P-ISSN: 1693-1246
E-ISSN: 2355-3812
December 2024

Jurnal Pendidikan Fisika Indonesia 20 (2) (2024) 197-213
DOI: 10.15294/jpfi.v20i2.17573

http://journal.unnes.ac.id/journals/jpfi

Development of Problem-Based Learning with A Variety of Media to Improve Problem-Solving Skills in Mechanical Wave Material

Abdul Haris Odja[1*], Jepri Dikum[1], Citron Supu Payu[1], Supartin[1], Wirawan Fadly[2]

[1]Program Studi Pendidikan Fisika, FMIPA, Universitas Negeri Gorontalo
Jl. Jendral Sudirman No.6, Gorontalo 96128, Indonesia
[2]Program Studi Tadris IPA, IAIN Ponorogo
Jl.Puspita Jaya, Ponorogo 63492, Indonesia
***abdulharis@ung.ac.id**

Received: 20 July 2024. Accepted: 04 October 2024. Published: 31 December 2024

Abstract

This research aims to produce learning tools that use a problem-based learning model with various media to improve valid, practical, and effective problem-solving skills. This research is a type of research and development (R&D). This research uses the ADDIE model, which stands for Analysis, Design, Development, Implementation, and Evaluation. The research results show that the learning tools are valid, practical, and effective and can be applied in the learning process. The learning tools' validation results are very valid and suitable for use. Practical learning tools with learning implementation results that reach very good criteria and the response given by teachers and students to positive learning tools. Effective learning tools are used to observe student activities, obtain good criteria, and test the results of problem-solving skills for data normality and normal distribution. The completeness of students' problem-solving ability scores is seen from the t-test results, which concludes the students' scores. Learning tools are very influential, as indicated by the value of the effect size test with high criteria. The results of problem-solving skills were increased by increasing the N-gain test in the medium category. Based on the research results, it can be concluded that the learning tools are valid, practical, and effective.

Keywords: Learning Device, Problem-Based Learning, Variety Media

INTRODUCTION

Problem solving is an advanced level of thinking that requires good skills, abilities, understanding, and sufficient experience. In physics lessons, problem-solving skills need knowledge, ability, experience, and determination in the face of adversity. Many students feel they cannot give up quickly and are hopeless in solving more complex physics problems, even though these students are considered intelligent. This is based on an assessment of physics learning in classes where students are not tolerant of problems in physics questions (Napis, 2018). Based on this, the teaching that is carried out should be able to direct students to think at a higher level in solving problems.

Indicators problem solving is generally divided into five indicators: understanding the problem, analyzing the problem, planning alternative problem-solving, implementing the problem-solving plan, and assessing the problem (Hidayatulloh, Suyono, & Azizah., 2020). Problem-solving skills include several indicators, including understanding problems, planning solutions, resolving issues according to plan, and double-checking that problems are resolved.

Problem-solving ability is the ability of students to use their skills, knowledge, and understanding to solve problems (Agustina & Imami, 2022). According to Elvianasti, Kharisma,

Irdalisa, & Yarza, (2022) skills solving problem is significant to know the problem-solving abilities of students. In addition, these skills are used in everyday life, so problem-solving skills are considered necessary. However, the ability of students' problem solving is low. This is evidenced by the results of the PISA survey, which measures students' problem-solving abilities; 70 percent of Indonesian students did not reach Level 2 of the PISA framework in 2018, while the average was only 23 percent. Students in 79 PISA countries did not reach Level 2 in reading, indicating that Indonesian literacy, including problem-solving, is still very low (Hidayatulloh, Suyono, & Azizah, 2020).

Problem-solving skills can be trained when supported by learning, which can encourage students to think at a higher level. Learning will go well if it begins with good learning planning, so learning tools are needed that can support students' problem-solving skills training (Fariroh & Anggraito, 2015). Learning in schools generally uses learning tools guided by the 2013 curriculum. However, the learning process and its application are still dependent and centered on the teacher. There is still a lack of teacher innovation in using learning models. Teachers only tend to use the same teaching method every day so that students do not tend to be passive. Lack of teacher innovation in using learning media.

The media plays a vital role in learning, and it is a tool that the teacher can use to achieve learning objectives according to the teacher's plan. In learning activities, the teacher must also do the same thing.

Therefore, the teacher must demonstrate and develop these elements in student learning. Like many things that students encounter, one likes to study a subject because these subjects are usually dull. To overcome these symptoms, teachers must be able to determine and organize the material to encourage and motivate students to learn it (Setiawan, Malik, Megawati, Wulandari. Nurazizah, Nurjaman, & Maldini., 2022). According to Hasan et al. (2021), there is no regulation on when to use learning media. However, teachers must be able to determine the right and most effective learning media. According to Astuti, Chayono, Supartono, Van, & Duong (2018), media is a factor that can make learning more successful.

The general definition of variation is the diversity of things consisting of forms and properties that differ. The term variation in learning means changing and combining methods, media, styles, situations, interactions, and learning approaches so that it does not seem monotonous. Variations in learning media use various forms of media to present lesson material. Learning media can be classified into three types: visual, audio, and audio-visual media. According to Suryani & Lestari (2019), using various learning media aims to reduce boredom in learning; students can experience a learning process that is not monotonous so that learning becomes more memorable.

One learning model that can provide opportunities for students to have experience in developing problem-solving skills is the problem-based learning model. According to Rati, Rohiat, & Elvinawati (2022), problem-based learning is a learning model that transforms problems into learning contexts where students can think critically and build problem-solving skills to gain maintained knowledge. Tanjung (2019) stated that the application of this learning model aims to improve students' problem-solving and communication skills, starting with a specific problem.

Problem-based learning is a learning approach where students work on real problems to build their own knowledge and develop competence and high demands, making students independent and increasing their independence. Problem-based learning is more than just an effective medium for learning specific information. This can help students improve problem-solving, teamwork, and communication skills.

