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Analysis of Students' Physics Critical Thinking Ability in Problem-Based Learning Models Assisted With Video

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Abstract

Critical thinking skills are one of the abilities that students must have in order to facilitate processing and analyzing the information obtained, as well as selecting or making the right decision about a problem in physics learning. This study aims to measure students' critical thinking skills using a video-assisted problem-based learning model. Syllabus, lesson plans, teaching materials, worksheet, learning videos, and test instruments are learning tools on elasticity and Hooke's law that support this research. The research method uses a quasi experiment with a One-Group-Pretest-Posttest design. A total of 30 students in class XI MS 2 in the odd semester of the 2022/2023 school year at SMAN 1 Kediri became research participants. Data collection techniques using worksheet and critical thinking ability test instruments. worksheet is used in order to facilitate critical thinking skills during learning activities, and the assessment scores are converted into percentages and then classified into the criteria for critical thinking skills. Test instruments are also used as pretests and posttests to measure critical thinking skills before and after learning activities, and the results are analyzed using the N-Gain test and interpreted into effectiveness interpretations. The results of the worksheet assessment showed that students' critical thinking skills were 82.22% with very critical criteria, and the N-Gain test instrument was 0.57 in the moderate improvement category and included in the criteria for being quite effective. So it can be concluded that there is an increase in students' critical thinking skills by using a video-assisted problem-based learning model and effective use in learning.

Keywords: *Critical Thinking Skills, Problem-Based Learning Models, Videos*, *Elasticity and Hooke's Law.*

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INTRODUCTION

Physics is a branch of natural science (IPA) that discusses events that occur in the natural environment and all the interactions therein. According to Khaeruddin et al. (2018), learning physics must be taught to students because it helps them develop the critical thinking skills they need to solve problems in everyday life, as well as the knowledge, understanding, and skills they need to advance science and technology.

Purwati et al. (2016) define critical thinking as the capacity to assess and evaluate information obtained through observation, experience, reasoning, and communication to determine whether the information is reliable and makes it possible to draw appropriate conclusions. Learning activities that emphasize thinking can be used to train critical thinking skills. To help students choose or make the right decisions about a problem when studying physics, critical thinking skills must continue to be developed and perfected. It can be said that critical thinking is one of the needs that must be possessed by students in processing and analyzing the information obtained and can also make it easier to understand a material or concept being studied, so that the learning outcomes of students in the cognitive domain can also increase.

It has been established that the learning resources utilized in classrooms are insufficient based on the findings of interviews and observations made at SMAN 1 Kediri. This is because the tools used are only the syllabus, lesson plans, and teaching materials. Learning tools have not been fully implemented during the learning process, so physics learning has not been carried out in accordance with the plans that have been prepared. The use of learning media is still not optimally utilized, and teachers have never used learning videos in teaching. It is also known that practicum activities have never been carried out.

Due to the tendency of students to be slower in understanding the material in class, especially learning physics, the students' critical thinking skills have never been measured before by the teacher. Especially because the previous learning system used an online system due to the COVID-19 pandemic, making it difficult for teachers to apply learning that measures critical thinking skills so that learning in class is only dominated by conventional learning models using the lecture method.

Learning activities that can help students comprehend the subject more fully, engage students in the learning process, and develop critical thinking abilities need to be improved by teachers. The application of a problem-based learning paradigm that may actively involve students is one of the innovations and efforts made.

Problem-based learning (PBL) is one of the learning models in the 2013 curriculum that involves students actively acquiring knowledge through learning activities. Problem-based learning, according to Arends in Rerung (2017), is instruction that focuses on giving students real-world situations that have significance. with the purpose of using it as a tool for undertaking research and studies. The use of problem-based learning models engages students directly in the learning that takes place in the classroom and teaches them how to solve issues via research. In accordance with Nurqomariah et al. (2015), issue-based learning is a paradigm that prioritizes student-centered learning and may provide students the freedom to undertake research, combine theory and practice, and use their knowledge and abilities to build solution discovery or problem solving. hence it is anticipated that employing the problem-based learning methodology would have a positive effect on students' critical thinking abilities.

