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Development of Student Worksheets based on Problem Based Learning Models with Video-assisted Scientific Approaches to Improve Science Process Skills

Elvi Suryanti[1*], Festiyed[2]

[1] Magister of Physics Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang, Indonesia.
[2] Physics Department, Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang, Indonesia.

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Corresponding Author:
Elvi Suryanti
elvi.sydb27@gmail.com

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Abstract: This study aims to produce a product in the form of Student Worksheets based on Problem based learning models with a video-assisted scientific approach to improve science process skills that are valid, practical, and effective. This study uses the Plomp model, namely preliminary research, prototyping phase, and assessment phase. The validity and practicality of the developed Student Worksheets were obtained through validation and practicality questionnaire instruments, the effectiveness of Student Worksheets on attitude competence used observation sheets, knowledge was carried out by giving tests to students, and science process skills using performance assessment sheets taken by observers learning takes place. The results of the Student Worksheet data analysis were declared valid with an average value of 0.86. The practicality assessment obtained an average value of 81.78 and 86.01 in the very practical category. The student worksheets were declared effective in the attitude competencies of students in the very good category and more than 85% of students obtained scores above the Minimum Completeness Criteria, in the knowledge competence experienced an increase in gain score of 0.63 in the medium category, and Assessment of science process skills obtained an average value of 85.51 with a very good predicate.

Keywords: Student Worksheets, Problem Based Learning, Scientific Approach, Videos, Science Process Skills.

Introduction

Education is one that is seen as the first and foremost means to improve the quality of human resources that are superior and ready to compete in the current era of globalization. Through education it is hoped that all the potential of students can be optimally developed in order to achieve development goals and the nation's philosophy of life (Fauzi, 2017). Education is the main program of each country to improve the quality of human resources, and serves to maintain self-existence in relations between nations. Each country positions education as the basis for improving the quality of human resources and the quality of life of the nation (Festiyed dan Desmalinda, 2018). Education is expected to provide human knowledge and skills so that they can develop their own potential, empower natural potential and the environment for the benefit of their lives. The success of an education is closely related relation to the problems encountered in order to achieve success in the learning process.

In the learning process the teacher must be able to encourage the development of student competence. In this case, the teacher should be able to encourage students' acquisition of new knowledge, improve student skills, gain student learning experience and build attitudes that allow students to learn (Asrizal et al., 2019). This educational development is carried out to answer and face the challenges of the development of science and technology in the future. One of the sciences that support Science and Technology is physics.

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Physics is part of science, which is a science that studies natural phenomena, not only as knowledge but more on its implementation and role in human life (Ramli et al., 2020). Physics, one of the scientific studies, is closely related to the process of studying phenomena in the universe through scientific methods (Festiyed & Yulkifli, 2013). Physics is one of the fields of science that underlies the development of advanced technology and the concept of living in harmony with nature. Physics not only makes a real contribution to the development of technology, but physics education also forms people who have good reasoning and thinking power, are creative, intelligent in solving problems and educating students in learning.

Learning objectives describe the processes and results expected to be achieved by students in accordance with basic competencies, namely the nature of learning objectives does not only refer to maximum learning outcomes, but the importance of the process in each of these learning (Azzah et al., 2021). In the learning process many problems are often found. Several studies have shown that achieving competence through the teaching and learning process in the classroom often faces obstacles caused by many factors, for example the learning environment (Maison et al., 2019), the not maximal implementation of practicum and the use of student worksheets (Hidayati & Masril, 2019), misconceptions experienced by students (Maison et al., 2020), and science process skills are still low (Maison et al., 2019). The above facts are similar to the results of observations with physics teachers at a public school at SMAN 1 Ulakan Tapakis which shows that students' science process skills are still low.

To improve students' science process skills in learning can be done using student worksheets (SWS). SWS are one of the tools used to assist and facilitate learning and learning activities (Marsa et al., 2016). SWS is a printed teaching material in the form of sheets of paper containing material, summaries, and instructions for implementing learning tasks that must be done by students, both theoretical and practical which refer to the basic competencies that students must achieve in learning (Prastowo, 2014). In the learning process, using a learning model that is in accordance with the characteristics of learning material.

