

[JPPIPA] Submission Acknowledgement

1 message

Drs. Aris Doyan, M.Si., Ph.D <aris_doyan@unram.ac.id> To: "Dr. Binar Kurnia Prahani" <binarprahani@unesa.ac.id> Thu, Jun 17, 2021 at 1:50 PM

Dr. Binar Kurnia Prahani:

Thank you for submitting the manuscript, "Implementation of Problem Based Learning Assisted by PhET to Improve Critical Thinking Skills of Senior High School Students in Dynamic Electrical Materials" to Jurnal Penelitian Pendidikan IPA. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

Manuscript URL: https://jppipa.unram.ac.id/index.php/jppipa/author/submission/799 Username: binar

If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.

Drs. Aris Doyan, M.Si., Ph.D Jurnal Penelitian Pendidikan IPA

Jurnal Penelitian Pendidikan IPA



[JPPIPA] Editor Decision

1 message

Editor JPPIPA <jppipa@unram.ac.id>

Wed, Aug 18, 2021 at 8:13 AM

Dr. Binar Kurnia Prahani:

We have reached a decision regarding your submission to Jurnal Penelitian Pendidikan IPA, "Implementation of Problem Based Learning Assisted by PhET to Improve Critical Thinking Skills of Senior High School Students in Dynamic Electrical Materials".

Our decision is: Revisions Required

Editor JPPIPA Mataram University jppipa@unram.ac.id

Jurnal Penelitian Pendidikan IPA

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Keputusan Editorial Team

2 messages

Raden Hamidi <hamidi@unram.ac.id> Wed, Aug 4, 2021 at 8:44 AM To: nabila.18085@mhs.unesa.ac.id, ekohariyono@unesa.ac.id, husnimubarok254@gmail.com, binarprahani@unesa.ac.id

Yth. Penulis

Kami informasikan bahwa, berdasarkan hasil review dari Editorial Team, Naskah Anda yang di Submit di Jurnal Penelitian Pendidikan IPA dinyatakan diterima dan akan diteruskan ke Reviewer Kami untuk di review. Berikut Kami kirimkan biaya publikasi untuk Vol 7 No 4 Oktober 2021. Demikian dan Terimakasih. Jika ada hal yang penting, jangan ragu untuk menanyakan kepada Kami

Editor JPPIPA hamidi@unram.ac.id WA. 081936732708



Binar Kurnia Prahani

binarprahani@unesa.ac.id> Wed, Aug 4, 2021 at 2:42 PM To: Eko Hariyono Hariyono <ekohariyono@unesa.ac.id>, husnimubarok254@gmail.com, Nabila Putri <nabila.17030184040@mhs.unesa.ac.id>

Dear Editor

Berikut ini kami kirimkan APC. Terima kasih [Quoted text hidden]



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[JPPIPA] Editor Decision

1 message

Editor JPPIPA <jppipa@unram.ac.id>

Wed, Sep 8, 2021 at 10:00 PM

To: "Dr. Binar Kurnia Prahani"

sinarprahani@unesa.ac.id>

Cc: Nabila Rahmadita <nabila.18085@mhs.unesa.ac.id>, Eko Hariyono <ekohariyono@unesa.ac.id>, Husni Mubarok <husnimubarok254@gmail.com>

Dr. Binar Kurnia Prahani:

We have reached a decision regarding your submission to Jurnal Penelitian Pendidikan IPA, "Implementation of Problem Based Learning Assisted by PhET to Improve Critical Thinking Skills of Senior High School Students in Dynamic Electrical Materials".

Our decision is to: Accept Submission

Editor JPPIPA Mataram University jppipa@unram.ac.id

Jurnal Penelitian Pendidikan IPA



[JPPIPA] Copyediting Review Request

1 message

Editor JPPIPA <jppipa@unram.ac.id> To: "Dr. Binar Kurnia Prahani" <binarprahani@unesa.ac.id> Fri, Oct 8, 2021 at 12:35 PM

Dr. Binar Kurnia Prahani:

Your submission "Profile of Problem-based Learning (PBL) Model Assisted by PhET to Improve Critical Thinking Skills of High School Students in Dynamic Electrical Materials" for Jurnal Penelitian Pendidikan IPA has been through the first step of copyediting, and is available for you to review by following these steps.

- 1. Click on the Submission URL below.
- 2. Log into the journal and click on the File that appears in Step 1.
- 3. Open the downloaded submission.
- 4. Review the text, including copyediting proposals and Author Queries.
- 5. Make any copyediting changes that would further improve the text.
- 6. When completed, upload the file in Step 2.

7. Click on METADATA to check indexing information for completeness and accuracy.

8. Send the COMPLETE email to the editor and copyeditor.

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https://jppipa.unram.ac.id/index.php/jppipa/author/submissionEditing/799 Username: binar

This is the last opportunity to make substantial copyediting changes to the submission. The proofreading stage, that follows the preparation of the galleys, is restricted to correcting typographical and layout errors.

If you are unable to undertake this work at this time or have any questions, please contact me. Thank you for your contribution to this journal.

