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The Influence of Problem Based Learning Model Assisted by Video on Student's Problem-Solving Skills in Static Fluid Material

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Abstract: This research aims to find out whether the problem-based learning (PBL) model, assisted by physics learning videos using static fluid material, influences students' problem-solving abilities. The population of this research was class XI students at SMAN 2 Mataram, with a sample of class 11 Science-Technology as the experimental class and class XI Science-Health as the control class. The data collection technique uses a problem-solving ability instrument in the form of 6-item description questions. The instruments used have been tested for their suitability through tests of validity, reliability, distinguishability and level of difficulty. Hypothesis testing uses an independent sample t-test with a significance level of 5% or 0.05 using the PSPP version 3 application. The results of the independent sample t-test show that a significance value of 0.002 is obtained. This means that the significance value is smaller than 0.005, so H0 is rejected, and Ha is accepted; in other words, the problem-based learning model assisted by physics learning videos using static fluid material influences students' problem-solving abilities.

Keywords: Physics Learning Videos; Problem based learning; Problem solving skill; Static Fluid

Introduction

The advancements in information and technology during the 21st century have profoundly influenced numerous facets of life, including the realm of education. Indonesia hopes that the education system can prepare future generations to overcome the challenges of the industrial era 5.0. In facing this challenge, Jayadi (2020) emphasizes the importance of students being equipped with 21st-century skills known as 4C, namely critical thinking and problem-solving, collaboration, creativity and innovation, and communication. Efforts to support the development of 21st-century skills need to be made in all subject areas, including physics.

According to Hidayat et al. (2017), problem-solving ability is an essential skill for students. Physics subjects have the potential to guide students in improving and mastering problem-solving abilities if taught through a constructive and participatory learning approach (Rahmawati & Ika, 2020). Students can develop the skills to develop solutions to challenges faced in learning and in social life systematically and constructively through good problem-solving skills (Sujarwanto et al., 2014; Noviatika et al., 2019). Problem-solving ability involves a cognitive process where individuals identify and address a problem by gathering information from various sources until they arrive at an appropriate solution (Rahmawati & Ika, 2020). The presence of problem-solving abilities is significant for students because the aim of learning physics is not only about understanding concepts but also about applying these concepts to solve various problems. Polya (1973) identified indicators of problem-solving ability, this encompasses the capacity to recognize issues, devise plans, execute strategies, and assess outcomes.

Results obtained from interviewing a physics teacher in one of high school in Mataram City, show that, in general, students' problem-solving abilities are still classified as moderate or low. Lack of motivation to learn is the main factor that causes them to judge physics subjects as scary, difficult and tedious. Additionally,

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students must demonstrate proficiency in effectively applying physics concepts and principles to address assigned problems. This suggests that there is still room for enhancement in students' problem-solving skills. Hence, it is imperative to undertake endeavors aimed at enhancing teachers' competencies and capabilities in designing engaging learning experiences that cater to students' requirements. One possible method to utilize is the Problem-Based Learning (PBL) model.

The efficacy of problem-based learning (PBL) in enhancing students' problem-solving skills has been proven. This model emphasizes students' active participation in learning and connecting lesson material with everyday life (Janah et al., 2018). Apart from that, the PBL model can also move students to develop and organize their knowledge (Widiawati et al., 2022), hone high-level skills (Hidayatin et al., 2022), and strengthen students' self-confidence through meaningful learning (Yusuf et al.., 2022). Hence, findings from studies conducted by Firmansyah et al. (2022), Mariana et al. (2022), and Siregar et al. (2022) indicate that implementing the PBL model in physics education enhances students' problem-solving skills.

The utilization of the PBL can be combined with various types of learning media. Incorporating this media into the educational process can heighten engagement, efficacy, and efficiency of learning (Martin et al., 2022). A sample of educational material suitable for physics instruction is video content. Learning videos are a series of moving images arranged to convey learning material with the aim of helping students achieve learning goals, including learning static fluid material (Ardinata & Parmiti, 2021; Ario, 2019). The use of learning videos has a number of advantages, such as increasing conceptual understanding, problem-solving abilities, and students' learning motivation (Gusmania & Dari, 2018; Sitinjak, 2022; Agustini & Ngarti, 2020). Apart from that, learning videos are also able to show material, provide tutorials, and maximize learning time (Agustini & Ngarti, 2020). The objective of this study is to evaluate the impact of implementing the PBL model with video support in teaching static fluid material on students' problem-solving skills.