Problem-based learning has been studied widely (Timbuleng, Salajang, & Tumalun, 2021). According to Cahyono (2017), the PBL learning process focuses more on students' problems and activities and makes students understand.

Based on the description above, a problem-based learning model learning tool was developed with various media to improve students' problem-solving skills on mechanical wave material. This research aims to produce a learning tool that uses a problem-based learning model with various media to enhance problem-solving skills on mechanical wave material that is valid, practical, and effective.

METHOD

This research was conducted in class XI IPA II SMA Muhammadiyah Batudaa for the 2022/2023 academic year. This research is a type of research and development (Research and Development) that uses the ADDIE development model. This model was taken because the ADDIE model describes further systematic teaching development (Sugihartini & Yudiana, 2018). The ADDIE model has five stages: analysis, planning, development, implementation, and evaluation. Depending on the model chosen, (1) at the analysis stage, analysis of needs and problems is carried out in the form of relevant materials, textbooks, and learning conditions; (2) Several activities are carried out at the planning stage, including formulating learning objectives, determining study materials or topics, and preparing teaching materials systematically and adapting them to the needs of students. (3) stages of developing, assembling, and writing teaching materials adapted to the needs of students' learning activities; (4) implementation stage, namely the use of development products as teaching materials in learning activities; (5) and the evaluation stage, which is carried out formally in line with the product development stage (Safitri & Aziz, 2022).

The stages of the ADDIE development model are briefly presented in Figure 1.

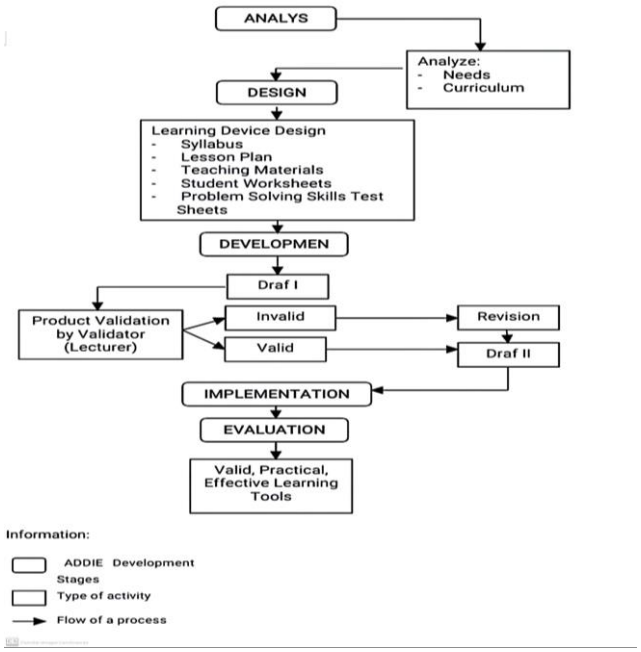

Figure 1. ADDIE Development Flow

The research instruments used in this research are 1) a learning tool validation sheet. Validators use this validation sheet to assess learning tools developed before use; 2) student activity observation sheet. This instrument is used during the learning process; 3) observation sheet on learning implementation. the same as student activity sheets, learning implementation sheets are

also used when the learning process is in progress; 4) teacher and student response questionnaires. Both teachers and students use this questionnaire after the learning has been carried out; and 5) problem solving ability test. This test is given before and after learning is carried out.

Table 1. Types of Instruments, Grids, and Assessment Weights

Instrument Type	Utility	Grille	Assessment Weight
Learning device validation sheet	The device validation sheet is used to obtain data about the suitability of the learning device to be developed. The validation sheets used in this instrument are the syllabus validation sheet, RPP, teaching materials, LKPD, and problem-solving skills test validation sheet.	The validation sheet grid for the learning tools to be used consists of 5 parts of assessment indicators, namely construction, content, readability, language, and appearance.	Evaluation of the validation sheet is carried out by providing a checklist in the selected number column with the following weighting: 4 : Very Good 3 : Good 2 : Not Good 1 : Very Poor
Student activity observation sheet	Observation sheets are used to see students' actions in responding to the learning model used by the teacher.	The student observation sheet consists of 10 aspects that are assessed according to the learning model used. These aspects consist of 1) listening to apperception, 2) listening to the teacher's explanation, 3) listening to the learning objectives, 4) paying attention to the material through lectures and demonstrations, 5) answering questions from the teacher, 6) working on the LKPD, 7) presenting the results of the LKPD, 8) comment on different answers, 9) ask questions about the material you don't understand, 10) listen to the reinforcement given by the teacher	The assessment is carried out by providing a checklist in each column of the specified aspect indicators. The weighting given to the assessment of student activities is: 1 : Implement 0 : Not Implementing
Learning implementation observation sheet	This observation sheet is used to evaluate the learning taking place in class and see whether the RPP used by the teacher is in accordance with the steps outlined and is easy to implement in class.	The learning implementation sheet used is in accordance with the RPP syntax of the learning model used.	The assessment is carried out by providing a checklist in the column provided. The weighting in this assessment is: 1: Done 0: Not Implemented
Questionnaire	The questionnaire used to obtain teacher and student responses to the device that will be developed and to obtain data about its practicality.	The response questionnaire used consists of a teacher questionnaire and a student questionnaire. The teacher questionnaire consists of 5 indicators containing 63 statements. These indicators include syllabus, lesson plans, teaching materials, LKPD, and problem-solving skills tests. The student response questionnaire	The assessment used in the questionnaire is by providing a checklist in each assessment column provided. The assessment weights used are: 5 : Strongly Agree

Instrument Type	Utility	Grille	Assessment Weight
		contained 20 statements.	4 : Agree 3: Doubtful 2 : Disagree 1 : Strongly Disagree

Validation is a data collection technique that uses a validation sheet. Validation aims to determine the level of validity of the learning developed. This research data collection technique is useful for determining whether the learning devices developed are valid or feasible. The learning devices used are validated by 2 expert validators with the devices to be validated, including the syllabus, learning implementation plan (RPP), teaching materials, student worksheet (LKPD), assessment instruments, student activity sheets, teacher and student questionnaires, and student learning implementation sheets. The analysis of the validity or otherwise of the learning devices used is determined based on the opinions of professionals who review the learning devices to be developed. The aspects assessed by the experts are the structure, content, readability, language, and appearance of each learning device instrument. The research results obtained are used as input suggestions for revising the learning devices. According to Purnomo (2014), the validity criteria for learning tools can be seen in Table 1.