One of the learning models recommended in the 2013 curriculum is the problem-based learning (PBL) model. According to Argusni & Sylvis (2019) which states that PBL is a learning process based on problems that ask students to solve them scientifically. PBL is related to science process skills because science process skills are needed to solve a problem and encourage students to form concepts independently (Janah et al., 2018). Previous research stated that SWS based on PBL were developed to improve students' SPS to achieve 87% student completeness (Arimurti & Purnomo, 2018). SWS based on PBL can train SPS in the overall valid criteria (Maryam et al., 2018).

The learning process according to the 2013 curriculum is using a scientific approach. Implementation of the 2013 curriculum in learning with a scientific approach is a learning process designed in such a way that students actively construct concepts, laws or principles through the stages of observing, formulating hypotheses, collecting data, analyzing data, and drawing conclusions and communicating (Hosnan, 2014). To make it easier for students to master important concepts in learning, in addition to appropriate learning approaches and models, appropriate learning methods are also needed, namely the presentation method using learning videos.

Learning videos are media used to convey material to students in order to achieve learning objectives. Learning videos are a combination of various media, namely images, audio, video, animation, and others that can be used in the learning process. Learning videos can be used to understand the material being studied by students including abstract and complex concepts (Yelensi et al., 2020) so that students can get interesting learning. Based on research by cahyono et al. (2017), learning videos have a significant effect on students' SPS. The results of previous studies also show that learning videos can significantly improve students' SPS (Fitriyanto & Sucahyo, 2016).

Based on the problems that have been raised, as an effort to improve the quality of learning physics, it is necessary to do research on the development of teaching materials in the form of SWS based on the PBL model with a video-assisted scientific approach to improve science process skills that can be used in learning physics. The development of SWS based on the PBL model with a video-assisted scientific approach is expected to have an impact on improving students' SPS to make them better.

Method

The type of research conducted is research and development. This study aims to produce a product in the form of SWS based on PBL models with a video-assisted scientific approach to improve science process skills that are valid, practical, and effective. Design research will be carried out using the Plomp model (2013). Design research as development studies (development research) with three stages, namely: preliminary research, development or prototyping phase (iterative design phase), and assessment phase (semi-summative evaluation) (Plomp, 2013).

The initial investigation stage aims to obtain information about existing problems and the possibility of needing improvements and innovations as well as to get an overview of the temporary characteristics of the products being developed for use in learning activities. Important activities that will be carried out in this step are needs analysis and analysis of student characteristics. Furthermore, at the Development or The Prototyping Phase which aims to design a solution to the problem identified at the initial investigation stage. Activities carried out at the development or prototype stage include prototypes I, II, II, and IV. Furthermore, the assessment stage is the final stage of research development. At this stage a practicality test is carried out by filling out a questionnaire by the teacher and students as well as testing the effectiveness of using problem-based learning SWS with a video-assisted scientific approach to improve students' SPS.

The test subjects for the development of SWS based on PBL models with a video-assisted scientific approach to improve students' SPS were carried out in class XI IPA SMAN 1 Ulakan Tapakis. The type of data in this study is primary data, namely data obtained from the results of product trials in the form of validity trials of SWS accompanied by videos conducted by validators, practicality data by teachers and students, and effectiveness data obtained from the implementation of learning according to the device of observer and evaluation of students.

The instrument used in this development research was, at the Preliminary Research stage , an instrument was used in the form of a questionnaire consisting of a needs analysis and an analysis of the characteristics of students. Furthermore, at the Development or Prototyping, namely self-evaluation sheets and SWS validation sheets based on PBL models with video-assisted scientific approaches to improve students' SPS by experts. Then at the assessment stage, namely the practicality assessment questionnaire sheet which was filled out by the teacher and students was given after the teacher and students saw and used the SWS based on the PBL model with a video-assisted scientific approach to improve SWS in small groups and large group (field test). Furthermore, evaluating the effectiveness of student worksheets based on PBL models with a video-assisted scientific approach to improve SPS in three aspects, namely attitude competence using observation sheets, knowledge is carried out by giving tests to students, and SPS using performance assessment sheets taken by the observer during the learning process takes place.

The data analysis technique used is descriptive data analysis by describing the validity, practicality, and effectiveness of SWS based on PBL models with a scientific approach assisted by Video Videos to improve SPS. The data analysis techniques used in this study are as follows:

Preliminary Research Phase

Data analysis techniques for needs analysis questionnaires and student analysis using a Likert scale. The categories of needs analysis and analysis of student characteristics are obtained by calculating the scores obtained from each respondent using the Equation.

$$s_k = \frac{\Sigma X_i}{X_{max}} \text{x } 100 \quad (1)$$

Data analysis to assess the needs analysis for each indicator uses the provisions in Table 1.

