JPPIPA 9(12) (2023)

Jurnal Penelitian Pendidikan IPA

*Journal of Research in Science Education*

http://jppipa.unram.ac.id/index.php/jppipa/index

# Effectiveness of Problem Based-Learning Model Assisted by Phypox Application to Improve Students' Critical Thinking Skills

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Received: July 16, 2023
Revised: November 9, 2023
Accepted: December 25, 2023
Published: December 31, 2023

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DOI: 10.29303/jppipa.v9i12.4687



**Abstract:** With the correct approach to education, students may develop their capacity for critical thinking. With the use of the phypox app, this research intends to detail how well a problem-based learning paradigm may improve students' critical thinking abilities. Eleven students from Science 2, 4, and 5 at SMA Negeri 22 in Surabaya participated in this quasi-experimental study by taking pre- and post-tests as a group. A quantitative descriptive approach was used for data analysis. With an average n-gain score of 0.80 for XI Science 2, 0.83 for XI Science 4, and 0.78 for XI Science 5, the findings demonstrated that students' critical thinking abilities increased. Classes 4 and 5 of the XI Science program had the greatest and lowest n-gains, respectively. And a Non-Parametric Anova Test result of 0.13 was achieved. After considering the evidence, it is clear that phypox-assisted problem-based learning significantly enhances high school students' critical thinking abilities.

**Keywords:** Critical Thinking Skills; Phypox Application; Problem Based Learning

## Introduction

Critical thinking skills are the basic foundation for the education of the nation's next generation which makes it important to support learning activities. Explained by Agustiani et al. (2022), Labibah et al. (2021), Pamungkas et al. (2018), Education is the main component that cannot be separated from human life, because learning aims to provide knowledge, develop self-personality and morals and honor. However, learning is still difficult for students to understand, especially in subjects that require students to think more, one of which is physics learning (Rahayu & Eliyarti, 2019; Tanti et al., 2021). Students find physics learning difficult to understand because there are too many formulas to learn (Yanto et al., 2021).

Physics learning emphasizes direct learning experiences that do not only emphasize knowledge of materials and concepts (Kurniawan et al., 2022). One part of physics learning is that students are asked to find problems in everyday life that are associated with physics concepts learned scientifically, in the form of investigation activities, hypothesis generation, hypothesis testing, and making conclusions (Negoro et al., 2020; Parno et al., 2019; Wartono et al., 2018). Johnson explains in (Wartono et al., 2018) that the ability to think critically equips people to examine evidence and verify the veracity of information. To prepare students for the challenges of the next century, it is necessary to enhance their critical thinking abilities before they graduate. Teachers use a variety of strategies to ensure that their pupils get the subject and can apply it in real-life situations (Arsih et al., 2023; Indawati et al., 2023; Priska et al., 2021).

The ability to think critically may be honed via the problem-based learning paradigm (Hikmah et al., 2023; Tengku, 2022). An earlier study by Rizki et al. (2022) titled "Application of Problem Based Learning Model Assisted by HOTS Instrument-Based PhET Simulation to Students' Critical Thinking Skills" indicated that

**How to Cite:**
Permana, K. L., Ain, T. N., & Hasyim, F. (2023). Effectiveness of Problem Based-Learning Model Assisted by Phypox Application to Improve Students' Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(12), 10671–10678. https://doi.org/10.29303/jppipa.v9i12.4687

students' critical thinking skills improved from an average pre-test score of 40.88 to a final post-test score of 75.73rd percentile. This study builds on previous work by combining problem-based learning models with phypox learning assistance tools in an effort to enhance students' critical thinking abilities.


**Figure 1.** Initial view of the Phypox app

Phypox is an application that utilizes smartphone sensors and can be accessed through a laptop as a basis for experimental observations (Sari et al., 2023). The advantage of this application is that it is free and the sensor output can generate or store observation data that has been done before (Madroji et al., 2019; Manuaba et al., 2022).

Observations conducted by researchers at SMA Negeri 22 Surabaya obtained information that the learning model used is still very teacher-centered or teacher centered, lack of practicum activities and has not been assisted by learning that uses learning applications to support student understanding, causing students' critical thinking skills to be less than optimal. This is due to students who are only centered on teacher explanations and do not try to explore problems that occur in students' daily lives (Shida et al., 2023). Important research is carried out with the following considerations, first after preliminary research at the school shows low indicators of critical thinking skills, especially at the point of analysis and interpretation, then for self-regulation even shows a value of 0. Secondly, the school was appointed by the Surabaya city government and the Ministry of Education to realize the Pancasila student profile, one of which is critical thinking skills, then thirdly there has never been research conducted at the school that trains critical thinking and analysis questions, especially in the field of physics which is exacerbated by the absence of supporting learning media, especially in the field of software, considering that now learning with digital assistance can increase student understanding. This, therefore, in the author's opinion, the correct opportunity to use the problem-based learning paradigm with the help of phypox in order to teach pupils to think critically. A student-centered paradigm, in which students take an active role in their own education, may replace the traditional teacher-centered model as a means of addressing this issue (Aristawati et al., 2021).