The success of learning can also be influenced by the use of learning media. The learning medium used in this research is learning videos. According to Yunita et al. (2017), video is a collection of elements or media that may simultaneously show visuals and sound. So that the use of the video-assisted problem-based learning model as a learning medium in this study is expected to create fun and interesting learning, students become active in acquiring knowledge, maintain their attention during learning activities, and increase their understanding of physics concepts, thereby affecting their ability to think critical students.

The problems in this research are similar to research previously conducted by Rahmana et al. (2021), which shows that the problem-based learning model can improve students' problem-solving skills with the help of learning videos. And also research conducted by Sulardi et al. (2015) and Hasanah et al. (2021) shows that the problem-based learning model can improve students' critical thinking skills. So, further research is needed to determine how video-assisted problem-based learning models can aid students in developing their critical thinking abilities in light of this description. It is hoped that using these devices will become one of the alternatives that teachers can use in the learning process.

This study aims to measure students' critical thinking skills using a video-assisted problem-based learning model. The ability to think for students is important in the teaching and learning process so that they can overcome a problem in learning and find the right solution. Students' critical thinking abilities are assessed using test tools that are adjusted to the indicators from facione, which include interpretation, analysis, evaluation, inference, and explanation.

METHOD

This research uses a video-assisted problem-based learning methodology to evaluate students' critical thinking abilities. The research method uses a quasi-experiment with a One-Group-Pretest-Posttest design. The data collection technique used worksheets and critical thinking ability test instruments. As many as 30 students in class XI MS 2 in the odd semester of the 2022/2023 academic year at SMAN 1 Kediri were the subjects of this study. Syllabus, lesson plans, teaching materials, worksheet, learning videos, and test instruments are learning tools that support this research.

Analysis of Students' Critical Thinking Ability During Learning Activities

Worksheet is used to support teaching pupils how to think critically while they are studying. Worksheet had three meetings and conformed to the problem-based learning paradigm in order to enhance the development of students' critical thinking abilities. Data from

the worksheet is transformed into percentages and then categorized using the standards for critical thinking abilities, as shown in Table 1 below.

Table 1. Criteria for Critical Thinking Ability

Percentage (%)	Critical Thinking Ability Criteria
81-100	Very critical
61-80	Critical
41-60	Moderately critical
21-40	Less critical
1-20	Not critical

(Arikunto, 2016)

Analysis of Increasing Students' Critical Thinking Ability

Before the instrument is used in learning, it is carried out validity test assessed by expert validators and practitioners. The value obtained is then interpreted into the validity criteria according to Fatmawati (2016), as shown in Table 2 below.

Table 2. Learning Device Validity Criteria

Score (%)	Criteria
85,01-100	Valid
70,01-85	Moderately Valid
50,01-70	Less Valid
0-50	Invalid

(Fatmawati, 2016)

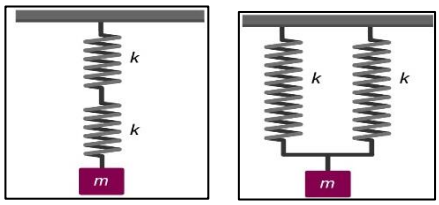
The critical thinking ability test instrument in the form of 10 descriptive questions, is used to determine the increase in students' cognitive learning outcomes. Materials used in this study are elasticity and Hooke's law. The N-Gain test was performed to examine the value after this test instrument was used for the pretest and posttest. The formula for calculating the N-Gain test is as follows:

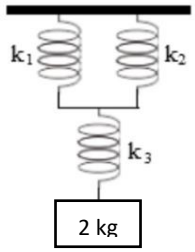
$$\langle g \rangle = \frac{posttest\ score - pretest\ score}{max.score - pretest\ score}$$

Students' critical thinking ability viewed base on the achievement on materials of elasticity and Hooke's law. The instrument used based on the critical thinking indicators indentified in the current study consisted of 10 item as showed in Table 3.