Table 1. Categories of Needs Analysis and Student Characteristics Analysis

Category	Achievement Rate
Very good	90< N ≤ 100
Good	75 < N ≤ 90
Not enough	60 < N ≤ 75
Very less	≤ 60

(Kemendikbud, 2013)

Product Validation

Product evaluation based on a questionnaire that has been filled out by experts is analyzed to determine the level of validity of the product developed using a Likert scale. Giving a value of validity using the Aiken's V formula, Equation 2.

$$V = \frac{\Sigma s}{[n(c-1)]} \quad (2)$$

The validity category can be seen in Table 2.

Table 2. Validity Category

Achievement Rate	Criteria
≥0.6	Valid
< 0.6	Invalid

(Azwar, 2015)

Product Practicality

The practicality of the product is analyzed based on a questionnaire that has been filled out by educators and students. Giving a value of validity by using the Equation 3.

$$\text{Practicality Value(PV)} = \frac{\text{score obtained}}{\text{maximum score}} \text{x } 100 \quad (2)$$

Interpreted values correspond to the categories shown in Table 3.

Table 3. Categoris of Practicality Assessment

% intervals	Category
81-100	Very Practical
61-80	Practical
41-60	Pretty Practical
21-40	Less Practical
0-20	Impractical

(Yanto, 2019)

Product Effectiveness

The percentage of completeness of the learning outcomes of students' attitudes uses the Equation 4.

$$\text{Affective Value (AV)} = \frac{\text{sobtained score}}{\text{maximum score}} x100\% \quad (4)$$

The criteria for evaluating student attitudes are in accordance with Table 4.

Table 4. Attitude Assessment Category

% intervals	Category
81-100	Very Practical
61-80	Practical
41-60	Pretty Practical
21-40	Less Practical
0-20	Impractical

(Yanto, 2019)

students' knowledge competency values by using the Equation 5.

$$<g>= \frac{\langle S_{post}\rangle-\langle S_{pre}\rangle}{100\%-\langle S_{pre}\rangle} \quad (5)$$

N-gain calculation is then converted using the criteria shown in Table 5.

Table 5. Criteria for Normalized Gain

intervals	Criteria
(<g>)>0.7	Tall
0.3 ≤(<g>) ≤0.7	Currently
(<g>) <0.3	Low

(Hake, 1999)

Students' SPS are analyzed using the following Equation 6.

$$J = \frac{K}{L}100\% \quad (6)$$

The criteria for assessing students' SPS are in accordance with Table 6.

Table 6. SPS Assessment Category

% intervals	Category
81-100	Very Practical
61-80	Practical
41-60	Pretty Practical
21-40	Less Practical
0-20	Impractical

(Yanto, 2019)

Result and Discussion

Preliminary Research Phase

At the preliminary research stage it aims to find out what problems teachers and students face. The analysis carried out is needs analysis and analysis of student characteristics.

Needs analysis aims to find out the fundamental problems faced by students in learning physics to develop teaching materials. The analysis was carried out by giving questionnaires to teachers at SMAN 1 Ulakan Tapakis, SMAN 1 Nan Sabaris, and SMAN 1 Enam Lingkung. Based on the observations made, it is known that students do not yet have an understanding of facts, concepts, principles, and procedural in the learning process, teachers still rarely use teaching materials in the form of SWS which contain learning approaches and models and students are less active in carrying out practicum activities. Furthermore, the results of the analysis of the characteristics of students show that students' learning motivation is still lacking and students' SPS are still low.

Based on this, teaching materials are needed that can motivate students to learn and can improve students' SPS. The results of the study Ubaidillah (2016) state that the development of SWS can improve students' SPS. SWS based on problem based learning to practice science process skills with valid categories (Margareta & Purnomo, 2018). The results of previous studies also show that SWS based on a scientific approach that have been developed train students' SPS(Syafi'ah & Laili, 2020).

Development or Prototyping Phase

This stage begins after the initial investigation phase (Preliminary Research Phase) is completed. During this step, the prototype model is iteratively developed, evaluated, and revised. This step has a microcycle that helps in developing and improving the product until it produces a valid and practical product result. In this development or prototype phase, the product is developed in several stages, namely Prototype I, Prototype II, Prototype III, and Prototype IV.