Editor JPPIPA Mataram University jppipa@unram.ac.id

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Implementation of Problem Based Learning Assisted by PhET to Improve Critical Thinking Skills of Senior High School Students in **Dynamic Electrical Materials**

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Article Info Received:	Abstract:		
Revised:	Implementation of Problem Based Learning (PBL) Assisted by Virtual Lab (PhET) to		
Accepted:	Improve Critical Thinking Skills of High School Students on Dynamic Electrical		
	Materials. The purpose of this research is to obtain a profile of students' thinking	; C	Commented [AD1]: Tidak tebal
Correspondence:	skills and the implementation of Problem Based Learning Virtual Lab Assisted(PBL)		
Phone: +62	in senior high schools. The method researchused is a descriptive preliminary study.	(c	Commented [AD2]: Tidak tebal
	Data collection techniques with written tests, student response questionnaires, and	. –	
	teacher interviews. The analysis was carried out using a qualitative descriptive		
	analysis technique. Findings from students as many as 100 people. The category of	- C	Commented [AD3]: Tidak tebal
	critical thinking skills is divided into three categories, namely, low, medium and	L	
	high. Where in the low category there are 17 students, then in the medium category	·	
	there are 53 students and in the high category there are 30 students. The conclusion	y c	Commented [AD4]: Tidak tebal
	is that students' critical thinking skills are at a moderate level, and training questions		
	are needed to improve critical thinking skills.	C	Commented [AD5]: 1 spasi

Keywords: Problem Based Learning (PBL), Critical Thinking, Virtual Labs, PhET

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1	Commented [AD4]: Tidak tebal
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Introduction

Learning is a process of interaction between teachers and students, students and students and students with teaching materials that take place in situations that are educational in order to achieve the goal (Depdiknas, 2003). The interaction or reciprocal relationship between teachers and students is the main requirement for the ongoing learning process. But in reality, in the learning process, the teacher is often too active while some of the students only listen to the

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Email: <u>xxxx@xxx.xxx</u> (*Corresponding Author)

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explanation. So that the interaction between students and teachers in the learning process becomes less effective. The learning process in schools can be carried out to achieve learning objectives at the level of knowing, understanding, using and not yet growing the habit of thinking high which is an important thing in learning activities (Kamdi and Mustaji, 2010). So that a teacher is needed to design learning that can develop students' thinking skills.

The science that helps one to survive in this ever changing scientific and technological world is Science. Life requires changes that require people to apply scientific thinking. Science itself is inseparable from physics lessons, physics subjects provide students with a conceptual understanding of natural phenomena that occur to students, as well as a vehicle for growing thinking skills and solving problems in everyday life (Shisgu, 2017).

Critical thinking is one indicator of high thinking, critical thinking is a term critical thinking that can be interpreted with convergent thinking, logical thinking (logicalthingking), and reasoning. Critical thinking is thinking well, contemplating about the thought process is part of thinking well. Critical thinking is used in mental activities such as solving problems, making decisions, analyzing assumptions and conducting scientific research (Alwasilah, 2010). The purpose of critical thinking is uncovering the truth by getting rid of all that is wrong so that the truth can be seen.

According to Harsanto (2005:44) states, one side of being a critical person, his mind must be open, clear, and every decision taken must be accompanied by reasons based on facts and he must also be open to differences of opinion. Someone can see their critical thinking skills based on critical thinking indicators, namely: 1) providing simple explanations (elementary clarification), 2) building basic skills (basic support), 3) making inferences (inferring), 4) making further explanations (advanced clarification), 5) managing strategies and tactics (Komalasari, 2011: 266).

Teachers have an important role in training students' critical thinking skills in physics subjects, so the teacher can choose the right learning model. The learning model chosen must have a learner-centered learning syntax. One of the interactive learning models that are constructivist, student centered, and emphasize learning is the model Problem Based Learning (PBL). PBL is a learning model whose starting point is learning based on problems in everyday life (Harsono, 2010). The characteristics of this learning model are, using problems in life as something that students must learn to train, develop in thinking skills and problem solving skills, learn adult roles and make independent students.

In Problem Based Learning (PBL), collaboration between students is needed to encourage research and discussion together so that they can develop thinking skills and social skills. The application of the PBL model, which has been studied by several experts before (Qosyim, 2015), concluded that learning physics using a problem-based learning model with the help of cartoon videos can affect students' physics learning outcomes. It was proven by the students that the results of learning physics using the PBL model with the help of cartoon videos were higher than the learning outcomes of students who applied the ordinary problem-based learning model.

Zahara (2015) applying the use of PhET-based computer media concluded that learning physics using PhET media experienced an increase in learning outcomes and higher critical thinking skills than learning taught with conventional models. Problem-Based Learning can significantly improve student learning outcomes and conceptual understanding, in addition to having advantages that distinguish it from other models, problem-based learning models also have drawbacks, namely not providing sufficient time for students to be deeply involved in learning, one way to overcome this is with the help of media, both simple and technology-based media, one of the media used is computer-based media that can provide convenience for students is PhET media, which is an interactive simulation media that invites students to learn, PhET is used to clarify concepts physical concept.

The use of PhET makes it easier for teachers to deliver a lot of material in one place so that the use of time is more efficient, besides using PhET media the learning process feels more fun to watch, read, digest and remember. The purpose of the study was to determine the students' critical thinking skills and the application of Problem Based Learning (PBL) in high school. Whether in school students are taught using the learning model Problem Based Learning (PBL)assisted by PhET simulation or not and whether students' critical thinking skills are good or not.

Method

This type of research uses a preliminary study. Preliminary study is a study conducted to find the information needed by researchers so that the problem becomes clearer. This research does not use hypothesis testing but uses a descriptive research design. Where, the results of this study will later be used as material for consideration to improve learning models and Commented [AD7]: Sitasi 5 tahun terakhir

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learning media that improve critical thinking processes in high school / MA level students.

This research was carried out online through the distribution of google forms on March 22, 2021 at SMA Negeri 8 Surabaya to students in class XI MIPA 4, XI MIPA 2, XI MIPA 1, and XI MIPA 5 with a total of 100 respondents. Data collection techniques were carried out using research instruments. The research instruments used in this study were written tests, student response questionnaires, and teacher interviews.

Data analysis techniques or data collection is a strategic step in research, because it has the goal of getting data (Sugiyono, 2010). In this study, qualitative descriptive analysis techniques were used. Written tests are test questions that contain questions that must be answered by students by distributing written answers. Each question given must be based on predetermined indicators. To assess students' critical thinking skills, this study used a written test which was used a critical thinking essay test (Ennis, 2011). [This critical thinking skills test consists of material about effort and energy which consists of twelve essay questions with each indicator consisting of three questions.