Table 2. Validity Criteria

Score Interval	Assessment Criteria	Description
$3,6 \leq P < 4$	very valid	Can be used
$2,6 \leq P < 3,5$	valid	Can be used with a little improvement
$1,6 \leq P < 2,5$	less valid	Could be used with some improvements
$1 \leq P < 1,5$	invalid	Cannot be used it and still need advice

Use learning implementation sheets and teacher and student response questionnaires to see the practicality of learning tools. To find out the percentage of implementation of activities for all aspects of learning, a formula is used.

$$\text{Implementation of learning} = \frac{Mshbt}{Nops} \times 100\% \quad (1)$$

Information:
Mshbt : Many steps have been taken
Nops : Number of planned steps

Assessment of learning implementation is carried out by matching the average total score results with the learning implementation criteria according to Kurniasari & Kusnan (2018) as follows.

Table 3. Interpretation of Learning Implementation Scores

Percentage (%)	Valuation
81 – 100	very good
61 – 80	good
41 – 60	moderate
.21 – 40	poor
.0 – 20	very poor

Evaluation of teacher and student response questionnaires towards learning using the problem-based learning model with a variety of media using a Likert scale. The respondent choices used were: 1) strongly disagree, 2) disagree, 3) undecided, 4) agree, and 5) strongly agree.

To see the effectiveness of the learning tools developed using student activity sheets and problem-solving skills tests. Student activity sheets consist of 10 indicators and are carried out when learning takes place for 3 meetings and are used as a tool to collect data. Student problem-solving skill test sheets to improve student problem-solving skills. The grid and indicators for the problem-solving skills test can be seen in Table 3.

Table 4. Problem-Solving Skills Test Grid

Question Indicator	Question Number	Indicator of Problem-Solving Skills				Cognitive Level	Question Type
		D1	D2	D3	D4		
Determine the concept of waves by finding the speed of propagation of transverse waves	1	√	√	√	√	C3	Essay
Calculate the physical quantities of mechanical waves by finding the wavelength and propagation speed of longitudinal waves	2	√	√	√	√	C3	Essay
Calculate the frequency and speed of wave propagation	3	√	√	√	√	C3	Essay
Analyze the characteristics of mechanical waves by looking for the speed of light in water	4	√	√	√	√	C4	Essay
Analyze the characteristics of mechanical waves by looking for the refractive index of the waves in the glass layer	5	√	√	√	√	C4	Essay
Explain the nature of mechanical waves	6	√	√	√	√	C2	Essay

With D1: Understanding the Problem, D2: Designing and Planning Solutions, D3: Implement the Solution Plan, and D4: Check again.

The analysis of whether or not the learning tools used are valid is determined based on the opinion of professionals who examine the learning tools to be developed. The aspects assessed by experts are the structure, content, readability, language, and appearance of each learning tool instrument. The research results obtained are used as input suggestions for revising the learning tools.

To determine the magnitude of the influence of learning on students' problem skills. In following the learning process for 3 meetings, the results of observing the activities of students were analyzed using a formula.

$$\text{Student Activity} = \frac{A}{N} \times 100\% \quad (2)$$

with

A : total score obtained

N : maximum number of scores

The following is a table of student activity criteria according to Nurpratiwi, Sriwanto, & Sarjanti (2015).

Table 5. Student Activity Criteria

Activity (%)	Criteria
76-100	Very good
51-75	Good
26-50	Pretty good
≤ 25	Not good

The normality test carried out the data obtained. The normality test was carried out using the IBM SPSS Statistics trial application. The formulas or equations used in the normality test are:

$$D = [F_S(X) - F_t(X)] \quad (3)$$

with

D : Calculated value

$F_S(X)$: Cumulative sample frequency distribution

$F_t(X)$: Cumulative sample frequency distribution

Then, a t-test or hypothesis test is carried out using the IBM SPSS Statistics application with the t-test one sample t-test. The equation used is:

$$t = \frac{X-\mu}{S/\sqrt{n}} \quad (4)$$

with

X : sample mean

μ : population average

S : standard deviation

N : number of Samples

Then, proceed with the effect size test to determine the effect of learning devices that use problem-based learning models on the results of students' problem-solving skills. The effect size test was carried out using the IBM SPSS Statistics

application. The equation used in determining the effect size is as follows:

$$\text{Cohen's d} = \frac{\text{Sample mean} - \text{Population mean}}{\text{Standard Deviation}} \quad (5)$$

The effect size criteria according to Cohen in Utami & Roektiningkroem (2018).