In prototype I determine the validity level of SWS based on a PBL model with a video-assisted scientific approach designed. Based on the validation results, an analysis was carried out. If the results of the analysis state that it is not valid, then it is revised so that the SWS is obtained based on a PBL model with a valid video-assisted scientific approach. SWS based on the PBL model with a video-assisted scientific approach can be seen in Figure 1.

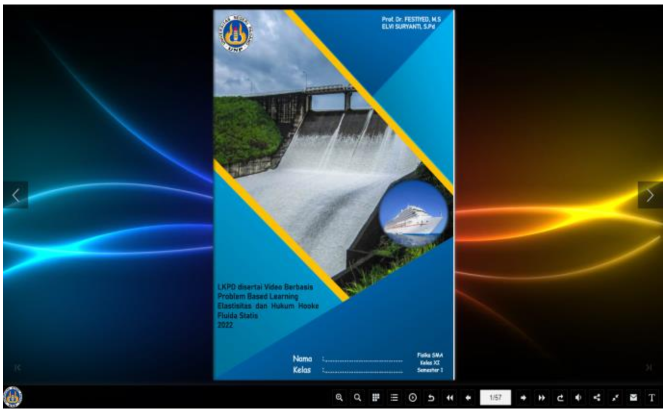

Figure 1. SWS based on *the* PBL model with a Video-assisted scientific approach

There were several things that were done at the protomodel I stage, namely: a) Doing a self-evaluation, namely revising the designed SWS yourself. Self evaluation uses self-evaluation sheets, b) Consults and discusses SW Sthat have been expertly designed. This uses a SWS validation sheet based on a PBL model with a video-assisted scientific approach. The validation results of SWS based on the PBL model with a video-assisted scientific approach by a team of experts can be seen in table 7.

Table 7. Results of SWS validation assessments based on PBL models with video-assisted scientific approaches.

Aspect	V grade	Criteria
Content eligibility	0.87	Valid
Presentation eligibility	0.88	Valid
language eligibility	0.84	Valid
Graphical eligibility	0.83	Valid
Average	0.86	Valid

Based on Table 7, it is stated that the SWS developed are in the valid category with an average value of 0.86, where in the aspects of content, presentation, language, and graphics the Aiken's V score is greater than 0.6. So, SWS based on PBL models with video-assisted scientific approaches can be used in the learning process. This is in line with the opinion of Ridho et al (2020) which states that if a teaching material can be declared valid if all of its components meet the minimum valid criteria..

After the revision was carried out, there was prototype I , then it was continued to stage two, namely prototype II , namely with the following steps: a) Conducting individual evaluations. This evaluation is carried out by asking students for comments on the SWS that has been designed, b) Conduct small group evaluations. This evaluation is carried out by practicing the SWS that have been designed to a group of students. Based on the results of the evaluation, revisions were made. The results of individual evaluations and small group evaluations were obtained through evaluation sheets.

The practical value of SWS based on PBL models with a scientific approach assisted by the One to One Evaluation video stage can be seen in Table 8.

Table 8. The practicality value of SWS the One-to-One Evaluation stage

Aspect	Mark	Practicality Criteria
convenience	80.00	Practical
Practicality	84.72	Very Practical
Attractiveness	79.17	Practical
Average	81.30	Very Practical

In general, all samples of the three samples stated that they understood the SWS easily in terms of language, instructions, and the contents of the SWS. This can be seen from the average score of Student Worksheets at the One to One Evaluation stage , which is 81.30 with very practical criteria. The results of previous studies also show that the SWS developed are practical to use (Lestari et al., 2018).

The results of the One to One Evaluation stage are called Prototype III. After being revised based on individual evaluation input and small group evaluations, a field test was carried out. Field tests were carried out under the same conditions as the actual conditions. All of these evaluations aim to see the practicality of small group evaluations. This evaluation is carried out by practicing the SWS model PBL with a video-assisted scientific approach that has been designed. If the Student Worksheet If it is not practical, then it is revised, in order to obtain SWS accompanied by a practical video. The practicality of SWS is seen from observations during the implementation of learning, and giving questionnaires. The instruments used were observation sheets and practicality questionnaires for educators and students.

The practical value of SWS based on the PBL model with a video-assisted scientific approach to the Small Group Evaluation stage can be seen in Table 9.