Questionnaire is a research instrument consisting of a number of questions aimed at collecting information from respondents. In this study, the questionnaire used has the aim of knowing about the learning process that has been carried out by students and teachers. As well as regarding the perspectives of students based on the learning model Problem Based Learning (PBL) Virtual Lab Assisted (PhET) by presenting ten questions in a questionnaire that will be filled out by students.

According to (Moleong, 2008) the interview is a conversation that has a specific purpose. The conversation was carried out by two parties, namely the interviewer (who asked the question) and the interviewe (who answered the question). In this study, interviews conducted with teachers contained six questions about the process of teaching and learning activities carried out by teachers in class.

The information sought is whether there has been a learning model that can improve the critical thinking process of students, as well as the teacher's opinion about Problem Based Learning (PBL) Assisted by Virtual Labs (PhET). From the results of the interview, the goal is to adjust the answers between students and teachers. The following is a research method flow procedure regarding the profile of students' critical thinking skills at the high school level and the implementation of the learning model Problem Based Learning (PBL) Virtual Lab Assisted (PhET) to Improve Critical Thinking Skills in Dynamic Electrical Materials.

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Result and Discussion

The results of the research that have been carried out are aimed at obtaining an overview of students' critical thinking skills, especially dynamic electricity.

Critical Thinking Skills Test

Based on research conducted using a written test instrument consisting of an essay test with a total of twelve questions with each indicator consisting of three questions equipped with four critical thinking indicators, namely, indicators of analysis, evaluation, interpretation, and inference (Facione, 2013). [Then students are asked to answer according to the existing problems. For the value of the level of critical thinking skills of students based on answers from students. And based on the question instrument, students are expected to be able to analyze, draw conclusions, evaluate and interpret.

For the assessment of the level of critical thinking skills can be calculated based on the respondents' answers. Where, if the answer given is logical, complete and systematic will get 5 points, but if the answer given only meets two elements, namely complete and logical or logical and systematic will get 3 points, but if the answer given only meets one element it will get a value of 1 point, and if the answer given is wrong or does not meet the three elements, then the value obtained is 0 points.

1. Interpretation

Internatas lawpu A dan lawpu B tetap, tetap linternatas lawpu S berturang barena naklar S dilihilip. Commented [AD17]: Sitasi 5 tahun terakhir
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Figure 1. Students answers on the interpretation indicators.

From the answers given, it can be seen that only one element is correct. Supposedly, the correct answer is that the intensity of lamps A and B is the same as bright, while the intensity of lamp C is the brightest. And the power in the circuit is fixed.



Figure 2. Students answers on the analysis indicators

From the answers given, it can be seen if it only fulfills one element, so the answer is not correct. And the correct answer is because, there are two conditions for an electric current to occur, namely there is a potential difference and a closed circuit. The two legs of the bird, namely point A and point B are at high voltage. Current flows through the air wire (conductor) and both legs of the bird have the same electric potential (VA = VB) and this means the potential difference between points A and B is VA - VB = 0. As a result, current does not flow through the bird's body, and birds do not burn under high-voltage wire.



From the answers given, it can be seen if the answers do not meet the three elements. So that the answer is wrong, the correct answer should be if the formula used is V/I. Given that V is 3V, and I is 0.02 A. Then look for the value of R or Resistor by means of R = V / I = 3 / 0.02 = 150 (150 is a fixed value). After finding the value of the resistor then calculating the value of I (4,5V)

$$I = \frac{V}{R} = \frac{4,5 V}{150\Omega} = 0,03 A = 30 mA$$

For the conclusion that can be drawn from the above calculation, namely, if $\rm V$ is inversely



proportional to I. So, the greater the value of the

voltage and the smaller the value of the current.

Figure 4. Students answers on the evaluation indicators

From the answers given by students, it can be seen that the answers only meet two elements. Most parts are also the same as answering only two elements, the correct answer should be that the principle used is a series circuit where the voltage (V) is divided and the current (I) is the same, while the parallel circuit is the voltage (V) is the same and the current (I) is divided. When viewed from the circuit above, it is a mixed circuit consisting of a parallel circuit and a series circuit. The P lamp is the brightest. The R and Q lights are equally bright. The T and U lights are the faintest. The current and voltage have been divided for the resistance S. So the U lamp and T lamp are the faintest. From the four indicators above, the average value for each indicator is as follows.



indicator.

Based on the picture above, the lowest value of the average critical thinking indicator is interference, while the highest is the analysis indicator. The thing that causes the interference indicator to get a low value is because the ability of students to draw conclusions is still relatively low, this is because students do not understand the questions, concepts and equations given to the dynamic electricity material. Overall, there are 100 students. Divided into three categories, namely, low, medium and high. Where in the low category there are 17 students, then in the medium category there are 53 students and in the high category there are Commented [AD24]: Gambar 5? Commented [AD25]: Tidak tebal

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Commented [AD26]: Buang kalimat average indicator critical thingking di dalam gambar. Cukup keterangan sumbu x dan sumbu y saja. Keteranga lengakap beri di Figure 6.

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30 students. From this description, it can be seen in the image below.



It can be seen from the picture above, where students who get grades in the low category are 17 students, then in the medium category as many as 53 students, and in the high category as many as 30 students.

Differences in critical thinking skills of male and female students can be calculated based on indicators of critical thinking skills. The results can be seen in the image below.