Method

Research Types and Designs

This study utilizes a quasi-experimental method employing a non-equivalent control group designTwo cohorts, specifically the experimental group and the control group, were recruited as subjects for the investigation. The experimental group underwent intervention through the utilization of the PBL model, augmented by physics instructional videos on static fluid material, whereas the control group received conventional teaching methods. The research design is described in detail in Table 1. The study population comprised all eleventh-grade students at SMA Negeri 2 Mataram. The sample included Class XI Science-Technology 1 as the experimental group and Class XI Science-Health 2 as the control group.

Students' problem-solving abilities were analyzed based on four indicators adapted from Polya (1973), namely problem identification, strategic planning, strategy implementation, and solution evaluation. The study's hypothesis was examined through an independent t-test performed using the PSPP version 3 software. The null hypothesis (H0) of this study states that the PBL model supported by physics learning videos for static fluid material does not affect problem-solving abilities. In contrast, the alternative hypothesis (H1) states the opposite. If the significance level falls under 5% (0.05), The null hypothesis (H0) will be refuted. Before testing the hypothesis, the data is first analyzed to ensure normality and homogeneity.

Table 1 *Non-equivalent Control Group Design*

Class	Pretest	Treatment	Posttest
Experiment	O_1	X_1	O_2
Control	O_1	X_2	O_2

Information:

O_1 : Experimental and control groups prior to receiving intervention

O_2 : Experimental and control groups post-treatment intervetion

X_1 : PBL model supported by videos focusing on static fluid material

X_2 : Conventional learning

Test Instrument Trial

This research uses a problem-solving ability test consisting of 6 essay questions to collect data. The validity, reliability, discrimination, and level of difficulty of the test instrument have been verified. Validity testing is carried out to determine whether the designed research instrument is suitable for research. The technique used to measure the instrument's validity in this research is to use the product-moment correlation equation (Equation 1). Reliability tests are used to determine the certainty and reliability of the question items to support their validity. A test can be said to have a high level of confidence if the test can provide consistent results (Sundayana, 2018). One way to find the reliability of question items on a description test is to use Cronbach's Alpha formula (Equation 2).

$$r_{xy}=\frac{N\sum XY-(\sum X)(\sum Y)}{\sqrt{\{N\sum X^2-(\sum X)^2\}\{N\sum Y^2-(\sum Y)^2\}}} \quad (1)$$

$$r_{11}=\left(\frac{n}{n-1}\right)\left(1-\frac{\sum\sigma_i^2}{\sigma_t^2}\right) \quad (2)$$

Information:

r_{xy}	:	The correlation coefficient between variable Y and variable X.
X	:	Score of test items
Y	:	The total score for each question
$\sum XY$	:	The number of times x is multiplied by y
$\sum X$	:	Sum of x
$\sum Y$	:	Sum of y
$\sum X^2$	:	The sum of the squares of x
$\sum Y^2$	:	The sum of the squares of y
N	:	The number of data
r_{11}	:	Calculated reliability
n	:	The number of questions
σ_t^2	:	total variance
$\Sigma\sigma_t^2$	:	The amount of variance for each question item

Arikunto (2013) states that test difficulty is determined by its capability to evaluate the proportion of students who can provide correct answers. The complexity of the essay test questions can be assessed using Equation 3, and the categorization of the question difficulty index is outlined in Table 2. The differential power of the questions is their capability to differentiate between students of different proficiency levels, identifying individuals with higher skills from those with lower ones. The differentiating power of questions for the essay test is determined using the formula in Equation 4. The classification of the question power index is presented in Table 3.

$$TK=\frac{SA + SB}{IA + IB} \quad (3)$$

$$DP=\frac{SA - SB}{IA} \quad (4)$$

Information:

TK	:	Question difficulty level
SA	:	The cumulative score of the higher-tier category
SB	:	The cumulative score of the lower-tier category
IA	:	The total ideal score of the higher-tier category
IB	:	The ideal score for the lower-tier category
DP	:	Level of differentiation of questions
SA	:	The total score of the higher-tier category
SB	:	The total score of the lower-tier category
IA	:	The total ideal score of the higher-tier category

Tabel 2. Question Difficulty Index Classification

Question difficulty level	Category
0.00 ≤ TK ≤ 0.30	Hard
0.30 < TK ≤ 0.70	Medium
0.71 < TK ≤1.00	Easy

(Sundayana, 2018)

Tabel 3. Differential Power Index Classification

Level of differentiation	Category
0.00 – 0.20	Not good
0.21 – 0.40	Pretty good
0.41 – 0.70	Good
0.71 – 1.00	Very good

(Arikunto, 2013)

Result and Discussion

Results of the trial test instrument

Before being used, the test instrument went through a validity and reliability testing process, according to references from Yusup (2018) and Khumaedi (2012). Apart from that, the instrument was also evaluated for its differentiability and level of difficulty based on research conducted by Fatimah and Alfath (2019). The instrument test results showed that all the questions were proven to be valid and reliable, with three questions showing a good level of differentiation, three other questions showing a pretty good level of differentiation, and five questions having a moderate level of difficulty, and one question having a manageable level of difficulty.

Tabel 4. Results of Instrument Trial Validity Analysis

Question Item No	Validity		
	r_{xy}	r_{table}	Category
1	0.617	0.373	Valid
2	0.563		Valid
3	0.815		Valid
4	0.397		Valid
5	0.762		Valid
6	0.857		Valid

Tabel 5. Results of Reliability Analysis of Instrument Trials

Question Item No	Reliabilitas		
	r_{11}	r_{table}	Category
1	0.757	0.373	reliabel
2	0.757	0.373	reliabel
3	0.757	0.373	reliabel
4	0.757	0.373	reliabel
5	0.757	0,373	reliabel
6	0.757	0.373	reliabel

Tabel 6. Results of Analysis of Difficulty Level of Question Items

Question Item No	SA	SB	IA	IB	TK	Category
1	55	28	60	60	0.69	Medium
2	62	39	60	60	0.84	Easy
3	46	18	60	60	0.53	Medium
4	34	18	60	60	0.43	Medium
5	58	21	60	60	0.66	Medium
6	53	17	60	60	0.58	Medium

Tabel 7. Results of Analysis of Differentiating Ability of Question Items

Question Item No	SA	SB	IA	DP	Category
1	55	28	60	0.45	Good
2	62	39	60	0.38	Pretty good
3	46	18	60	0.47	Good
4	34	18	60	0.27	Pretty good
5	58	21	60	0.62	Good
6	53	17	60	0.60	Good

Data on Students' Problem-Solving Skills

Data on student problem-solving ability test results consists of initial test results and final test results. This initial data is used to assess students' initial ability to solve problems in both groups, control and experimental, as well as to evaluate the homogeneity and normality of these classes as a first step before conducting hypothesis testing. Table 8 illustrates the outcomes of the initial assessment concerning problem-solving skills in both the experimental and control groups. These findings indicate that the experimental group achieved a maximum score of 48.00 and a minimum score of 7.00 on the initial assessment, with a mean score of 26.00. Meanwhile, in the control class, the highest and lowest scores were 55.00 and 13.00, respectively, with an average of 28.00. From this data, there does not appear to be a significant difference in problem-solving abilities between the two groups, control and experimental.

Table 8. Pretest Results of Students' Problem-Solving Ability

Class	N	The highest score	The lowest score	Average
Experiment	35	48.00	7.00	26.00
Control	35	55.00	13.00	28.00

The final data are the results of the final tests in the control and experimental classes, which are then used to test the research hypothesis. Before testing the hypothesis, the homogeneity and normality of the final data were first tested. Based on Table 9In the experimental group, the highest and lowest scores on the final assessment were 100.00 and 28.00, respectively, with an average score of 68.00. On the final exam, the control group attained a maximum score of 80.00 and a minimum score of 20.00, with an average score of 53.00. When compared with the data from the initial test results, students' problem-solving abilities in the final test in the control class and experimental class increased. Figure 1 depicts the contrast between the mean results of the initial and concluding evaluations within both the experimental and control cohort.