The PBL learning model is learning based on problems in everyday life that are unstructured and open-ended so that it can develop skills, solve problems and think at a high level (Halimah et al., 2023; Kamala et al., 2022). In addition, with the help of the Phypox application, it can help students to visualize concepts completely and clearly (Safitri et al., 2023; Samsudin et al., 2023). Through the use of PBL and Phypox simulation media, students have the opportunity to get instruction in critical thinking skills, which is anticipated to ultimately result in an increase in their critical thinking capabilities.

The fundamental objective of this project is to enhance the critical thinking skills (CTS) of high school students. To do this, the project utilizes a problem-based learning (PBL) strategy to teach physics via the use of Phypox platform. In the course of this study, a number of critical thinking skills were put to the test, including interpretation, inference, analysis, evaluation, and explanation. According to Facione's observations, they are fashioned.

## Method

This type of research is descriptive quantitative research with quasi experimental method (Hoefler et al., 2020; Maciejewski, 2020; Miller et al., 2020). The research design used is one grub pre-test and post-test design with the following pattern. This research design can be seen in table 1 of the research design. The research flow can be seen in Figure 2.

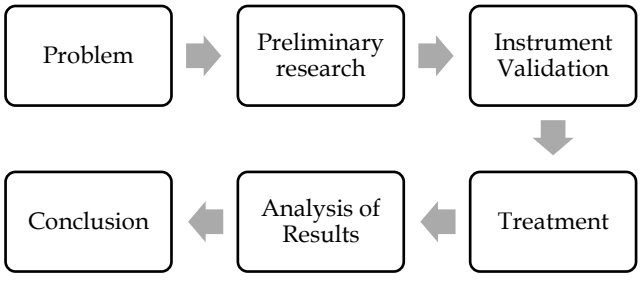


**Figure 2**. Research flow

The research began with finding problems at school, then we conducted preliminary research and obtained low results, then we validated the instrument to conduct the next research, then we tested and analyzed the results of our research.

**Table 1.** Research Design

| Group | *Pre-test* | Treatment | *Post-test* |
|---|---|---|---|
| Experiment | $O_1$ | X | $O_2$ |
| Replication 1 | $O_1$ | X | $O_2$ |
| Replication 2 | $O_1$ | X | $O_2$ |

Description:
$O_1$: Pre-test given before treatment
X: Treatment is given to the experimental class, replication 1 and replication 2 by applying the model.
$O_2$: The final test (post-test) given after the treatment.

This design is applied to three classes, namely the experimental class, replication 1 and replication 2. Replication in an experiment is the same repetition (Rizki et al., 2022). Replication is done so that the conclusions obtained from the research results have strength and are not a coincidence (Fatmawati & Shofiyah, 2022). The research was conducted in May - June 2023 at SMAN 22 Surabaya in the academic year 2022/2023. The subjects of this study were experimental class students (XI science 2) totaling 35 students, replication 1 (XI science 4) totaling 32 students, and replication 2 (XI science 5) totaling 31 students.

The three classes before the learning activities were given an initial test, then given treatment using the PBL model assisted by Phypox. After the treatment, students were given a final test. The final test was used to inform the improvement of students' CTS with the model used in SMAN 22 Surabaya students on the subject of the doppler effect.

Learning was conducted for 3 meetings. The research was conducted using learning tools based on the PBL model in the form of lesson plans, Learner Worksheet, Slide Presentation, and CTS test questions. The research instruments included tests in the form of pre-test and post-test of 5 questions based on critical thinking skills indicators as well as response questionnaires and observation sheets. Learning is said to be effective if, there is an increase in the average value of students' CTS statistically significant at 5% alpha; and then The average n-gain value is at least moderate category; the average n-gain is not different in the two replication classes.

Devices in the form of lesson plans, Learner Worksheet, teaching materials, and test questions were validated by three validator lecturers. Validation is done by providing a validation sheet regarding the device used. The validation percentage was obtained using a Likert scale. Analysis of students' CTS using n-gain is interpreted by Table 2.

