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# IMPLEMENTATION OF JUPYTER APPLICATION TO IMPROVE PHYSICS LEARNING AT UNIVERSITAS BUDI DARMA

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**ABSTRACT**

Physics learning often faces challenges in conveying abstract and complex concepts to students. To overcome this obstacle, the use of computing-based technology can be an effective solution. One potential technology is Jupyter Notebook, a web-based application that supports a variety of programming languages such as Python. This research aims to improve the effectiveness of Basic Physics learning by implementing Jupyter Notebook in the teaching process. The methods used include training, development of teaching materials, and learning evaluation. The results showed significant improvements in concept understanding, computational skills, and student involvement in the learning process.



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## INTRODUCTION

Basic Physics is a fundamental course in science and engineering. However, his learning often encounters obstacles due to the abstract nature of the concept. Technology-based learning innovations such as Jupyter Notebook can be a solution to clarify concepts through visualization and interactivity. Jupyter Notebook allows students to learn with code, simulations, and narratives in a single document. This study aims to evaluate the effectiveness of the use of Jupyter Notebook in Basic Physics learning at Budi Darma University (Du et al. 2024; González-Carrillo et al. 2021; Laipaka, Mustika, and Runda 2021; Pimentel et al. 2021)

Jupyter Notebook is a web-based platform that supports the integration of narrative text, code, and visualization. In the context of physics learning, this allows students to explore concepts directly through interactive simulations and data analysis. With Python libraries such as NumPy, SymPy, and Matplotlib, students can understand the relationship between theory and practice in physics in real-time(Borovský, Hanč, and Hančová 2024; Kim and Henke 2021; Lane, Galanti, and Rozas 2023; TOPSAKAL 2023; Tufino, Oss, and Alemani 2024b).

Several studies have shown that the use of Jupyter improves concept comprehension, student engagement, and digital literacy. Jupyter's integration in Basic Physics lectures supports active and collaborative learning that is oriented towards problem-solving.(Castilla and Peña 2023; Tufino, Oss, and Alemani 2024a)

The implementation of Jupyter Notebook in Basic Physics learning is expected to improve students' understanding of the material through a computational and visualization-based approach. In addition, the use of this tool is also in line with the needs of the digital era which demands students to have computing skills as part of their academic and professional

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competencies in the future (Borovský, Hanč, and Hančová 2024). With this technology-based learning platform, students can develop critical thinking, analytical, and adapt to technological developments that continue to develop in the world of education and industry(Nikitin et al. 2022; Purnama et al. 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:

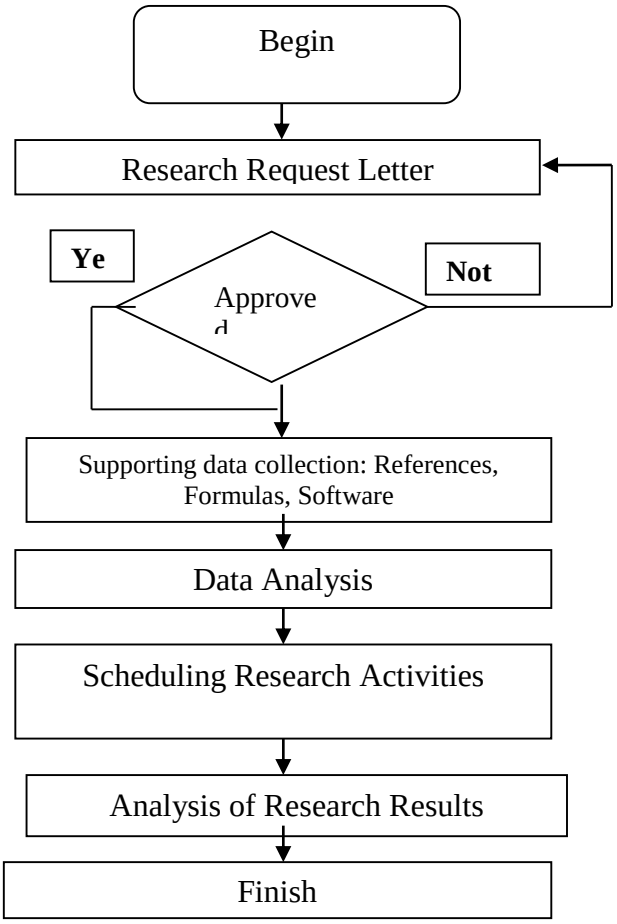


**Figure 1.** Flow Chart of Research Implementation Methods

## RESULTS AND DISCUSSION

This study aims to determine the effectiveness of the use of the Jupyter Notebook application in improving the process and outcomes of physics learning at Budi Darma University. The research was carried out on students in the second semester of the Physics Education Study Program with a quasi-experimental quantitative approach.

A total of 30 students were divided into two groups:

1. Experimental group using Jupyter Notebook-assisted learning (Python-based and interactive)
2. The control group used conventional methods (lectures and practice manual questions).

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Table 1 Pretest and Posttest Average

| Group | Pretest | Posttest | Gain Score | Category: Gain |
|---|---|---|---|---|
| Eksperimen | 51,2 | 83,4 | 0,66 | Medium - High |
| Control | 52,1 | 69,3 | 0,36 | Low - Medium |

The results of observations showed that students in the experimental class were more active in trying to simulate, discuss, and explore physics concepts through Python code in Jupyter. Interviews with several students stated that learning became more interesting, concrete, and easy to understand because it was supported by interactive visualizations and simulations.

## DISCUSSION

Jupyter Notebook is an interactive platform that is very suitable for use in modern physics learning. In this study, its use has a positive impact on improving students' understanding of concepts and learning motivation.

Jupyter allows a combination of text, code, visualization, and simulation in a single document. Students can directly run the code to see physics simulations such as parabolic motion or waves. This helps them understand the relationship between concepts and the results of observations digitally.

The increase in learning outcomes can be seen from the higher gain scores in the experimental group. This shows that students understand the material better when given interactive and computing-based learning media. In addition, the use of Jupyter also trains students' digital skills and logic thinking.

This research is in line with studies that state that the use of Python and Jupyter in science significantly increases students' engagement and understanding of scientific concepts (Birkenkrahe 2023; Charles and Gwilliam 2023; Purnama et al. 2023; Vallejo, Díaz-Uribe, and Fajardo 2022). The main challenge is the students' initial ability to understand Python syntax. However, this can be overcome by providing basic training, the use of code templates, and step-by-step guides in learning.

## CONCLUSION

Based on the results of the research and data analysis that has been carried out, it can be concluded that the use of the Jupyter application has proven to be effective in improving student learning outcomes, which is shown by a significant difference in pretest and posttest scores. The experimental group using Jupyter achieved a gain value of 0.66 (medium-high category), while the control group only 0.36 (low-medium category). Learning with Jupyter increases students' active participation, especially in exploring physics concepts through simulations, graphs, and simple Python-based programming. Jupyter supports the development of analytical thinking, problem-solving, and digital literacy skills, which are the demands of physics learning in the era of the Industrial Revolution 4.0. In general, the implementation of Jupyter creates a more interactive, visual, and applicative learning atmosphere, so that students can more easily understand abstract concepts in physics.

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