The average result of critical thinking skills by gender (male and female), shows that there is a significant difference. This is because male students identify using the facts given in the questions clearly, logically, concisely, effectively and efficiently, and male students identify problems based on elements that are only related to the problem. In contrast to women, if they identify using the facts given in the questions in a clear, logical, detailed and complete manner, whether they will be used to work on the questions or not. So that there is a difference between male and female students, namely being able to identify problems and understand the questions in the questions, this can be seen from the ability to write down the elements that

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are known from the questions and which are asked in the questions correctly. These findings are in accordance with research conducted by Rubin (Cahyono, 2017) which shows that there is no significant difference between men and women in the aspect of intelligence in general, although in certain aspects there can be differences between boys and girls.

Student Response Questionnaire

Based on the results of filling out a questionnaire by students regarding problem-based learning models and students' critical thinking skills. The following are the results of interviews conducted with students.

Table 1. Student's questionnaire on critical								
thinking skills								
No.	Questions	Yes	No					
1	Do you like physics	54	63					
2	Do you think dynamic electricity is important to understand?	100	0					
3	Do you think the subject of dynamic electricity is difficult to understand?	92	8					
4	Is the lecture method often used by teachers compared to experimental-based learning in the laboratory in physics learning?	81	19					
5	Have you ever done any learning activities for improve critical thinking skills?	79	22					
6	Have you ever been trained with critical thinking skills test questions?	65	36					
7	Do you have difficulty when you have to answer the test questions? critical thinking skills?	83	19					
8	Do you like the method used by the teacher in learning physics?	68	32					
9	Do you like online learning during a pandemic Covid-19 going on?	8	92					
10	Have you ever been trained by a teacher to use PhET in physics lessons?	48	52					

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Commented [AD30]: Gambar 7?
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Commented [AD35]: Tidak tebal dan tanpa spasi

Commented [AD32]: Edit Kembali gambar 8 ini. Buang kalimat Average critical thingking skill by gender Keterangan lengkap gambar 8 diberikan tidak double Koma dalam Bahasa Indonesia menjadi titik dalam Bahasa inggris

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In the table above, it can be seen that students' responses to critical thinking skills are that most of

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them like physics and think that dynamic electricity needs to be studied, although many students say that dynamic electricity is difficult to learn and understand, because teachers often use this method. lectures in teaching and never doing practicum in the laboratory especially during this pandemic. Some of the students have also done practice questions to improve critical thinking skills, but there are also students who still have difficulty when given critical thinking questions. Students themselves also like the lecture method given by educators when learning takes place, but there are also those who don't like the method, especially during this pandemic. Students have also never been trained to conduct experiments using virtual laboratories because educators have not used PhET. Therefore, it is important for educators to find alternatives so that students can still improve their critical thinking skills.

Teacher Interviews

Based on the results of interviews with the physics teacher concerned, regarding the problems of problem-based learning models and students' critical thinking skills. The following are the results of interviews conducted with teachers.

Table 2. Results of Interviews with Teachers

INO.	Questions	Answers/Responses
1	How do you usually teach Physics concepts, especially on dynamic electricity?	Provide material from youtube, then invite discussion through google classroom, google meet, or whatsapp group with the lecture method
2	Have you ever carried out physics learning by training students' critical thinking skills?	It is rarely done, because critical thinking skills require an interesting learning model in order to foster critical thinking processes in students. And also not all of the classes that I hold are enthusiastic about physics lessons, especially on electricity
3	Have you ever given questions to capture students' critical thinking skills?	Very rarely, because critical thinking skills themselves use high indicators. And less effective, if given to

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		students who lack
4	According to your mother, how are the efforts made in learning to improve students' critical thinking skills?	Must provide an interesting learning model so that the interest of students increases. Not only that, the problems presented must also be interesting so that students have the curiosity to investigate them.
5	How do you respond to the profile of students' critical thinking skills conducted by researchers?	Very good, because at this time critical thinking is very necessary and can also be a reference for teaching.
6	In your opinion, if there is an abased learning activity Problem Based Learning Virtual Lab (PhET) Assisted(PBL)with	Very well, this learning model is suitable for the purpose of students' critical thinking, because students' skills also tend to be
	the aim of improving students' critical thinking skills?	low. Therefore, with this learning method, students will be enthusiastic, because of the new learning model.

The table above shows the results of interviews, that teachers do not always follow the design of the learning implementation that is made. This is because the teacher adapts to the conditions during the learning process, so that critical thinking skills are categorized as moderate. Critical thinking skills are important to be trained, because critical thinking is so important that it becomes a matter of concern for educators and researchers. One of the experts who put forward the importance of critical thinking including according to Facione (2006), namely as self-regulation in deciding (judging) something that results in interpretation, analysis, evaluation and inference, as well as exposure using evidence, concepts, methodologies, criteria, or contextual considerations. on which the decision is based. In addition, critical thinking is also important as an inquiry tool. Apart from the importance of critical thinking, critical thinking is very useful in making a person more independent, confident and able to solve problems more wisely. Therefore, improving the critical thinking process can be done with varied learning

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models so that students do not feel bored, such as problem-based learning that is carried out online and offline.

Based on the research that has been done, it can be seen that if there are still some students who are less precise in answering, and solving critical thinking skills questions with indicators of analysis, evaluation, interpretation, and inference, the average results are less than satisfactory. So that the level of students' critical thinking skills is in the medium category, but in the current era critical thinking skills are needed because they can be a reference in facing challenges and problems that arise in the future. Therefore, critical thinking skills are one of the important elements needed by students to become the main focus in education.

Then the number of students who do not understand this Dynamic Electricity material so that students' skills in solving problems are not optimal. It can be identified several factors that cause students to have difficulty in completing tests of students' critical thinking skills, namely, the learning method used by teachers tends to use the lecture method and the lack of critical thinking skills test practice which causes the learning process is not optimal and learning objectives are not achieved. Therefore, teachers must replace the lecture learning model with a more varied learning model such as Problem Base Learning (PBL). Where the learning model is Problem Base Learning (PBL)very suitable to be applied in SMA/MA because the learning model is complex and can improve critical thinking skills. This is in line with Hosnan's opinion (Ahmad Farisi, 2017) which states, the main purpose of the PBL model is not the delivery of most of the knowledge to students but rather on developing critical thinking skills and problem solving. And also students do not know about virtual labs (PhET) because teachers have not implemented online experiments using PhET to students.