Table 6. Effect Size Criteria

Great Effect	Category
0 – 0.20	very low
0.21 – 0.50	low
0.51 – 1.00	currently
>1.00	high

The N-gain test is carried out using the formula:

$$N(g) = \frac{\text{Spost} - \text{Spre}}{100\% - \text{Spre}} \quad (6)$$

with

$\langle g \rangle$: N-Gain

Spost : Post-test score

Spre : Pre-test value

The N-gain score category, according to Hake (1999), namely, the high category for $N^{(E)} > 0{,}7$, the medium category for $0{,}3 \leq N^{(E)} \leq 0{,}7$, and the low category for $N^{(E)} < 0{,}3$

RESULT AND DISCUSSION

This research is development research that aims to see the effectiveness of learning tools with video-assisted problem-based learning models, PhET simulations, and teaching aids to improve the problem-solving skills being developed. This research uses the ADDIE model, which stands for Analysis, Design, Development, Implementation, and Evaluation. This model was taken because the ADDIE model describes further systematic teaching development (Sugihartini & Yudiana, 2018).

The analysis stage is the first stage in the development of ADDIE. This stage is divided into two analysis stages: needs analysis and curriculum analysis. The results of the analysis are as follows.

Needs analysis is carried out to analyze the problems that students have or are experiencing. Based on the results of interviews with physics subject teachers and also surveys that have been conducted, it was found that problems often occur in physics learning, where students tend to be more passive during the physics learning process. This is because the learning carried out is still teacher-centered. The lack of use of media causes students' disinterest during the learning process. The media used so far has only relied on textbooks.

Next, a curriculum analysis was carried out at Muhammadiyah Batudaa High School, which currently still uses the 2013 curriculum. The curriculum used in this school still uses the 2013 curriculum, whereas the learning tools used still refer to the 2013 curriculum. The results obtained are based on the analysis at this school. The 2013 curriculum is still applied. even though it is in the transition period to the new curriculum. Even though it is in the transition period, the 2013 curriculum is still a benchmark for teachers to plan learning. Rati (2022) stated that the 2013 Curriculum, as a benchmark for teachers in planning and implementing the learning process, now requires students to be more actively involved in learning so that learning is no longer teacher-centered but student-centered. Based on the results of the curriculum analysis that has been carried out, it is known that the learning tools used are in accordance with the 2013 curriculum, but the tools used tend not to undergo significant changes to attract student interest and activity. Therefore, in this research, the researcher developed a physics learning tool that refers to the 2013 curriculum, which includes core competencies and basic competencies.

The second stage is design; at this stage, the learning tools that will be used are designed according to the problems found and find alternative solutions or solutions to these problems. Then, a learning device is designed or compiled using a problem-based learning model,

which can improve students' problem-solving skills. According to Senada in Supartin (2022), problem-based learning (PBL) is a creative learning alternative and provides energetic learning conditions for students. Based on the results of surveys and literature studies, problem-based learning tools can improve students' problem-solving skills (Supartin, 2022).

Next, learning tools are designed or developed using video-assisted problem-based learning models, PhET simulations, and teaching aids, which include syllabi, lesson plans, teaching materials, LKPD, and problem-solving skills tests.

The next stage is the learning device development stage. In this stage, the researcher will develop learning tools consisting of syllabi, lesson plans, student worksheets, teaching materials, and problem-solving skills tests. The learning tools developed are adapted to video-assisted problem-based learning models, PhET simulations, and teaching aids. The learning tools are developed as research material at this stage to determine their validity. The device developed is a learning device that uses a video-assisted problem-based learning model, PhET simulation, and teaching aids, which include syllabus, lesson plans, teaching materials, LKPD, and problem-solving skills tests.

The first learning tool developed was a syllabus. The syllabus was developed based on the 2013 curriculum guide, which contains KI, KD, indicators, learning materials, learning activities, assessments, time allocation, and learning resources. The syllabus developed is adapted to the problem-based learning model, which is assisted by a variety of media.

Next, the RPP was developed. The RPP that was developed was prepared according to the problem-based learning model assisted by a variety of media. The lesson plans are designed according to the problem-based learning syntax: orienting students to problems, organizing students, guiding investigations, developing and presenting work results, and analyzing and evaluating. The teaching materials developed are adapted to the learning materials to be used. The material used in the teaching materials is material about mechanical waves.

The LKPD developed is based on a problem-based learning model assisted by a variety of media. Next, the problem-solving skills test developed is based on problem solving indicators. The problem-solving indicators used in developing problem-solving skills tests include understanding the problem, designing and planning a solution, completing the problem plan, and checking again. Based on the results of the development of learning tools consisting of syllabi, lesson plans, teaching materials, LKPD, and problem-solving skills tests, it was declared suitable for use and implementation in the learning process.

This is based on the results of the validation of learning tools that have been carried out. The validity of each learning tool developed is categorized as very valid with the average score obtained ranging from 3.65 – 3.8, so the learning tool is declared valid and suitable for use. The results of the learning device validation can be seen in Table 7.

Table 7. Validation Results of Learning Tools

Learning Tools and Learning Instruments	Value	Criterion
Syllabus	3.8	very valid
Learning Implementation Plan	3.8	very valid
Teaching materials	3.75	very valid
Student Worksheet	3.75	very valid
Problem-Solving Skills Test	3.65	very valid
Teacher Response Questionnaire	3.8	very valid

Student Response Questionnaire	3.7	very valid
Learning Implementation Sheet	3.8	very valid
Student Activity Sheet	3.7	very valid

Table 7 shows that the results of the validation of learning tools and research instruments, namely the results of the validation of the syllabus, obtained a score of 3.8 with very valid criteria, the results of the lesson plan validation were 3.8 with very valid criteria, the results of the validation of teaching materials were 3.75 with very valid criteria. valid, the results of the LKPD validation were 3.75 with very valid criteria, the validation results of the problem-solving skills test were 3.65 with very valid criteria, the validation results of teacher and student response questionnaires were respectively 3.8 and 3.7 with the criteria very valid, the validation result of the learning implementation sheet was 3.8 with very valid criteria, and the validation result of the student activity sheet was 3.7 with very valid criteria. In this way, the learning tools and research instruments developed can be implemented in the learning process.