Table 3. Crititcal Thinking Ability Instrument Based On Material Of Elasticity And Hooke's Law

No	Critical Thinking Ability Indicator	Item
1	Interpretation	Look at the following picture!  Robin really likes to play with the rubber band, she often pulls it and releases it until it returns to its original shape. One time, Robin pulled the rubber band until it broke. Why did Robin's rubber band break? Explain!

No	Critical Thinking Ability Indicator	Item
2	Analysis	Look at the picture below!  A baby with a mass of 4 kg is placed on a cradle suspended by a spring, as shown in the figure. Thus causing the length of the spring to increase, from 10 cm to 17 cm. Based on this event, explain how it relates to the concept of stress and strain!
3	Evaluation	Nami has a wire with a length of 2 m and a cross-sectional area of 6.16 mm^2, which is then hung with a weight of 100 grams. The wire increases in length to 2.55 m. If the earth's gravitational acceleration is 9.8 m/s^2, determine the modulus of elasticity experienced by the wire!
4	Inference	Look at the following spring elasticity experiment results table! No | F (N) | Δx (cm) 1 | 12 | 4 2 | 17 | 5 3 | 22 | 6 Based on the table, draw a graph of the relationship between the force (F) and the increase in the length of the spring (Δx)! And what can be concluded based on the graph?
5	Eksplanation	A group of students conducted an experiment with a spring that has a length of 7 cm. Then, the spring is hung by a load of 450 grams, causing the spring to increase in length to 20 cm. Then they observed it, it turns out that the spring can no longer be elastic. Why can't springs be elastic anymore? Explain why this can happen based on the theory of elasticity that you have learned!
6	Interpretation	A student conducts a spring circuit experiment arranged as shown below!  (Arrangement 1) (Arrangement 1) Both arrangements hung the same load, which is equal to 3 kg. Based on the picture, explain the difference between the two spring arrangements based on Hooke's law! Include the constants for each circuit!
7	Analysis	In everyday life, one example of Hooke's law is the catapult. Catapults are usually used by children to play, and stones are used as a tool for aiming. When the stone is placed in front of the slingshot rubber, the rubber will be pulled so that it extends. After the tensile force is removed, the stone will be thrown, and the rubber will return to its

<table>
<tr><th>No</th><th>Critical Thinking Ability Indicator</th><th>Item</th></tr>
<tr><td></td><td></td><td>original shape. Based on this event, how does it relate to Hooke's law!</td></tr>
<tr><td>8</td><td>Evaluation</td><td>Three identical springs with a spring constant of 100 N/m are arranged in series-parallel and a load weighing 2 kg is suspended at the bottom as shown in the picture below. If the acceleration due to gravity is known to be 10 m/s^2, determine:
a. Combined spring constant
b. Extended length of spring system
  </td></tr>
<tr><td>9</td><td>Inference</td><td>Nadin conducted an experiment using a spring that had an initial length of 0.1 m. Then the spring is given a load with different masses and is alternately suspended on the spring. So the following data is obtained:
<table><tr><th>Load mass (kg)</th><th>Final length (m)</th><th>Long gain (Δx)</th><th>Potential energy (E_p)</th></tr><tr><td>15 x 10^{-3}</td><td>12 x 10^{-2}</td><td>2 x 10^{-2}</td><td>1,5 x 10^{-3}</td></tr><tr><td>30 x 10^{-3}</td><td>14 x 10^{-2}</td><td>4 x 10^{-2}</td><td>6 x 10^{-3}</td></tr><tr><td>45 x 10^{-3}</td><td>16 x 10^{-2}</td><td>6 x 10^{-2}</td><td>13,5 x 10^{-3}</td></tr><tr><td>60 x 10^{-3}</td><td>18 x 10^{-2}</td><td>8 x 10^{-2}</td><td>24 x 10^{-3}</td></tr><tr><td>75 x 10^{-3}</td><td>20 x 10^{-2}</td><td>10 x 10^{-2}</td><td>37,5 x 10^{-3}</td></tr></table>What can be concluded based on the table?</td></tr>
<tr><td>10</td><td>Eksplanation</td><td>When someone drives through potholes, the vehicle is not shaken and still feels comfortable. Try to explain why this can happen based on the concept of elasticity theory that you have learned!
  </td></tr>
</table>

The obtained analysis is then classified into the N-Gain classification, as listed in Table 4 below.