The results of the research analysis presented can be useful for assessing the effectiveness of the learning model Problem Based Learning Virtual Lab Assisted(PBL)to Improve Critical Thinking Skills. The selected studies include the research researched in 2017. The summary of the relevant research analysis can be seen in table 3.

Table 3. Review of the 2017 study

Penulis	Judul	Temuan
(Tahun)	Penelitian	
Ahmad	Effect c	of This study used an
Farisi	Learning	experimental method
(2017)	Model	with quantitative

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	Problem Based Learning Against Thinking Skills Critical in Improving Student Results In concept Temperature And Heat	approach Data collected in two phases, namely pre- test and posttest. The Effect of Problem Based Learning Learning Model on Critical Thinking Ability in Improving Students' Learning Outcomes. The results of the research and data analysis in this study can be concluded that there is an influence of the Problem Based Learning (PBL) learning model
Cahyono, Budi. 2017	Analysis of Critical Thinking Skills in Solving Problems in terms of Gender Differences	This study uses a descriptive method. The data collected in the form of qualitative data and analyzed by data reduction, the presentation of the data is then drawn conclusions. The results of the study are that there are differences in the process and results of critical thinking tests between male subjects and female subjects

Conclusion

Based on the results of research and discussion, we can conclude that the critical thinking skills of students of SMAN 8 Surabaya are at a moderate level, of such tests There are four questions indicators, namely indicators of interpretation, analysis, evaluation and inference. Based on student questionnaires and teacher-interviews, it can be seen that educators in every school need to train students' critical thinking skills and it is necessary to change the applied learning model. Therefore, based on the conclusion of the study, the researcher suggests changing the innovative and creative learning model into an index based on critical thinking skills, namely improving students' critical

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Commented [AD38]: Masih Bahasa indonesia

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thinking skills through the use of virtual laboratory problem-based learning (PBL) learning models. The main problem is improving dynamic electrical thinking skills.

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Profile of Problem-based Learning (PBL) Model Assisted by PhET to Improve Critical Thinking Skills of High School Students in Dynamic Electrical Materials

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Article Info

Received: June 17th, 2021 Revised: September 8th, 2021 Accepted: October 8th, 2021 **Abstract:** This study discusses the implementation of problem-based learning (PBL) assisted by physics education technology (PhET) as a virtual laboratory to improve the critical thinking skills of high school students on dynamic electrical materials. The purposes of this research were to obtain the profile of students' critical thinking skills and the implementation of PBL assisted by PhET in senior high schools. This research method was a preliminary study with a qualitative descriptive analysis, written tests, student response questionnaires, and teacher interviews. The finding of students' critical thinking skills was categorized into three levels (low, moderate, and high). There are seventeen students in the low category, fifty-three students in the moderate category, and thirty students in the high category. The conclusion of this study revealed that students' critical thinking skills at the senior public school Surabaya were in the moderate category, and training questions were needed to improve students' critical thinking skills.

Keywords: Problem based learning; critical thinking; virtual labs; PhET

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Introduction

Physics is one of the natural science branches, which studies the formulas and theories in nature, including scientific events experienced by humans. Physics itself is part of the Natural Sciences, which have an empirical nature. Everything studied in physics results from observations about natural phenomena and natural phenomena (Rahayu, 2017).

According to Depdiknas (2003), the purpose of physics subjects for senior high school is to mastery the knowledge, concepts, and principles of physics and have knowledge of scientific skills and attitudes. From the objectives listed above, it can be seen that the physics learning process in secondary schools should be carried out with methods. Not only master knowledge, concepts, and principles, but students must also have scientific skills and attitudes. One of the skills in question is critical thinking skills.

Critical thinking skills are essential to be taught, trained as early as possible, and carried out continuously according to students' age and developmental stages so that students can observe various problems that may occur in learning activities and think of solutions to these problems. So that good learning outcomes can be realized, can overcome the problems of life that are passed at each stage of the development of students by finding solutions based on the experience that has been passed (Ismayawati et al., 2016).

According to (Qurniati et al., 2015), critical thinking skills require students to analyze their own thoughts to prove that students have found choices and can draw smart conclusions. Knowing critical thinking

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is very important and can determine the success of life, both in solving problems, making decisions, and being a supporter in developing broad knowledge. Meanwhile, according to (Latifa et al., 2017), critical thinking skills are processes and abilities involved in making rational decisions. Someone who thinks critically will always ask himself every time he faces a problem to determine the best decision. Based on this, one solution, according to the researcher, is to apply Problem Based Learning.

PBL is a learning approach that uses real-world problems as a context for students to learn about critical thinking and problem-solving skills. As well as to obtain the essence and problem-based learning is used to foster critical thinking in situations that lead to problems so that students can learn to solve problems. (Maryati, 2018).

PBL changes the learning process from teachercentered to student-centered, while teachers experience a change in role from being a source of knowledge to being a facilitator in gaining knowledge (Rositasari et al., 2014). The implementation of the problem-based learning model can train several thinking skills such as critical thinking, analyzing and solving complex, collaborative, and communicative problems verbally and in writing (Rosa & Pujiati, 2016)

PBL is a learning model that involves participants' students solving problems through the stages of the scientific method. Thus, students can learn knowledge related to problems and at the same time have skills in solving problems. PBL is a learning process where the starting point of learning is based on problems that exist in everyday life. From these problems, students are required to study this problem based on new knowledge and practice gained (Maryati, 2018).