The next stage is application or implementation. The application of learning tools that have been developed is carried out in class XI IPA SMA Muhammadiyah Batudaa, namely class XI IPA I. The learning devices developed are carried out in 3 meetings on mechanical wave material, as seen in Table 8.

Table 8. Learning Syntax

Syntax	Learning Activities		Time Allocation
	Teacher	Student	
	Preliminary activities		
Introduction	a. The teacher gives greetings. b. The teacher invites students to pray by asking one of the students to lead the prayer. c. The teacher checks students who are present and absent. d. The teacher provides motivation to learn about the material to be studied. e. The teacher provides apperception to students in the form of videos and questions: What is meant by vibration? f. The teacher conveys the learning objectives that will be achieved in the lesson which are displayed with the help of power points. g. The teacher conveys the scope of the material to be studied.	a. Respond to greetings b. A student leads the prayer c. Acknowledge students who are absent d. Listen to the motivation given by the teacher e. Listen and answer the teacher's apperception f. Listen to the learning objectives	10 minutes
	Core activities		70 minutes
Student orientation to the problem	a. The teacher shows ocean waves or waves via the LCD. b. The teacher gives students the opportunity to ask questions related to the show. c. The teacher provides responses regarding student questions	a. Pay attention to the impressions displayed on the LCD b. Asking question	
Organizing	a. The teacher divides students into 3	a. Form groups as	

Syntax	Learning Activities		Time Allocation
	Teacher	Student	
	Preliminary activities		
students	groups according to the media that will be used: Group learning videos, PhET simulation group, and Props group. b. The teacher distributes LKPD to each group. c. The teacher explains how to work for each group using PowerPoint and cellphones to focus students' work steps in carrying out simple experiments.	directed b. Read the instructions in the LKPD c. Listen and pay attention to the teacher's explanation	
Guiding the investigation	a. The teacher guides students in carrying out simple experiments in groups. b. The teacher guides students to discuss the results of simple experiments that have been carried out and utilizes teaching materials to make data processing easier.	a. Carry out simple experiments on the material studied according to the LKPD. b. Conduct discussions based on experimental results	
Develop and present work results	a. The teacher directs each group to present the experimental results obtained in front of the class b. The teacher gives other groups the opportunity to respond to the presentation made by the group presenting	a. Each group presents the results of their simple experiment in front of the class. b. Respond to presentations of other group discussion results	
Analyze and evaluate	a. Students and the teacher analyze the results of their simple experiments. b. The teacher provides reinforcement regarding the results of student discussions. c. The teacher gives appreciation to each group that has performed. d. The teacher and students evaluate the learning activities that have been carried out. e. The teacher reflects on the activities that have been carried out.	a. Analyze the results of simple experiments b. Evaluate the learning activities that have been carried out	
	Closing Activities		10 minutes
	a. The teacher conveys the next lesson plan. b. The teacher asks one of the students to lead a prayer to close the learning activity. c. The teacher conveys greetings.	a. A student leads the prayer b. Respond to greetings	

The learning syntax used is a learning syntax based on the problem-based learning model. Problem-based learning, commonly called problem-based learning (PBL), is a learning approach model that helps students develop thinking skills by formulating problems from real-

life objects and then analyzing them (Putri, 2019). Table 8 is the learning syntax used in this research. The learning syntax used is in accordance with the problem-based learning model combined with several learning media. The learning media contained in the learning syntax include learning videos, PhET simulations, and teaching aids. Learning video media is audio-visual media that combines two elements, namely audio and visual, which means that the media used in audio-visual can be seen or heard. Such media objects tend to have more interesting value (Aini et al, 2022). PhET is an interactive simulation of research-based physics events that link real-world events with the science behind them to increase students' knowledge and interest in learning (Muzana et al., 2021). Teaching aids are learning media that can make students' work easier because students can see, observe, and understand actual events directly (Wulantri & Ali, 2018). Meanwhile, the material used in the learning syntax is mechanical waves.

The last stage of the ADDIE development model is the evaluation stage. In this stage, an assessment is carried out to see the effectiveness of the learning tools related to student observations, including student activities, and the results of students' problem-solving skills after using video-assisted problem-based learning models, PhET simulations, and visual aids.

The practicality of learning tools is seen from the observations of learning implementation and the results of teacher and student response questionnaires. The following are the practical results obtained. The implementation of learning in this research was seen in accordance with the steps or sequence in the lesson plan, which were observed during the learning process and carried out in 3 meetings on the material of mechanical waves. The results of the percentage of observations of learning implementation can be seen in Table 9.

Table 9. Percentage Results of Learning Implementation

Meeting	Percentage (%)	Assessment
I	96	Very Good
II	96	Very Good
III	100	Very Good
Average	97.33	Very Good

Table 9 shows that the implementation of learning carried out in 3 meetings achieved a very good assessment based on the criteria according to Kurniasari & Kusnan (2018) with an average of 97.33%. Thus, it can be concluded that the learning carried out is effective and in accordance with the planned learning implementation plan.

After the learning process, a teacher response questionnaire was given to problem-based learning tools with various media. The questionnaire consists of 5 indicators translated into 63 statements and uses a Likert scale for the score for each question. The percentage of teacher responses to learning tools is shown in Figure 1.

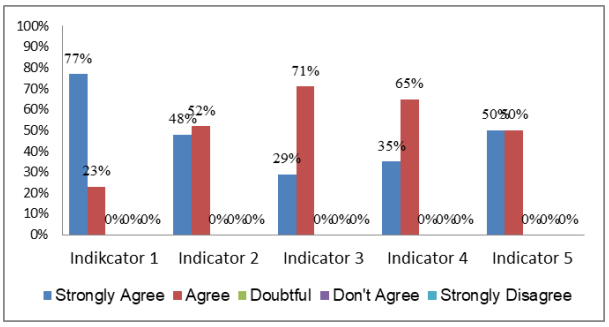

Figure 1. Percentage of Teacher Response Questionnaires

Figure 1 shows the results of the teacher response questionnaire regarding learning tools using the problem-based learning model with a variety of media developed to meet the practical criteria for use in physics learning. Where teacher responses to learning tools show a percentage of 77% strongly agree and 23% agree on the syllabus, 48% strongly agree, 52% agree on the RPP, 29% strongly agree, and 71% agree on teaching materials, 35% strongly agree, and 65% agree on the LKPD, and 50% strongly agree and 50% agree on the problem-solving skills test.