Table 4. *N-Gain* Classification

The value of g	Interpretation
g > 0.7	High
0.3 < g ≤ 0.7	Medium
g ≤ 0.3	Low

(Hake, 1998)

Following that, the N-Gain scores of the students were translated to percentages and then grouped according to how the N-Gain was perceived to be successful. There are four degrees of effectiveness: more than 76% fall under the effective category, followed by 56-76% under moderately effective, 40-55% under less effective, and less than 40% under ineffective (Solikha *et al*., 2020). According to this understanding, a learning tool is considered effective if it meets the necessary requirements for effectiveness..

RESULTS AND DISCUSSION

Critical Thinking Ability During Learning Activities

The goal of using worksheet is to assist students in strengthening their critical thinking abilities. Work on the worksheet is done in groups of six students. The following table provides an analysis of the information from each group's first, second, and third meeting worksheets.

Table 5. Critical Thinking Skills Data

	Value Acquisition		
	Worksheet 1	**Worksheet 2**	**Worksheet 3**
Group 1	80.00	80.00	86.67
Group 2	93.33	73.33	80.00
Group 3	86.67	86.67	73.33
Group 4	93.33	93.33	80.00
Group 5	73.33	80.00	66.67
Average Value	**86.67**	**82.67**	**77.33**
		82.22	
Criteria		**Very critical**	

Based on Table 5, the average value for worksheet 1, 2, and 3 in groups is 82.22 with very critical criteria. It is intended that through the use of worksheet in the classroom, students will have the ability to think critically about physics.

Analysis of Increasing Students' Critical Thinking Ability

Before the instrument is utilized for learning, a validity test has been done to assess its level of validity. The results of the validity test yielded the following score:

Table 6. Result of The Analysis of The Validity Learning Devices

Instrument	Validity	Category
Syllabus	90.83	Valid
Learning Implementation Plan (RPP)	90.90	Valid
Teaching Materials	88.54	Valid
Worksheet	90.41	Valid
Learning Videos	89.06	Valid
Test Instrument	90.01	Valid

This analysis seeks to ascertain whether there has been an improvement in critical thinking abilities following problem-based learning activities. The data was examined by doing an N-Gain test calculation in order to determine the improvement in critical thinking abilities. This analysis seeks to ascertain whether there has been an increase in critical thinking skills after participating in problem-based learning activities. The data is examined by calculating the N-Gain test to determine the increase in critical thinking skills.
The score for interpretation indicators is 0.67, analysis is 0.47, evaluation is 0.59, inference is 0.50, and explanation is 0.64 in the medium category. Table 7 displays the outcomes of the N-gain test for critical thinking abilities.

Table 7. N-Gain Test Results for Critical Thinking Ability

		Minimum value	Maximum value	*N-Gain*	Category
Critical Thinking Skills	Pretest	10	43	0.57	Medium
	Posttest	53	80		

The data shows that the class XI MS 2 students' rise in critical thinking abilities, 0.57, falls into the category of modest improvement. The N-Gain number is then translated to a percentage and classified based on how the N-Gain's efficacy is perceived. With a percentage of 57%, the result falls within the category of being highly effective.

To enhance students' critical thinking abilities, this study employed video-assisted problem-based learning models, which include a syllabus, lesson plans, teaching resources, worksheet, learning videos, and test items. Research conducted by Putri & Djamas (2017) said that a syllabus with a problem-based learning model can facilitate the development of students' critical thinking skills with the acquisition of validation results in a very valid category so that it can be used in learning. According to the developed RPP, the learning activities are conducted over the course of three meetings.