Based on the explanation above, the learning method that can improve critical thinking skills is the experimental method. In physics learning itself, the experimental method is one method that supports the PBL. Learning using PBL is one of the learning models with a scientific approach. In the selection of this learning model, it is suitable to be applied at the senior high school because the learning model is complex and requires critical thinking with good analytical skills. Through this PBL, students are required to be more active in solving problems. According to the opinion expressed by Ennis (Cahyono, 2017) which can be concluded that there is a relationship between critical thinking and solving problems.

The characteristics of this learning model are, using problems in life as something that students must learn to train, develop thinking skills and problemsolving skills, learn adult roles and make independent students. In PBL, a collaboration between students is needed to encourage research and discussion together to develop critical thinking skills and social skills. The application of the PBL model has been researched by several experts before. Al-Idrus et al. (2015) state that learning physics using a PBL model with cartoon videos can affect students' learning outcomes of physics.

The Zahara et al. (2015) study revealed that students learning physics using PhET media experienced had increased the learning outcomes and higher critical thinking skills than students with conventional models. PBL can improve learning outcomes and students' understanding of concepts significantly. In addition to having advantages that distinguish it from other models, PBL models also have drawbacks, namely not providing sufficient time for students to be deeply involved in learning. One way to overcome this is with the help of media, both technology-based and straightforward media. One of the media used in computer-based media that can provide convenience for students is PhET media, which is an interactive simulation media that invites students to learn. PhET is used to clarify the physics concept. The use of PhET makes it easier for teachers to deliver a lot of material in one place so that the use of time is more efficient. Besides using PhET media, the learning process feels more fun to watch, read, digest, and remember. The purpose of the study was to determine the students' critical thinking skills and the application of PBL in high school. Whether in school students are taught using the learning model PBL assisted by PhET simulation or not and whether students' critical thinking skills are good or not.

Method

This study used a preliminary study with qualitative descriptive analysis. The preliminary study is conducted to find the information needed by researchers to make the problem more precise. This research did not use hypothesis testing but used a descriptive research design. The results of this study will be used as consideration for improving the learning models and learning media that enhance students' critical thinking skills in senior high school.

This research was carried out by online learning at the senior public school Surabaya in 11th grade. The total participant of this study was 100 students in four classes.

Three types of data were collected, namely written tests, student response questionnaires, and teacher interviews. According to Sugiyono (2017), data collection techniques are critical in research because the primary purpose of research is to obtain data. Written tests are test questions that contain questions that students must answer by providing written answers. The critical thinking ability test was developed from the five aspects of critical thinking skills that became the benchmark (Pradana et al., 2017). Therefore, in this study, researchers used a critical thinking skill test with dynamic electrical material, which consisted of twelve essay questions with each indicator consisting of three questions.

The questionnaire is a research instrument consisting of several questions aimed at gathering information from respondents. In this study, the questionnaire used aims to know about the learning process that students and teachers have carried out as well as students' perspectives on this learning model by presenting ten questions in a questionnaire that students will fill out.

Figure 1 shows the procedure for the flow of research methods regarding the profile of students' critical thinking skills at the senior high school and the implementation of the problem-based learning (PBL) learning model assisted by physics education technology (PhET) as a virtual laboratory to improve critical thinking skills in dynamic electrical materials.



Figure 1. Research flowchart

Result and Discussion

Critical thinking skills test

This research was conducted using a written test instrument consisting of an essay test with twelve questions. Each indicator consists of three questions equipped with four critical thinking indicators: analysis, evaluation, interpretation, and inference (Facione, 2015). From the twelve questions, students are then asked to answer according to the existing problems, then for the assessment system of students' critical thinking skills based on the answers given. Students are expected to analyze questions, make conclusions, evaluate, and interpret based on the existing question instruments.

The assessment of critical thinking skills can be calculated based on the respondents' answers. Suppose the answer given is logical, complete, and systematic. In this case, the respondent will get 5 points to answer full element. If the answer given meets only two elements, namely complete and logical, and systematic, the respondent will get 3 points. If the answer given meets only one element, the respondent will get a value of 1 point. If the answer given is wrong or does not meet the three elements, then the value obtained is 0 points.

1. Interpretation

Sekelompok siswa melakukan percobaan dan berhasil merangkai enam buah lampu identik dengan rangkaian di bawah ini :



Dari rangkaian diatas, manakah lampu yang menyala palingredup adalah.... (Berikan alasan mengapa Anda memilih jawaban tersebut)

Figure 2. Ou	estion on	interpre	tation	indicator

Intensitas	lampu	A	olan lam	pu B	tetap,	tetapi	intensitas	lampu S
berkurang	karen	101	saklar	s olit	uhup.			

Figure 3. Students answers on the interpretation indicators

From the answers given, it can be seen that only one element is correct. Supposedly, the correct answer is that the intensity of lamps A and B is the same as bright, while the intensity of lamp C is the brightest, and the power in the circuit is fixed.

2. Analysis

Seekor burung merasa cukup aman berdiri pada kawat tegangan tinggi yang sedang mengalirkan arus listrik. Namun, jika kawat di antara kedua kakinya dipotong dan di antara ujung-ujung potongan disambungkan suatu lintasan kawat yang panjang kira-kira 200 m, burung akan merasakan kejutan listrik. Mengapa?

Figure 4. Question on analysis indicator

Karena lisotik akan merambas meraici kawas dan kawas adarah, kanduksor ya dapas menghandarkan lisotik maka dari lisu barung akan bereaksi cerkena sengatan lisotik

Figure 5. Students answer on the analysis indicator

From the answer given, it can be seen that it meets only one element, so the answer is wrong. The correct answer is that there are two conditions for an electric current to occur; there are potential differences and closed circuits. The two legs of the bird, namely point A and point B, are at high voltage. Current flows through the air wire (conductor), and both legs of the bird have the same electric potential ($V_A=V_B$), and this means the potential difference between points A and B is $V_A-V_B = 0$. As a result, current does not flow through the bird's body, and birds do not burn under the high-voltage wire.