Table 9. Posttest Results of Students' Problem-Solving Ability

Class	N	The highest score	The lowest score	Average
Experiment	35	100.00	28.00	68.00
Control	35	80.00	20.00	53.00

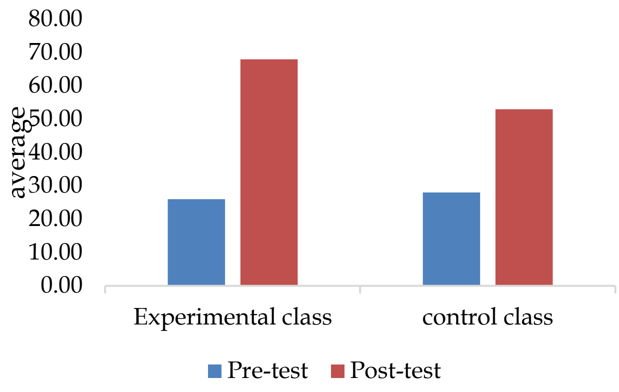

Figure 1. Average Comparison Graph for Control and Experiment Classes

Data Homogeneity and Normality Test Results

Homogeneity checks were carried out to verify whether the initial abilities of the control and experimental classes were balanced. A homogeneity check is an essential step before proceeding to hypothesis testing. If both classes are homogeneous, then their initial abilities are equivalent. The homogeneity test uses the Levene method and PSPP version 3 software based on data from the final test. The results from Table 10 show that the homogeneity test on the initial test and final test data for the control and experimental classes has a significance value of 0.614 and 0.051, respectively. Based on the homogeneity test criteria, when the significance value surpasses 0.05, it suggests that the data exhibits homogeneity.

Table 10. Results of the Pretest and Posttest Data Homogeneity Test using the Levine test

Class	Data	Significant Level	Sig.	Criteria
Experiment & Control	Pretest	0.05	0.614	Homogen
	Posttest		0.051	Homogen

The purpose of conducting the normality test is to ascertain whether the collected data follows a normal distribution. In this study, normality assessments were conducted on both cohorts, namely the control and experimental groups, utilizing pre-test and post-test datasets. The Kolmogorov-Smirnov test, facilitated by PSPP version 3 software, was employed as the method for normality testingThe normality test outcomes are showcased in Table 11. In the pre-test phase, the control group registers a significance value of 0.072, while the experimental group yields 0.390. For the post-test, the control group reports a significance value of 0.166, with the experimental group showing 0.542. According to the established criteria for normality tests, a significance value exceeding 0.05 suggests that the data adheres to a normal distribution. Therefore, the test results affirm that both pre-test and post-test datasets within both the control and experimental cohorts exhibit normal distribution patterns.

Table 11. Pretest and Posttest Data Normality Test Results using the Kolmogorov-Smirnov test

Class	Data	Significant Level	Sig.	Criteria
Control	Pretest	0.05	0.072	normal
	Posttest		0.166	normal
Experiment	Pretest		0.390	normal
	Posttest		0.542	normal

Hypothesis Test Results

Hypothesis testing was performed to ascertain the impact of utilizing the PBL model along with physics instructional videos focusing on static fluid material, on students' problem-solving abilities. The data used in this hypothesis test are the final test results from the two groups, specifically the control group and the experimental group which previously met the requirements for homogeneity and normality. The independent sample t-test was conducted using PSPP version 3 software to test the hypothesis. The significance value of 0.002 is observed in the results of the hypothesis test, as indicated in Table 12. Based on the criteria used to make decisions regarding hypothesis testing, If the significance value falls below the predetermined threshold of 0.05, the null hypothesis (H0) will be refuted, and the alternative hypothesis (H1) will be affirmed.