The lesson plan in this study employs a problem-based learning model's syntax to help students develop their critical thinking abilities. According to a study by Fahrunisa (2019), students' critical thinking abilities may be raised by using the problem-based learning (PBL) approach in scientific instruction. Besides that, research from Ismiati et al. (2020) state that lesson plans with a problem-based learning model can provide new experiences to students so as to make students active in learning and can develop students' critical thinking skills.

Learning videos are also presented at each meeting, which contain teaching materials and are equipped with presentations of problems that are often found in everyday life to arouse interest in learning and train students' thinking skills. According to Widyaningrum et al. (2018), video is one of the media that is effectively used in learning. With the video, it can be easier to visualize the material being taught so that students can better understand the teaching material, and presenting the problems in the video can train students' thinking skills. In line with that, Pratiwi (2019) argued that the use of video in physics learning would greatly assist students in understanding abstract and complex concepts.

Next, students conduct experiments with groups and answer discussion questions that have been presented in the worksheet to be able to develop their critical thinking skills. Based on the results of the worksheet at meetings 1, 2, and 3, it shows the percentage of the average score for practicum activities and group discussions, which is 82.22% in the very critical category. So it can be said that worksheet can facilitate students' critical thinking skills.

According to Rohmawati (2015), the definition of learning effectiveness is "a measure of the success of an interaction process, both between students and between students and teachers in the learning environment." The measurement of a learning process' performance in attaining its goals is known as learning effectiveness. The efficiency of the learning tools in this study was evaluated using the results of the N-Gain test calculations of the pretest and posttest scores provided to class XI MS 2 students at SMAN 1 Kediri. The outcomes of these computations will indicate whether students' physics-related critical thinking abilities have improved or decreased.

Based on the values obtained, it is known that data acquisition for each indicator of critical thinking ability is in the medium category.The critical thinking ability test instrument on the analysis indicator experienced the lowest increase compared to other indicators, where students still answered many questions incorrectly or even did not answer questions on that indicator. The RPP still has implementation issues, which accounts for the poor growth in critical thinking abilities on this analytical indicator. Lesson plans cannot adequately develop students' critical thinking abilities as a result. However, because they are not accustomed to instruction that develops critical thinking abilities, they also have a tendency to comprehend material more slowly.

However, learning activities that use the video-assisted problem-based learning model show that there is a process for training critical thinking skills. This is because critical thinking skills cannot develop if they are not trained from an early age. As explained by Handriani et al. (2015), critical thinking skills do not occur externally but need to be trained to prepare students to become critical thinkers.

In addition, based on the outcomes of the pretest and posttest, students in class XI MS 2 showed an average improvement in critical thinking abilities of 0.57. According to Table 7's categorization, the improvement in students' critical thinking abilities falls within the moderate range. After converting the average number to a percentage, 57%, which is considered to be highly effective, is obtained.

The video-assisted PBL model in this study has been able to improve students' critical thinking skills. This is because learning presents a problem related to everyday life, which can stimulate students interest in finding solutions to problems presented during learning. According to research by Putri et al. (2017), the video-assisted problem-based learning

paradigm has a reasonably significant impact on students' critical thinking abilities since it allows students to recollect what they saw rather than merely reading the materials. In addition, research conducted by Hasanah et al. (2021) said that practical problem-based learning tools are used in learning and are able to improve students' critical thinking skills on harmonic vibration material. Practicum activities are carried out in groups to solve the problems presented in the worksheet. The worksheet used contains practical instructions as well as questions about the results of practicum activities that can hone students' critical thinking skills. As for the test instrument, questions related to elasticity and Hooke's law are presented, which have been adapted to indicate indicators of critical thinking ability, namely interpretation, analysis, evaluation, inference, and explanation.

Based on the description above, it can be said that video-assisted problem-based learning model learning tools can improve students' physics critical thinking skills in the moderate category and are quite effective in learning.

CONCLUSION

Based on the results of the research and discussion, it can be concluded that there is an increase in students' critical thinking skills using video-assisted problem-based learning models that are effectively used in learning.

RECOMMENDATION

This research is suggested for study in other schools using various learning media.

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