Student response questionnaires were given after the learning process was carried out for 3 meetings using a problem-based learning model with a variety of media. The student response questionnaire contains positive and negative statements consisting of 20 statement items. Scoring for each statement uses a Likert scale. The percentage of student responses to learning tools can also be seen in Figure 2.

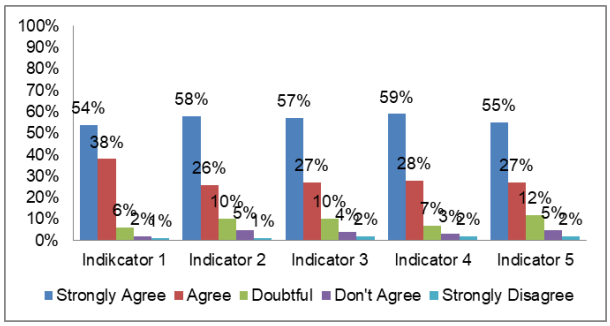

Figure 2. Percentage of Student Response Questionnaires

Figure 2, which shows the results of a questionnaire on student responses to learning tools, shows that students mostly gave positive responses to learning tools with a problem-based learning model with a variety of media developed. So it can be concluded that the learning tools have met the practical requirements based on student responses and can be used in learning.

The effectiveness of learning tools in terms of student activities and student problem-solving skills. The following results of the effectiveness were obtained. Student activity was assessed for 3 meetings in class XI IPA I I and was assessed by observers during the learning process using student observation sheets, as seen in Table 10.

Table 10. Student Activity Results

Meeting	Activity (%)	Criteria
I	73,54	good
II	77,74	very good
III	74,19	good
Average	75,15	good

Table 10 shows the percentage of student activity in 3 learning meetings. At the first meeting, the percentage of student activity was 73.54 %, with good criteria. Then, at the second meeting, the percentage of student activity was 77.74 %, with very good criteria. Furthermore, at the third meeting, the percentage of student activity was 74.19 %, with good criteria. Based on the three meetings' average percentage of student activity was obtained, namely 75.15% with good criteria based on the criteria according to Nurpratiwi, Sriwanto, & Sarjanti, (2015).

The results of students' problem-solving skills used an essay test consisting of 6 questions according to the learning indicators. The test is given before and after learning or pretest-posttest involving 32 respondents. The pretest and posttest results obtained are 15.7 and 84.24, respectively. So, the difference between the two is 68.53. This proves that there is a very large difference between the scores before and after treatment from the KPM test.

Furthermore, a normality test was carried out on the data resulting from the problem-solving skills obtained. The normality test in this study was carried out using the IBM SPSS Statistics trial application. The normality test results data can be seen in Table 11.

Table 11. Normality Test Results

Result of Problem-Solving Skills	Kolmogorov-Smirnov	Shapiro-Wilk	Criteria
Posttest	0.081	0.093	normal distribution

Table 11 shows that the normality test results for data on solving skills or post-test results

are 0.081 on the Kolmogorov Smirnov and are normally distributed. Then on Shapiro Wilk, that is, it was obtained by 0.093 with a normal distribution. These results are based on the normality test criteria, which state that data is expected if the data is above 0.05.

After the data normality test was carried out, the t-test was carried out with one sample t-test using the IBM SPSS Statistics trial application. The t-test in this study was used to test the individual learning completeness, the average problem-solving ability of students in class XI IPA II who had received learning using problem-based learning tools with a variety of media had met the KKM, which was 70 using the one-sample t-test. The hypothesis proposed:

Ho: The average value of problem-solving abilities is less than 70

Ha: The average value of problem-solving abilities is more than 70

The test criteria used are if t-count > t-table, then Ho will be rejected; otherwise, if t-count < t-table, then Ho will be accepted. The following results of the t-test can be seen in Table 12 below.

Table 12. Test Results t

T_{count}	T_{table}	Status
38,496	2,056	Ho rejected

Based on Table 12, the SPSS output results show that the t-count value is 38.496. Then the t-table is obtained, which is equal to 2.056; therefore, according to the t test criteria where 38.496 > 2.056, then Ho is rejected. Based on the average difference test and data from the problem-solving skills test results for class XI IPA, I can conclude that the average problem-solving skills of the class are more than 70 props, which means they have met the KKM. There are 28 students who meet the KKM or more than 70 out of a total of 32 students according to data obtained through the t-test, and there are still four students who do not meet the KKM or are still below 70 for the value of problem-solving skills in mechanical wave material.

Then, effectiveness can be seen from the results of the effect size test. The effect size test was carried out using the IBM SPSS Statistics trial application. The results of the effect size test can be seen in Table 13.

Table 13. Result Effect Size

Effect Size	Category
7,409	high

Table 13 shows that the effect size results obtained were carried out using the IBM SPSS Statistics trial application, with the results obtained being 7,409 in the high category according to Cohen's d. So, it can be concluded that learning tools that use video-assisted problem-based learning models, PhET simulations, and teaching aids have met the requirements for effectiveness and can be implemented in the learning process.

The increase in students' problem-solving skills is measured using the N-gain analysis or the N-gain test. The results of increasing students' problem-solving skills based on the results of the N-gain analysis can be seen in the following table.

