design stage, historyboards and storyboards are obtained as a design in making interactive multimedia at the development stage. The implementation stage states that interactive multimedia can function properly, because the evaluate stage is carried out at every other stage. The results of the validity test and practicality test also show that PBL-based interactive sound wave multimedia using Lumi is declared feasible and practical to use in the physics learning process.

Author Contributions

This article was prepared by three authors, namely V.O, N.I, and M.N. Three drafters work together to complete each stage of drafting.

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Conflicts of Interest
The authors declare no conflict of interest.

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