Table 9. The practicality value of SWS in the Small Group Evaluation stage

Aspect	Mark	Practicality Criteria
convenience	80.28	Practical
Practicality	83.80	Very Practical
Attractiveness	81.25	Very Practical
Average	81.78	Very Practical

Based on Table 9 it can be seen that the SWS are in the practical criteria in the aspect of convenience while the SWS are in the very practical criteria in the aspects of practicality and attractiveness. In this case, in general, of the nine samples, they stated that they understood easily in terms of the language of the work instructions, appearance, and contents of the SWS. This is from the average value of SWS at the Small Group Evaluation stage , which is 81.78 with very practical criteria. This is in accordance with the statement of Novia et al (2021) that PBL oriented SWS are easy to use in learning.

The results at the Small Group Evaluation stage are called prototype IV. In prototype IV Added support for analyzing context and user needs. These components were incorporated into the protomodel III, thereby extending its functionality.

Furthermore, the results of the practical analysis of students at the Field Test Evaluation stage . Practicality average value of 33 sample people. The practicality value of SWS for student responses at the Field Test Evaluation stage can be seen in Table 10.

Table 10. The practicality value of SWS according to students in the Field Test stage

Aspect	Mark	Practicality Criteria
convenience	79.99	Practical
Practicality	80.05	Practical
Attractiveness	77.44	Practical
Average	79.16	Practical

Based on Table 10 shows that SWS are in practical criteria in terms of convenience, practicality, and attractiveness. The results of previous studies also show that PBL oriented SWS are practically used in physics learning (Novia et al., 2021). Furthermore, the practicality assessment of SWS at the Field Test stage was seen from the teacher's response which included aspects of practicality, convenience, implementability, and time effectiveness. This is in accordance with the opinion of the practical value of SWS according to the teacher can be seen in Table 11.

Table 11. The practicality value of SWS according to the Field Test stage Teacher

Aspect	Mark	Practicality Criteria
Practicality	86.11	Very Practical
convenience	85.72	Very Practical
Execution	88.89	Very Practical
Time Effectiveness	83.33	Very Practical
Average	86.01	Very Practical

The average value of practicality from three teachers shows that SWS are in very practical criteria in terms of practicality, convenience, implementability, and time effectiveness. This is in line with the opinion of Lestari et al. (2018) that SWS can help study time more efficiently.

Assessment Phase

Attitude Competency Assessment Results

Assessment of student attitude competency is carried out at each meeting by one observer through the student attitude observation sheet. Student attitude assessment was carried out at three meetings on elasticity and Hooke's law. This assessment is carried out to see the extent to which the wishes and good attitudes of students respond to the learning that is carried out. The results of observations on student attitudes can be briefly seen in Table 12.

Table 12. Recapitulation of Student Attitude Competency Assessment Results

Attitude Aspect	Meeting Value (%)			Average	Criteria
	I	II	III		
Curiosity	81.82	81.06	86.36	83.08	Very good
Thorough	78.79	83.33	84.09	82.07	Very good
Cooperation	86.36	85.61	83.33	85.10	Very good
Responsibili	87.12	87.88	89.39	88.13	Very good

Table 12 shows the attitude of students is in the very good category and more than 85% of students get scores above the MCC. At each meeting the attitudes of students experienced an increase and a decrease. The attitudes that experienced the most significant improvement were conscientiousness and responsibility. This shows that SWS with PBL models can increase the accuracy and responsibility of students in developing and presenting their work, as well as analyzing data during experiments on elasticity and Hooke's law. In general, the attitude of students in using SWS accompanied by video based on PBL models is getting better during the learning process. Using the PBL model can motivate students to increase their attention and get them actively involved in fun and meaningful learning experiences (Parasamya & Wahyuni, 2017). This shows that student worksheets based on PBL models are in the effective category so that they can be used in physics learning to improve students' SPS.

Knowledge Competency Assessment Results

Assessment of students' knowledge competence can be determined by conducting tests before and after using Student Worksheets PBL models with video-assisted scientific approaches. Students do the pretest and posttest by answering multiple choice questions with a total of 20 questions. The results of the pretest and posttest tests of students in using the Student Worksheet can be seen in Table 13.