3. Inference



Figure 6. Question on inference indicator



Figure 7. Students answer on the inference indicator

From the answers given, it can be seen if the answers do not meet the three elements. So that the answer is wrong, the correct answer should be if the formula used is V/I. Given that the voltage (V) is 3V, and current (I) is 0.02 A. Then look for the value of resistor (R) by means of R = V/I = 3/0.02 = 150 (150 is a fixed value). After finding the value of the resistor then calculating the value of I (4,5V)

$$I = \frac{V}{R} = \frac{4.5 V}{150\Omega} = 0,03 A = 30 mA \dots (1)$$

Suppose the voltage (V) is inversely proportional to the current (I) from the calculation value. So, the greater the value of the voltage and the smaller the value of the current.

4. Evaluation

Anda memiliki sebuah voltmeter DC dan sebuah amperemeter DC. Gambar dua rangkaian berbeda yang dapat Anda gunakan untuk mengukur hambatan sebuah resistor. Dan jelaskan perbedaan kedua rangkain itu ...



Figure 9. Students answer on the inference indicator

Based on Figure 6, the lowest value of the average critical thinking indicator is interference, while the highest is the analysis indicator. The thing that causes the interference indicator to get a low value is because the ability of students to draw conclusions is still relatively low. This is because students do not understand the questions, concepts, and equations given to the dynamic electricity material. Overall, there are 100 students. It was divided into three categories, namely, low, medium, and high. Where in the low category, there are 17 students, then in the medium category, there are 30 students. From this description, it can be seen in the image below.



Figure 10. Categories of students' critical thinking skills

It can be seen from the picture above, where students who get grades in the low category are 17 students, then in the medium category as many as 53 students, and the high category as many as 30 students.

Differences in the critical thinking skills of male and female students can be calculated based on indicators of critical thinking skills. The results can be seen in the image below.



Figure 11. Average critical thinking skills by gender

The average result of critical thinking skills by gender (male and female) shows a significant difference. This is because male students identify using the facts given in the questions clearly, logically, concisely, effectively, and efficiently, and male students identify problems based on elements that are only related to the problem. In contrast to women, if they identify using the facts given in the questions in a clear, logical, detailed, and complete manner, whether they will be used to work on the questions or not. So there is a difference between male and female students, which are able to identify problems and understand the questions in the question. This can be seen from the ability to write down the known elements of the

Table 1. Student's of	questionnaire on	critical	thinking	skills
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question and those asked in the question correctly. These findings are in accordance with research conducted by Rubin (Cahyono, 2017), which shows no significant difference between men and women in the aspect of intelligence in general. However, in certain aspects, there can be differences between boys and girls.

Student response questionnaire

Based on the results of filling out a questionnaire by students regarding problem-based learning models and students' critical thinking skills. The following are the results of interviews conducted with students.

No.	Questions	Yes	No
1	Do you like physics	54	63
2	Do you think dynamic electricity is important to understand?	100	0
3	Do you think the subject of dynamic electricity is difficult to understand?		
4	Do teachers often use the lecture method compared to experimental-based learning in the	81	19
	laboratory in physics learning?		
5	Have you ever done any learning activities for improving critical thinking skills?	79	22
6	Have you ever been trained with critical thinking skills test questions?	65	36
7	Do you have difficulty when you have to answer the test questions? Critical thinking skills?	83	19
8	Do you like the method used by the teacher in learning physics?	68	32
9	Do you like online learning during a pandemic Covid-19 going on?	8	92
10	Have you ever been trained by a teacher to use PhET in physics lessons?	48	52

The table above shows that students' responses to critical thinking skills are that most of them like physics and think that dynamic electricity needs to be studied. However, many students say that dynamic electricity is difficult to learn and understand because teachers often use this method. Lectures in teaching and never doing an experiment in the laboratory, especially during this pandemic. Some of the students have also done practice questions to improve critical thinking skills, but some students still have difficulty when given critical thinking questions. Students themselves also like the lecture method given by educators when learning takes place. Still, some do not like the method, especially during this pandemic. Students have also never been trained to conduct experiments using virtual laboratories because educators have not used PhET. Therefore, educators need to find alternatives to improve their critical thinking skills.

Teacher Interviews

Based on the results of interviews with the physics teacher concerned regarding problem-based learning models and students' critical thinking skills. The following are the results of interviews conducted with teachers.

Table 2. Results of Interviews with Teachers

No	Interview Questions	Answers/Responses
1	How do you usually teach Physics concepts,	Provide material from youtube, then invite discussion through google
	especially on dynamic electricity?	classroom, google meet, or WhatsApp group with the lecture method
2	Have you ever carried out physics learning by	It is rarely done because critical thinking skills require an interesting
	training students' critical thinking skills?	learning model to foster students' critical thinking processes. And also,
		not all of the classes that I hold are enthusiastic about physics lessons,
		especially on electricity
3	Have you ever given questions to capture	Very rarely, because the critical thinking skills themselves use high
	students' critical thinking skills?	indicators. And less effective, if given to students who lack interest in
		physics.
4	According to your mother, how are the efforts	Must provide an interesting learning model so that the interest of
	made in learning to improve students' critical	students increases. Not only that, the problems presented must also be

No	Interview Questions	Answers/Responses
	thinking skills?	interesting so that students have the curiosity to investigate them.
5	How do you respond to the profile of	Very good, because at this time critical thinking is very necessary and
	students' critical thinking skills conducted by	can also be a reference for teaching.
	researchers?	
6	What is your opinion of the problem-based	Very well, this learning model is suitable for the purpose of students'
	learning (PBL) model assisted by physics	critical thinking, because students' skills also tend to be low. Therefore,
	education technology (PhET) as a virtual	with this learning method, students will be enthusiastic, because of the
	laboratory to improve critical thinking skills?	new learning model.