**Table 2.** n-gain criteria

| Value (g) | n-gain criteria |
|---|---|
| n-gain ≥ 0.7 | High |
| 0.7 > in-gain ≥ 0.3 | Medium |
| n-gain > 0.3 | Low |

The Wilcoxon test was used in this study because there were two classes whose data were not normally distributed (Trullàs et al., 2022). The Wilcoxon test is a nonparametric statistical test used to compare two groups of related data (Lonergan et al., 2022). In this study, the Wilcoxon test was used to determine whether there was significance in the value of CTS.

Due to the fact that there was one class that had data that was normally distributed, the paired sample t-test was used in this inquiry (Houghton, 2023). Researchers have the ability to compare sets of data that are comparable via the use of parametric tests such as the paired sample t-test (Ernawati et al., 2022). For the purpose of determining whether or not the CTS value was statistically significant, the paired sample t-test was used in this investigation. In the context of dealing with data that is not normally distributed, the Kruskal-Willis Test is used to ascertain whether or not the CTS values of the three classes differ considerably from one another.

## Result and Discussion

The learning device before use was tested by three physics validator lecturers of STKIP Al Hikmah Surabaya. The results of the device validation test are shown in Table 3. The results of device validation in table 3 show valid criteria in the lesson plan, questionnaire and CTS questions so that it is feasible to use for learning activities. Initial activities before learning using the PBL model assisted by Phypox, students took a pre-test as initial information about critical thinking skills in the three classes.

**Table 3.** Device validity results

| Research aspects | Average rating | Criteria |
|---|---|---|
| Teaching Plan | 3.0 | Valid |
| Questionnaire | 3.1 | Valid |
| Question CTS | 3.2 | Valid |

The Phypox application is used in the data collection process on the subject of the doppler effect. Before students start learning, the first step is to install the phypox application through Google Play store. Then

students choose the doppler effect option menu and the features appear as shown in Figure 3.


**Figure 3**. Phypox application view when used to collect data using the doppler effect option

Based on research conducted by (Putri et al., 2022; Sari et al., 2023; Suganda et al., 2022) the phypox application is effective for stimulating students in improving critical thinking skills on sound wave material, compared to students who do not use the phypox application.

Students performed a post-test to determine their final CTS after finishing treatment utilizing the PBL paradigm with Phypox. This was done after each of the three classes had undergone therapy. The results of the exams of critical thinking skills that were given in XI SCIENCE 2, SCIENCE 4, and SCIENCE 5 are shown in Table 4, which gives the average scores.

**Table 4.** Mean scores of Pre-tests and Post-test of the three classes

| Class | Pre-test | Post-Test |
|---|---|---|
| XI Science 2 | 39.00 | 87.00 |
| XI Science 4 | 36.00 | 89.00 |
| XI Science 5 | 35.00 | 86.00 |

Table 4 shows the pre-test and post-test scores of the three classes. The average scores of the three classes before the treatment were 39, 36 and 35. After the treatment, the average CTS of students increased to 87, 89, and 86. Furthermore, table 5. shows the average in-gain results of the three classes.

**Table 5.** average in-gain of CTS 3 Classes

| Class | Average in-gain |
|---|---|
| XI Science 2 | 0.80 |
| XI Science 4 | 0.83 |
| XI Science 5 | 0.78 |

Table 5 shows the average difference in the results of critical thinking skills in three classes with the same treatment obtained by XI science 2 class with an average n-gain of 0.80 than the average in-gain of XI science 4 class of 0.83 and XI science 5 of 0.78. This shows that all classes treated with the problem-based learning model assisted by phypox have different improvements. Next, the normality test was conducted. The results of the normality test are listed in table 6.

**Table 6.** Normality Test

| Class | Sign | Information |
|---|---|---|
| XI Science 2 | 0.12 | Not Normal |
| XI Science 4 | 0.70 | Normal |
| XI Science 5 | 0.06 | Not Normal |

In table 6, it is obtained that class XI science 2 and class XI science 5 are not normally distributed, the value is less than 0.05 which means the data is categorized as abnormal. Therefore, the two classes will then do the Wilcoxon test. Wilcoxon test results are listed in table 7.