Table 12. Hypothesis Test Results Using Independent Sample T-Test

Class	Significant Level	Sig (2 *tailed*).	Criteria
Control & Experiment	0.05	0.002	H0 is rejected and H1 is accepted

This study took place at Senior High School 2 Mataram, during the latter part of the 2023/2024 academic year. The main objective was to explore the possibility of improving students' problem-solving abilities by utilizing the problem-based learning (PBL) instructional model along with physics instructional videos centered on static fluid material. This research involved class IX as the population, with class XI Science-health 2 as the control group and class XI Science-technology 1 as the experimental group. The experimental class received treatment using the PBL learning model supported by physics learning videos, while the control class was taught using the conventional learning model. Research data was obtained by carrying out initial tests and final tests related to static fluid material in both sample groups. The instrument used consists of six descriptive questions specifically designed to measure students' problem-solving abilities. Based on the results of the instrument test, it can be concluded that all questions on the instrument can be used to measure students' problem-solving abilities in the initial test and final test in both groups, both the control class and the experimental class.

After carrying out the initial test in both classes, namely the control class and the experimental class, the learning process continued by providing different treatments. The control class received treatment in the form of a conventional learning model. In contrast, the experimental class received treatment in the form of problem-based learning (PBL) learning model supported by physics learning videos. The learning time for physics subjects that the school has determined is 6 lesson hours per week, which is then divided into two meetings every week. In the context of this research, three meetings were held for each class. The implementation of the problem-based learning (PBL) learning model follows the PBL syntax steps, namely providing orientation to the problem, organizing students to study, guiding learning investigations, developing and presenting learning outcomes, and analyzing and evaluating investigation results (Arends, 2012; Sujarwanto et al., 2014). When learning is carried out in the experimental class, students are divided into small groups consisting of two students per group.

Physics learning videos on static fluid material are used at the problem orientation and investigation guidance stages. There are six learning videos in the form of problems posed as problem orientation. The duration of each problem orientation video is a maximum of 1 minute. Each meeting uses two videos for problem orientation. The problems posed are related to the topic of static fluid material. Among the problems are hydraulic pumps (Pascal's Law), divers in the sea (Hydrostatic Pressure), submarines (Archimedes' Law), water spiders (surface tension), wet tissue (capillarity), and honey (viscosity). The incorporation of instructional videos during the problem orientation phase aims to encourage students to connect academic content with real-world scenarios, thereby cultivating their interest and motivation for learning (Wisada, 2019; Wulandari & Nana, 2021). Apart from that, three physics learning videos were also used in the investigation guidance phase. The duration of each video in the investigation guidance phase is 11-12 minutes per video. The learning video used is related to the topic of static fluid material. The video for the first meeting is about Pascal's Law and hydrostatic pressure; for the second meeting, it is about Archimedes' Law and surface tension; and for the third meeting, it is about capillarity and viscosity. The use of physics learning videos in the investigation guidance phase is intended to guide students to find solutions to the problems posed (Kurniawati, 2021) so as to improve students' problem-solving abilities. All learning videos used in the problem orientation and investigation guidance phases are compilation videos on the youtube.com page.

The researchers are applying the PBL model learning process by learning videos using device assistance. Each student brings their device and works in groups to investigate the problems presented through the student worksheet provided. There is a student worksheet in hardcopy form as a worksheet that can be filled in directly and done together. The use of student worksheet is intended to guide and facilitate learners during the educational process so that they obtain information related to various everyday phenomena regarding static fluids. There is also student worksheet in softcopy form in .pdf format as a means for students to access video links, which are used for the problem orientation and investigation stages. After providing treatment to both the experimental and control groups, the researcher administered a concluding assessment to each group to evaluate the impact of utilizing the problem-based learning approach, supported by physics instructional videos, on students' problem-solving skills.

This research measures problem-solving abilities using indicators adapted from Polya (1973), including problem identification (IKPM-1), strategic planning (IKPM-2), strategy implementation (IKPM-3), and solution evaluation (IKPM-4). The preliminary examination findings indicated that the mean problem-solving capability within the control group was 28.00 (Attaining a highest score of 55.00 and a lowest score of 13.00), whereas in the experimental group, it amounted to 26.00 (with the highest score being 48.00 and the lowest score being 7.00). This indicates that problem-solving abilities in both classes are still low. This decline in ability can be caused by several factors, including monotonous learning methods (Rahmawati et al., 2024), lack of focus on students, and minimal use of media in the learning process (Harefa & La'ia, 2021). These factors directly influence students' motivation and interest in physics subjects, which then has an impact on reducing problem-solving abilities (Wulandari et al., 2018). After being given treatment, there was an increase in problem-solving abilities in both classes. However, the improvement that occurred in the experimental class was much more significant than in the control class. The average problem-solving ability in the control class increased to 53.00 (categorized as poor, with the highest score of 80.00 and the lowest score of 20.00). In contrast, in the experimental class, it increased to 68.00 (categorized as quite good, with the highest score 100.00 and the lowest 28.00).