Table 14. N-gain Test Analysis Results

Respondents	N-gain	Criteria
31	0.692	currently

Table 14 shows that the value of the N-gain test analysis results is 0.692, which is included in the moderate criteria according to Hake (1999). This indicates that there is a significant increase in problem-solving skills with the learning tools that have been developed. Therefore, learning tools that use the problem-based learning model have met the requirements for effectiveness.

Two validators validated the validation results of the learning tools developed, and based on the validation results, it showed that the assessment of the learning tools was declared valid with minor revisions, so it could be concluded that the learning tools developed were feasible and could be used in the learning process. This assessment is determined through professional opinion and a review of the device instrument as a whole. Data analysis used to assess the validity of learning tools uses a validation sheet. This is in accordance with the statement from Cahyono (2017) in his research regarding the development of learning tools, stating that the analysis to prove the validity of learning tools is intended to determine the extent of the learning tools being developed and expert assessment using validation sheets.

The practicality of learning tools can be seen from the implementation of learning and teacher response questionnaires and student response questionnaires to the learning tools developed. The implementation of learning tools is observed by the sequence of learning activity steps in the learning implementation plan (RPP). The learning activities in this research were carried out in 3 meetings. At each meeting, there were 25 steps of learning activities observed. The process of implementing learning activities follows the problem-based learning model, starting from preliminary, core, and closing activities. The results of observations from observers regarding the implementation of learning showed that the implementation of learning according to the criteria was very good.

The responses of teachers and students regarding the learning process using learning tools with a problem-based learning model with a variety of media can be seen from several indicators. Teacher responses to the learning tools developed were obtained through a teacher response questionnaire consisting of 5 indicators including syllabus indicators, lesson plans, teaching materials, LKPD, and problem-solving skills tests. The teacher response questionnaire contains 63 statements and gives a score for each statement using a Likert scale. The student response questionnaire consists of 5 indicators that express students' opinions regarding problem-based learning with a variety of media, which can make students concentrate and be effective in the learning process. Students' impressions of problem-based learning, students' feelings while participating in problem-based learning, students' interest in using a variety of media in learning, learning outcomes achieved in learning using the developed learning tools stated that after participating in problem-based learning activities with a variety of media and effectiveness use of LKPD. With this, it can be concluded that the learning tools developed can be applied in learning, because they meet practical requirements.

The effectiveness of the learning tools developed in terms of the activities of the students and the results of the problem skills of the students. Observers observe 10 aspects of student activity during 3 meetings. Assessment of student activity using student activity sheets carried out by observers by looking at student activities during the learning process takes place.

Results The average percentage of student activity during 3 meetings was 75.15 % with good criteria based on the criteria according to Nurpratiwi, Sriwanto, & Sarjanti, (2015). Thus learning tools can be said to be effective for improving problem solving skills. This is in line with research conducted by Arifin, Sahidu, & Makhrus, (2021) concerning the effectiveness of problem-based learning physics learning tools which state that problem-based learning-based learning tools are effective and can improve problem-solving abilities, so learning tools can be implemented in learning.

Effectiveness is then seen from the results of students' problem-solving skills. The results of students' problem-solving skills were obtained through the pretest and posttest, namely 15.7103% for the pretest and 84.2407% for the posttest so a difference of 58.6741 was obtained. Furthermore, the data obtained was carried out a t-test which was carried out using the IBM SPSS Statistical trial application to review the completeness of the results of the problem solving skills of students in class XI IPA II SMA Muhammadiyah Batudaa. The results obtained through the t-test are 38.496 > 2.056, then Ho is

rejected, and Ha is accepted. Thus, it can be concluded that the data on problem-solving skills test results for class XI IPA II SMA Muhammadiyah Batudaa on mechanical wave material using problem-based learning tools with a variety of media is declared complete because it has fulfilled a score of more than 70 or KKM.

The influence of learning devices that use the problem-based learning model can be seen from the results of the effect size test, which obtained a score of 7,409 with high criteria according to Cohen's d. This shows that learning that uses devices with problem-based learning models and a variety of media has a big influence. Likewise, when viewed from the results of the N-gain test, a score of 0.692 was obtained in the medium category, according to Hake (1999). This shows that there is an increase in problem solving skills. This is consistent with research conducted by Firmansyah, Sukarno, Kafrita, & Al Farisi, (2022) regarding the effect of learning models stating that problem-based learning models can affect students' problem-solving abilities. Effective means influential, able to provide results, successful and useful. Effectiveness is a measure of success or learning outcomes achieved by students after studying the learning materials/devices applied. Effectiveness covers the extent to which students can achieve the learning objectives set in each unit. To measure the effectiveness of learning tools by achieving learning objectives when implementing learning tools. Thus, the learning tools that use the problem-based learning model that has been developed meet the effective requirements and can be implemented in learning.

CONCLUSION

Based on the research results, it can be concluded that the learning tools developed using the problem-based learning model with a variety of mechanical wave material media are declared valid, practical, and effective and can improve students' problem-solving abilities. This research requires further research on learning tools using a problem-based learning model using several media on a larger or wider scale so that the learning tools developed can be useful for everyone.

REFERENCES

Agustina, P., & Imami, A. I.. (2022). Analysis of Mathematical Problem Solving Ability of Class IX Students in Solving Pisa Problems Based on Polya Steps. *Journal of Education, Mathematics and Science*, 7(1), 39-50.

Aini, U. N., Utami, T. W., Khalidiyah, T., & Huriyah, L. (2022). Utilization of Video-Based Learning Media Using the Benime Application to Increase Understanding of Islamic Religious Education and Character (PAIBP) Subjects for Middle School Students. Edudeena: Journal of Islamic Religious Education, 6(1), 57-65.

