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# STEM-BASED PHYSICS LEARNING MODEL TO IMPROVE CRITICAL THINKING SKILLS OF BUDI DARMA UNIVERSITY STUDENTS

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**ABSTRACT**

This study aims to analyze the effectiveness of STEM (Science, Technology, Engineering, and Mathematics)-based physics learning models in improving students' critical thinking skills. Using quantitative and qualitative approaches, this study involved two groups of physics education students in the second semester at Budi Darma University, namely an experimental class using a STEM-based model and a control class using conventional methods. The research instruments include pretest and posttest, observation, and interview. The results showed a significant improvement in critical thinking skills in the experimental group compared to the control group. These findings show that the STEM approach can be used as an effective strategy in developing high-level thinking skills in students.



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## INTRODUCTION

Physics is one of the disciplines that has an important role in the development of science and technology. As part of science, physics not only focuses on understanding basic concepts, but also trains students in critical thinking, problem-solving, and real-life application of theories. In physics learning, critical thinking skills are needed because students are required to be able to analyze phenomena, make inferences, and evaluate the results of experiments and theories they learn. However, some studies show that conventional learning methods that are still dominant in universities are not able to encourage students to develop critical thinking skills optimally.(Firdausi Nuzula and Budi Jatmiko 2023; Putra, Asrizal, and Usmeldi 2023; Rida Rahmawati, Suyidno 2024; Siti Nurhabibah Hutagalung, Anda Yanny 2020)(Agustina et al. 2022; Ayudha and Setyarsih 2021)

In this context, STEM-based learning offers innovative solutions with a more applicative and contextual interdisciplinary approach. This study examines the extent to which the application of STEM-based physics learning models can improve students' critical thinking skills.(Astawan et al. 2023; Borovský, Hanč, and Hančová 2024; Charles and Gwilliam 2023; Lane, Galanti, and Rozas 2023)

The STEM approach integrates science, technology, engineering, and mathematics to encourage problem- and project-based learning. This model has been shown to be effective in improving conceptual understanding and critical thinking skills at various levels of education.(Astawan et al. 2023; Charles and Gwilliam 2023; Ielda Paramita, Gustina 2021)

Critical thinking includes the ability to interpret, analyze, evaluate, infer and self-regulation. In

Doi: 10.54209/edumaniora.v4i01.94

Pages: 38-42

the context of learning physics, this ability is important for understanding concepts, analyzing experimental data, and solving complex problems(Ashidiq et al. 2024; novia krisetyaningrum 2023; Sathishkumar et al. 2022; Siti Fatimah et al. 2024)
Studies have shown that STEM-based learning is able to improve students' critical thinking skills through collaborative, exploratory, and contextual activities (Hanifah, Suwarma, and Rusnayati 2023; Nuraeni et al. 2024; Putra, Asrizal, and Usmeldi 2023)

## METHODS

### Place and Time of Research

The implementation of the research was carried out in the Physics learning process at Budi Darma University, the time for the implementation of the research lasted for 6 months.

### Research Methods and Design

The description of the research stages is as follows:

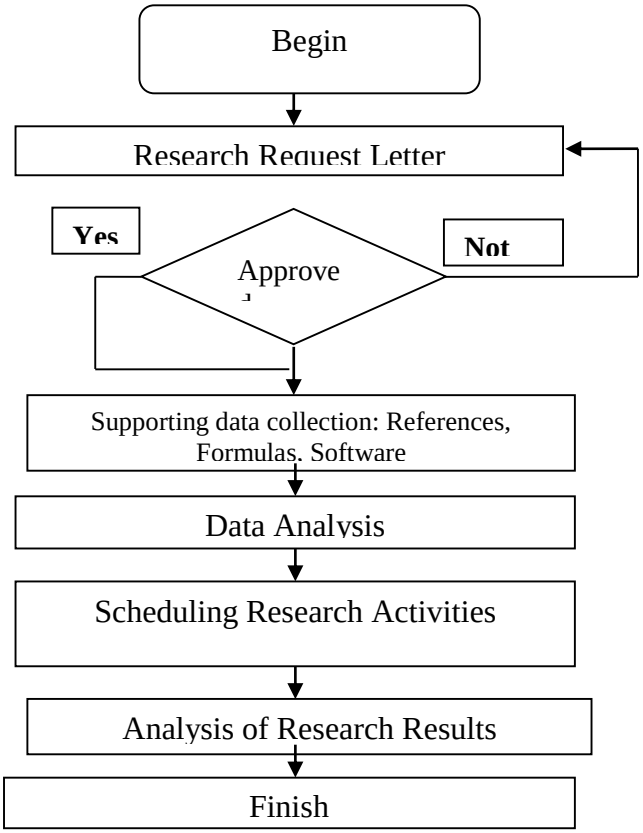


**Figure 1.** Flow Chart of Research Implementation Methods

## RESULTS AND DISCUSSION

This study aims to determine the effectiveness of the STEM-based physics learning model in improving the critical thinking skills of Budi Darma University students. The subjects of the study were 30 students in the second semester of the Physics Education study program which were divided into two groups: experimental class (using a STEM-based learning model) and a control class (using a conventional model).

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Doi: 10.54209/edumaniora.v4i01.94

Pages: 38-42

Table 5.1 Average Pretest and Posttest

| Group | Pretest | Posttest | Gain Score | Category: Gain |
|---|---|---|---|---|
| Eksperimen | 52,3 | 81,7 | 0,62 | Medium - High |
| Control | 50,9 | 67,5 | 0,33 | Low - Medium |

The calculation of score gain showed that the improvement of students' critical thinking skills in the experimental class was higher compared to the control class. This shows the positive influence of the STEM-based learning model.

The results of the observation showed that students in the experimental class were more active in discussing, asking questions, and analyzing contextual physics problems. The interviews also indicated that the STEM-based approach helped them understand the interplay between physics theory and its real-life application.

## DISCUSSION

The STEM-based physics learning model has been proven to improve students' critical thinking skills. This is because the STEM approach encourages integration between science, technology, engineering, and mathematics in solving real problems. Learning activities are designed on a project-based basis that demands analysis, evaluation, and decision-making, which are key elements of critical thinking.

STEM-based learning integrates Science, Technology, Engineering, and Mathematics in a single unit. In the context of physics courses, students not only learn physics concepts, but also apply technology, make simple designs, and calculate quantitatively. This process requires students to analyze problems from various points of view and come up with rational solutions.

Students in experimental classes are involved in problem-based projects such as designing simple props or simulating physical phenomena using software. This activity trains students to:

- Critically analyze information,
- Identifying assumptions or logical errors,
- Evaluate alternative solutions, and
- Communicate results scientifically.

STEM provides a tangible context that stimulates student engagement and curiosity. When students understand that physics can be used to solve real-world problems, they are more motivated to think deeply and critically.

The results of this study imply that the approach to learning physics in higher education needs to be designed more contextual and interdisciplinary. The application of STEM-based models can be used as an alternative to create a more challenging and meaningful learning experience.

## CONCLUSION

Based on the results of the research and data analysis that has been carried out, it can be concluded that: The STEM-based physics learning model significantly improves the critical thinking skills of Budi Darma University students compared to conventional learning models. The improvement in critical thinking ability can be seen from the difference in higher pretest and posttest scores in the experimental group, with a gain value of 0.62 (medium-high category), compared to the control group with a gain of 0.33 (low-medium category). Statistical analysis using the t-test yielded a $p<$ value of 0.05, which suggests that the difference is statistically significant. The application of STEM approaches in physics learning encourages students to actively think analytically, evaluate information, solve contextual problems, and develop creative solutions.

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Doi: 10.54209/edumaniora.v4i01.94

Pages: 38-42

## REFERANCE

Agustina, Heni, Syahrial A, Susilawati Susilawati, and I Wayan Gunada. 2022. "The Effect of the Use of Problem-Based Learning Physics Modules on Students' Critical Thinking Skills." *Scientific Journal of the Education Profession* 7(3): 1208–18.

Ashidiq, Rizki Maulana et al. 2024. "Investigating the Impact of STEM Learning on Students ' Critical Thinking Skills through Hand-Made Projector Activity." *journal of sciences learning* 7(September): 187–203.

Astawan, I. G. et al. 2023. "Stem-Based Scientific Learning and Its Impact on Students' Critical and Creative Thinking Skills: An Empirical Study." *Jurnal Pendidikan IPA Indonesia* 12(3): 482–92.