Table 2 shows the results of interviews that teachers do not always follow the design of the learning implementation that is made. This is because the teacher adapts to the conditions during the learning process so that critical thinking skills are categorized as moderate. Critical thinking skills are important to be trained because critical thinking is so important that it becomes a matter of concern for educators and Menurut (Facione, researchers. 2015), sebagai pengaturan diri dalam memutuskan (menilai) sesuatu yang menghasilkan interpretasi, analisis, evaluasi, dan kesimpulan, serta paparan menggunakan bukti, konsep, metodologi, kriteria, atau pertimbangan kontekstual yang menjadi dasar keputusan tersebut. In addition, critical thinking is also important as an inquiry tool. Apart from the importance of critical thinking, critical thinking is very useful in making a person more independent, confident and solve problems more wisely. Therefore, improving the critical thinking process can be done with varied learning models.

Based on the research that has been done, it can be seen that some students are less precise in answering and solving critical thinking skills questions with indicators of analysis, evaluation, interpretation, and inference. The average results are less than satisfactory. Therefore, the level of students' critical thinking skills is in the medium category. However, nowadays, critical thinking skills are needed because they can be a reference in facing challenges and problems that arise in the future. Critical thinking skills are one of the important elements needed by students to become the main focus in education.

Then the number of students who do not understand this dynamic electricity material so that students' skills in solving problems are not optimal. Several factors can be identified that cause student to have difficulty completing students' critical thinking skills tests, namely learning methods used by teachers tend to use lecture methods and lack of practice of critical thinking skills tests. This causes the learning process to be not optimal, and the learning goal is not achieved. Therefore, teachers must replace the lecture learning model with a more varied learning model, such as problem-based learning (PBL). The PBL learning model is very suitable to be applied in senior high school because the learning model is complex and can improve critical thinking skills. This is in line with Hosnan's opinion (Farisi et al., 2017), which states that the main purpose of the PBL model is not to deliver most of the knowledge to students but rather to develop critical thinking skills and problem-solving. And also, students do not know about PhET because teachers have not implemented online experiments using PhET to students.

The research analysis results presented can be useful for assessing the effectiveness of the PBL learning model Assisted by PhET to improve critical thinking skills. The selected research includes research that was researched in 2017. The summary of the relevant research analysis can be seen in table 3.

Table 3	. Review	Study	of the	last five years
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Author (Year)	Research Title	Finding
- Juhari, T., Hikmawati, & Wahyudi (2016)	- The influence of the media- based learning model assisted by Media Phet on the learning outcomes of physics students of class X SMAN 1 Gunungsari 2015/2016 academic year	 This research aims to find out the effect of the problem-based learning model with PhET media on the student's physics results. This research is a quasi-experiment with a nonequivalent control group design. So can be concluded that there is an effect of a problem-based learning model with PhET media on the student's physics results.
- Farisi, A., Hamid, A., & Melvina (2017)	- Effect of Learning Model Problem Based Learning Against Thinking Skills Critical in Improving Student Results In concept Temperature And Heat	- This research aims to see the influence of the Problem Based Learning (PBL) learning model on student critical thinking skills The approach used is quantitative in the form of experimental research. The sampling technique used the purposive sampling technique The conclusion of this research is the influence of using the Problem

Author (Year)	Research Title	Finding
		Based Learning (PBL) learning model on students' critical thinking skills.
- Agusmin, R., & Rohadi, N. (2018)	- Increased student motivation and learning outcomes with the Problem Based Learning model assisted by PhET simulated in class XI IPA-C SMAN 6 Bengkulu City.	 This study includes classroom action research that aims to determine the increase in learning activities, learning motivation, and student learning outcomes. This type of research is classroom action research, with the data collection techniques used are observation, questionnaires, and cycle tests. Based on the study results, it can be concluded that the implementation of the Problem Based Learning Model Assisted Simulation PhET can increase learning activities, learning motivation, and student learning outcomes.
- Gusniar, & Juliani, R. (2019)	- Analysis of the application of the Problem Based Learning (PBL) learning model assisted by Media PhET in 1 Public High School Mirror	 The research aims to determine the increase in learning outcomes by applying the PBL model assisted by Media PhET. This type of research uses quasi-experiments with the design of one group pretest-posttest, with instruments used to collect cognitive learning outcomes in the study of 15 multiple choice questions with five options that have been validated while learning outcomes of skills and activities are taken using the assessment sheet through observation observer. The results of data analysis obtained learning outcomes of students using the PBL model experienced an increase in both cognitive, psychomotor, and activity where cognitive increases.
- Ramadani, M. E., & Nana (2020)	- Application of Problem Based Learning Daunt Virtual Lab PhET on physics learning to improve understanding of the concept of high school students: Literature Review	 The research aims to describe the application of the Problem Based Learning (PBL) model based on Virtual Laboratory PhET in physics learning as an innovation to improve the understanding of concepts in high school students. The method used to analyze the application of Problem Based Learning Virtual Lab PhET in physics learning to improve the understanding of the concept of high school students namely literature studies. The results of this writing show that the application of the Problem Based Learning innovation can solve the problems encountered in the teaching and learning process in the classroom.

Conclusion

Based on the results of research and discussion, we can conclude that the critical thinking skills of students of the senior public school Surabaya were at a moderate level. Based on student questionnaires and teacher interviews, it can be seen that educators in every school needed to train students' critical thinking skills, and it was necessary to change the applied learning model. Therefore, based on the study's conclusion, the researchers suggest changing the innovative and creative learning model into an index based on critical thinking skills, namely improving students' critical thinking skills through the PBL learning model assisted by PhET. The main problem is improving dynamic electrical thinking skills.

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