Arifin, W. A., Sahidu, H., & Makhrus, M. (2021). The Effectiveness of Physics Learning Devices Based on Problem Based Learning Models to Improve Students' Problem Solving Ability and Critical Thinking Ability. *Indonesian Journal of Research and Learning Physics* , 3 (1), 19-23.

Astuti, F. K., Chayono, E., Supartono, S., Van, N. C., & Duong, N. T. (2018). Effectivenes of Elements Periodic Table Interactive Multimedia In Nguzen Tat Thanh High Scool. *IJIET (International Journal of Indonesian Education and Teaching),* 2 (1), 1-10.

Cahyono, A. E. Y. (2017). Development of Problem Based Learning Learning Tools Oriented to Students Creative Thinking Abilities and Initiatives. *Pythagoras : Journal of Mathematics Education,* 12 (1), 1-11.

Elvianasti, M., Kharisma, N. A. N., Irdalisa, I., & Yarza, H. N. (2022). Analysis of Students' Science Problem Solving Ability in Environmental Change Material. *Journal of Physics Research and Learning* , 8(1), 1-9.

Fariroh, A., & Anggraito, Y. U. (2015). Development of Problem-Based Learning Devices for Class X SMA Virus Material. *Unnes Journal Of Biology Education* , 4 (2), 149-155.

Firmansyah, F., Sukarno, S., Kafrita, N., & Al Farisi, S. (2022). The Influence of the Problem Based Learning Model (PBL) on the Physics Problem Solving Ability of Students of SMA Negeri 11 Muaro Jambi. *Physic and Science Education Journal (PSEJ)* , 2(2), 75-82.

Hake, R. R. (1999). Analyzing Change/Gain Scores*,* (1), 1-4.

Hasan, M., Milawati, M., Darodjat, D., Harahap, T, K., Tahrim, T., Anwari, A, M., & Indra, I. (2021). *Learning Media*. Klaten : Tahta Media Group.

Hidayatulloh, R., Suyono, S., & Azizah, U. (2020). Analysis of Problem Solving Skills of High School Students on the Topic of Reaction Rate. *Journal of Science Education Research* , 10(1), 1899-1909.

Kurniasari, D., & Kusnan. (2018). Implementation of the Probing Prompting Learning Model to Improve Student Learning Outcomes in Building Construction Subjects Class XI TGB at SMK Negeri 3 Jombang. Journal of Building Engineering Education Studies, 1-6.

Muzana, Syarifah R. (2021). Use of PhET Simulation on the Effectiveness of Science Learning. Journal of Educational Dedication, 5 (1), 227-236.

Napis. (2018). Analysis Of Physics Problem Solving In The Perspective Of Self Efficacy And Adversity Qoutient. *MIPA educational scientific journal* , 8 (1), 31-42.

Nurpratiwi, R. T., Sriwanto, S., & Sarjanti, E. (2015). Increasing Student Learning Activities and Achievements Through the Picture and Picture Method with Audio Visual Media in Geography Subjects in Class XI IPS of Bantarkawung State High School. *Geo-education* , 4 (2), 1-9 .

Ratti, F., Rohiat, S., & Elvinawati, E. (2022). Development of Problem Based Learning (PBL) Interactive Learning Multimedia Using Articulate Storyline Applications on Chemical Bonding Material. *Journal of Chemistry Education and Science* , 6(1), 70-79.

Safitri, M., & Aziz, M. R. (2022). ADDIE, A Model for Multimedia Learning Development. *Journal of Basic Education,* 3(2), 51-59.

Setiawan, U., Malik, A. S., Megawati, I., Wulandari, D,. Nurazizah, A., Nurjaman, D., & Maldini, C. (2022). *Learning Media* . Bandung: Widina Bhakti Persada Bandung.

Sugihartini, N., & Yudiana, K. (2018). ADDIE as a Model For Developing Educational Instructional Media (MIE) For Curriculum and Teaching Courses. *Journal of Technology and Vocational Education*, 15 (2), 277-286.

Supartin, S., Tantu, H., Mursalin, M., Arbie, A., Uloli, R., & Setiawan, D. G. E. (2022). The Effect of Applzing the Problem Based Learning on Student Learning Outcomes. *Educatio*, 17 (1), 12-20.

Suryani, D. R., & Lestari, N. (2019). Using a variety of learning media to increase motivation and interest in learning mathematics in class XI IPS 3 students at SMA Negeri 2 Merauke. *Musamus Journal of Mathematics Education*, *1*(2), 74-79.

Timbuleng, H. D., Salajang, S., & Tumalun, N. (2021). Development of Problem Based Learning Tools Open Ended Approach Material On Quadrilaterals and Triangles. *Unpatti Mathematics Education Journal,* 2 (3), 81-88.

Tanjung, H. S. (2019). Development of Problem Based Learning Tools to Improve Problem Solving and Mathematical Communication Skills for Students of SMA N 3 Kuala, Nagan Raya Regency. *Genta Mulia,* 10 (2), 178-187.

Utami, P. A., & Roektiningkroem, E. (2018). The Effect of Service Learning Strategy with Problem Based Learning Model on Problem Solving Skills and Students' Curious Attitudes. *E-Journal of Science Education*, 7 (7), 386-392.

Purnomo, B. (2014). Development of Integrated Social Science Teaching Materials Using a Contextual Approach in Middle School Class IX Semester 1. Batanghari University Scientific Journal 14(2)

Putri, Pungky Dilaka. (2018). The Effectiveness Of Problem-Based Learning (PBL) Models Based On Socio-Scientific Issues (SSI) To Improve The Ability Of Science Literacy On Climate Change Materials. *Jurnal Pendidikan PenelitianSains*, 7 (1), 1519-1524.

Wulantri & Ali, Syamsuri. (2018). Development of Physics Teaching Tools for Electromagnetic Induction Material in Class XII SMA. Indonesian Journal of Science and Mathematics Education, 01 (3), 179 -185.