Ayudha, Churoni Fryda Hajar, and Woro Setyarsih. 2021. "Literature Study: An Analysis of Physics Learning Practices in High School to Practice Problem-Solving Skills." *Journal of Physics Education Undiksha* 11(1): 16.

Borovský, D., J. Hanč, and M. Hančová. 2024. "Innovative Approaches to High School Physics Competitions: Harnessing the Power of AI and Open Science." *Journal of Physics: Conference Series* 2715(1).

Charles, Tessa, and Carl Gwilliam. 2023. "The Effect of Automated Error Message Feedback on Undergraduate Physics Students Learning Python: Reducing Anxiety and Building Confidence." *Journal for STEM Education Research* 6(2): 326–57.

Firdausi Nuzula, and Budi Jatmiko. 2023. "Physics Learning with a STEM-Based PBL Model to Improve the Critical Thinking Skills of High School Students." *Student Scientific Creativity Journal* 1(5): 311–23.

Hanifah, Luthfiyah Nur, Irma Rahma Suwarma, and Heni Rusnayati. 2023. "2-Application of STEM-Based Physics Learning to Sound Wave Materials on Problem Solving Skills of High School Students." *Proceedings of the National Seminar on Physics* 2(1): 203–8.

Ielda Paramita, Gustina, Wahyuni Laratu. 2021. "DEVELOPMENT OF STEM-BASED DIGITAL TEACHING MATERIALS TO INCREASE CRITICAL THINKING ABILITY OF STUDENTS IN INSTRUMENTATION PHYSICS MATERIALS." *Journal of Physics Education Online* 9(December): 56–63. http://jurnal.fkip.untad.ac.id/index.php/jpft.

Lane, W. Brian, Terrie M. Galanti, and X. L. Rozas. 2023. "Teacher Re-Novicing on the Path to Integrating Computational Thinking in High School Physics Instruction." *Journal for STEM Education Research* 6(2): 302–25. https://doi.org/10.1007/s41979-023-00100-1.

Married Krisetyaningrum, Dwi Yulianti. 2023. "Critical Thinking · STEM Education · STEM Based Learning." *Physics Education 8* (2): 109–23.

Nuraeni, F et al. 2024. "Examining Lesson Quality: An In-Depth Analysis of STEM-Based Lesson Design Crafted by Preservice Elementary Teachers." *journal of innovation in educational and cultural research* 5(2): 337–48. http://www.jiecr.org/index.php/jiecr/article/view/1369%0Ahttps://www.jiecr.org/index.php/jiecr/article/download/1369/225.

Putra, Nurhamdin, Asrizal Asrizal, and Usmeldi Usmeldi. 2023. "Meta-Analysis of the Influence of STEM on Physics Learning on Students' Conceptual Comprehension and Creative Thinking Skills." *Journal of Science Education* 12(3): 228–39. https://jurnal.uns.ac.id/inkuiri.

Rida Rahmawati, Suyidno, Qamariah. 2024. "Problem-Based Learning Model as a Strategy for Improving Students' Critical Thinking Patterns In." *Journal of Physics and Technology Education* 7 (April): 7–19. https://edu.ojs.co.id/index.php/jpm/article/view/425/508.

Sathishkumar, K. et al. 2022. "Enhanced Photocatalytic Degradation of Organic Pollutants by Ag–TiO2 Loaded Cassava Stem Activated Carbon under Sunlight Irradiation." *Chemosphere* 302(May): 134844. https://doi.org/10.1016/j.chemosphere.2022.134844.

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Doi: 10.54209/edumaniora.v4i01.94

Pages: 38-42

Siti Fatimah, Ani Rusiolwati, Edy Cahyono, and Rokhmaniyah. 2024. “STEM Learning in Higher Education: A Comparative Study of Science Curriculum in Singapore and Indonesia.” *International Journal of Scientific Multidisciplinary Research* 2(8): 1003–30.

Siti Nurhabibah Hutagalung, Anda Yanny, Sumiaty Adelina. 2020. "Electronics Workbench (EWB) Training in Physics Learning for Students at Citra Harapan Percut High School." *Journal of Social Responsibility Projects* 1(1): 9–11.

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