The data obtained from the final assessments conducted in both the control and experimental groups were utilized to test the hypothesis in this study. Before carrying out hypothesis testing, data from both classes was checked first to ensure that the distribution was normal and homogeneous using PSPP version 3 software as a prerequisite. The results of the preliminary examination indicate that the data satisfies the criteria for a standard and uniform distribution, enabling progression to the hypothesis testing phase. Hypothesis testing was conducted utilizing an independent t-test facilitated by PSPP version 3 software. The outcomes of the independent t-test revealed a significance value of 0.002, which is below the predetermined significance level of 0.05. This implies the refusal of the null hypothesis (H0) and the approval of the alternative hypothesis (H1). Based on the hypothesis test outcomes, it can be inferred that employing the problem-based learning (PBL) instructional model complemented by physics learning videos for static fluid material positively impacts students' problem-solving skills. This discovery aligns with the outcomes of prior studies conducted by Sibarani et al. (2024), Sitinjak (2022), Pratama et al. (2018), Manalu (2016), and Hastuti et al. (2016), indicating that implementing the PBL model with video support positively influences students' problem-solving skills.

The execution of the PBL methodology, which is supported by physics learning videos, provides a different learning experience for students. In this model, the learning process becomes more focused on students so that they are more actively involved in learning (Kono et al., 2016; Rohman & Hidayatullah, 2023). Based on research by Paratiwi and Ramadhan (2023), student engagement and involvement tend to rise with the implementation of the PBL approach. Furthermore, students are afforded the chance to employ physics concepts and principles within real-life contexts. The use of learning videos in the PBL model also increases students' motivation and interest in discussions and problem-solving processes (Yusri, 2018; Wulandari &

Nana, 2021; Karawahenni, 2024). Learning videos help facilitate and guide students in the problem-solving process by visualizing concepts, laws and principles of physics so that they can better understand problems, plan strategies, and evaluate solutions (Yusri, 2018; Wulandari & Nana, 2021; Karawahenni, 2024). Implementing the PBL model with the support of physics learning videos on static fluid material has demonstrated its effectiveness in enhancing students' problem-solving skills. This discovery aligns with the findings of Sibarani et al. (2024), who observed notable distinctions in students' problem-solving capabilities when employing the PBL model with the aid of instructional videos. Furthermore, Haqiqi & Syarifa's (2021) study demonstrates the effectiveness of employing the PBL model with the support of instructional videos in enhancing problem-solving skills.

While conducting research, researchers experienced a number of technical obstacles. First, some students still need an internet quota to access learning videos. To overcome this, researchers provide internet network facilities so that students can participate in learning as expected. Second, it was found that some students had difficulty accessing learning video links because the features on the devices they used could not recognize the links in the available student worksheet. As a solution, the researcher asked other students to share the video link via the class WhatsApp group so that other students could access the learning material. Finally, the research was carried out during the month of Ramadan, so the duration of class hours was adjusted from 45 minutes to 35 minutes per class hour. The researcher adjusts the duration of delivering the results of the investigation and reflecting on the results of the investigation to suit the needs of the available time. Taking into account the challenges encountered, researchers must enhance the suppy of necessary amenities to facilitate the learning process and ensure the attainment of learning objectives

Conclusion

Based on data analysis and deliberation, this study concludes that the problem-based learning (PBL) instructional model supported by physics learning videos on static fluid material significantly influences students' problem-solving skills. This determination is drawn from the hypothesis test results, where the significance value (0.002) is lower than the predetermined threshold (0.05). Furthermore, the video-assisted PBL approach proves effective in enhancing students' problem-solving skills.

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Conflicts of Interest
The authors declare no conflict of interest

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