**Table 7.** Wilcoxon test

| Class | Sign | Description |
|---|---|---|
| XI Science 2 | 0.13 | Accepted |
| XI Science 5 | 0.13 | Accepted |

In accordance with the data shown in table 7, the significance of the two groups is 0.03. This implies that the variance of the data is less than 0.05, which means that a significance of CTS may be attained depending on whether or not the value of Asymp.Sig. (2-tailed) is less than 0.05. The problem-based learning approach that was made feasible by phypox is directly responsible for the improvement in students' critical thinking ability that occurred in XI Science 2 and XI Science 5. Since the data follows a normal distribution, the next step is to perform the Paired t-test for the fourth science class in the eleventh grade. Table 8 presents the findings of the paired t-test that was conducted.

**Table 8.** Paired t-test

| Class | Sign | Description |
|---|---|---|
| XI Science 4 | 0.02 | Accepted |

Table 8 shows a significance value of 0.02, so if the Sig. (2-tailed) is less than 0.05 then there is a significance of CTS. This means that the problem-based learning model assisted by phypox is able to improve students' critical thinking skills in class XI Science 4. Then to find out the difference in the increase in CTS between each class whose data is not normally distributed, the researchers conducted a non-parametric ANOVA test,

namely the Kruskal Waillis Test. The results of the Kruskal Waillis test are listed in table 9.

**Table 9.** Kruskal Waillis Test

| Class | Sign | Description |
|---|---|---|
| XI Science 2, 4 and 5 | 0.32 | Accepted |

Table 9 informs that the significance number obtained is 0.32; which is less than 0.05. This shows that there is no difference in the improvement of students' critical thinking skills in the three classes. This implies that the model used during learning activities is effective in improving students' critical thinking skills.

One learning approach that has received attention is problem-based learning (Pnevmatikos et al., 2023; Rézio et al., 2022). PBL encourages students to learn through the exploration of real-world problems that are relevant to everyday life. In the context of science education, PBL encourages students to identify problems, design and conduct experiments, and find solutions based on the scientific knowledge they have learned (Kaczkó & Ostendorf, 2023; Nurdiana et al., 2023; Park et al., 2023).

According to the findings of the data analysis, the critical thinking skills of high school pupils are greatly improved when they are taught physics utilizing the projects-based learning (PBL) method with the assistance of Phypox. The results of this study are consistent with the findings of earlier studies that have attempted to investigate the influence that PBL models have on CTS. Based on research conducted by Nurjanah and Trimulyono (2022), the PBL paradigm is characterized by its emphasis on student-centeredness and its promotion of critical thinking. At SMA Unggul Negeri 4 Palembang, students' critical thinking skills were improved by the implementation of problem-based learning, according to research conducted by (Wulandari et al., 2020). According to the findings of a study (Fiqriah et al., 2022) that was conducted, the use of the problem-based learning paradigm in conjunction with learning support software has the potential to dramatically improve the critical thinking skills of students. According to Yahdi et al. (2020), the problem-based learning paradigm has a deeper and more significant influence on critical thinking skills (CTS) than the standard learning model does. Using the problem-based learning paradigm with Phypox resulted in a 3% increase in the students' knowledge and skills (KBK) (Saputro et al., 2022). According to Priska et al. (2021), the problem-based learning (PBL) method is based on real-world, everyday problems. These challenges are unstructured and open-ended, which gives students the opportunity to enhance their skills, find solutions to these problems, and think critically. After studying physics using a problem-based learning method and utilizing Phypox as an adjunct, the cumulative test score (CTS) of high school students is much higher than before. According to the findings of this research, teachers may be able to assist their students in developing greater critical thinking skills by using the problem-based learning paradigm with the use of Phypox. Issue that remains unanswered is whether or not the teacher is equipped with all of the tools that are required for more implementation in the future.

## Conclusion

According to the findings of the data analysis, the critical thinking abilities of students at SMAN 22 Surabaya were greatly improved when they were taught physics via the use of a problem-based learning paradigm using Phypox. The students' increased performance on both the pre-tests and the post-tests, a high average n-gain, and the fact that there were no significant changes in the students' critical thinking skills across the three courses all provided evidence in favor of this assertion.

**Acknowledgments**

Thank you to all participant who contributed to this research, especially teacher and student in Senior High School 22 Surabaya who have provided facilities this research and also Physics Education Study Program, STKIP Al Hikmah Surabaya who have facility to conduct and completing this article.

**Author Contributions**

The research team contributed to the writing of this scientific work, namely: idea, conception, data collection, analysis and interpretation of results, drafting of manuscript, K. L. P.; Guidance in writing articles, T. N. A., and reviewing before submitting F. H.

**Funding**

This research received no external funding.

**Conflicts of Interest**

The authors declare no conflict of interest.

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