Table 13. Pretest and posttest calculation data

Statistical Parameters	Pretest	Posttest	gains
Average value	52.12	82.12	0.63
Variance	34.42	43.80	
Standard deviation	5.87	6.62	
lowest value	35.00	75.00	
The highest score	65.00	90.00	
Median	50.00	80.00	
mode	50.00	80.00	
value range	30.00	35.00	

Based on the comparison between the results of the pretest and posttes, it can be calculated the increase in the knowledge competence of students using the gain score. Based on the analysis of knowledge competence using the gain score, it can be stated that there is an increase in the average learning outcomes. This can be seen from the results of an increase in the gain score of 0.63 in the moderate category. This is in line with the research of Yuliska et al (2020) which states that the results of students' knowledge competency tests result in increased gain scores of 0.64 in the moderate category. Thus, it can be concluded that SWS based on PBL models with video-assisted scientific approaches to improve SPS are declared effective for use in learning.

SPS Assessment Results

Data on the effectiveness of using SWS were also obtained from the results of observations on SPS while conducting experiments on elasticity and Hooke's law. Assessment of SPS during three meetings consists of ten aspects. The ten aspects are Observing (M1) , Inferring (M2) , Identifying Variables (M3) , Predicting (M4) , Formulating Hypotheses (M5) , Interpreting (M6) , Applying Concepts (M7) , and Communicating (M8) . Data from observations of students' science process skill competencies by observers can be briefly seen in Table 14.

Table 14. Results of Data Analysis of Students' SPS

Aspect	Meeting Value (%)			Average
	I	II	III	
Observing (M1)	80.30	83.33	84.09	82.57
Inferring (M2)	85.61	86.36	84.09	85.35
Identifying Variables (M3)	87.12	83.33	85.61	85.35
Predict (M4)	87.12	84.09	86.36	85.86
Formulating a Hypothesis (M5)	86.36	84.85	86.36	85.86
Interpret (M6)	85.61	84.09	87.12	85.61
Applying Concepts (M7)	86.36	87.12	84.85	86.11
Communicate (M8)	8788	87.12	87.12	87.37
Average	85.80	85.04	85.70	85.51

Table 14 shows the average value of students' SPS is 85.51 with a very good predicate and more than 85% of students get scores above the MCC. This means that SWS based on PBL models with a video-assisted scientific approach in class XI learning are effective in their implementation and increase student activity in the learning process. This is due to the use of SWS based on PBL models with a video-assisted scientific approach that makes students' SPS visible and increase according to the aspects being assessed. This means that SWS based on PBL models with a scientific approach make students active, creative, and able to work together in groups, as well as being able to build their knowledge in scientific investigations individually and can develop SPS. The PBL model requires students to carry out authentic investigations to find solutions to real problems (Handayani et al., 2018). The results of previous studies also show that SWS are oriented towards a scientific approach, SPS have increased (Anggriani et al., 2023).

Overall, more than 85% of students used the SWS which was developed to score above the MCC with a very good predicate on attitude and skill competencies. Whereas in the knowledge competency there is a very significant difference when carrying out tests before and after using the SWS model PBL with a video-assisted scientific approach. This shows that SWS approaches are effectively used in physics learning to improve students' SPS.

Conclusion

Based on the development that has been carried out on SWS based on PBL models with a video-assisted scientific approach to improve students' SPS that are valid, practical, and effective. So, it was found that the SWS produced in this development research had a valid validity level based on the validator's assessment with an average value of 0.86. At the practicality level, the average value of SWS in the very practical category was obtained at the Small Group Evaluation stage, namely 81.78 and at the field test stage, namely 86.01. The effectiveness of SWS based on PBL models with a video-assisted scientific approach can be seen from the assessment carried out on the competence of attitudes, knowledge, and SPS. The assessment carried out on the attitude competence of students is in the very good category and more than 85% of students get scores above the MCC. In the knowledge competency analysis carried out using the gain score, it can be stated that there is an increase in the average learning outcomes. This can be seen from the results of an increase in the gain score of 0.63 in the moderate category. The assessment of SPS was obtained from observations of SPS during experiments with an average score of 85.51 with a very good predicate and more than 85% of students scored above the MCC. This shows that SWS based on PBL models with video-assisted scientific approaches are effectively used in physics learning to improve students' SPS.

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Author Contributions
conceptualizing ideas, preparing designs, and drafting Elvi Suryanti and Festiyed's articles. Festiyed scientifically designed the development of LKPD accompanied by video. Elvi Suryanti conducted research on the development of worksheets accompanied by videos based on problem-based learning models with a scientific approach.

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Conflicts of Interest
No Conflicts of interest.

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