Virtual Instrumentation-Based Learning Media for Improving Scientific Reasoning Skills in Basic Physics Experiments

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Keywords
virtual instrumentation, physics laboratory, scientific reasoning, digital learning media, experimental physics

Abstract
The development of virtual instrumentation in physics education has opened new possibilities for enhancing students' scientific reasoning skills. This study aims to design and evaluate a virtual instrumentation-based learning media to support basic physics experiments in higher education. The media enables students to conduct simulated measurements, analyze experimental data, and interpret results through interactive interfaces. A quasi-experimental approach was applied involving undergraduate students enrolled in a basic physics laboratory course. Scientific reasoning skills were measured using pre-test and post-test instruments covering hypothesis formulation, data interpretation, and conclusion drawing. The results demonstrate a significant improvement in students' scientific reasoning abilities, indicating that virtual instrumentation can effectively substitute and complement conventional laboratory activities.

1. Introduction
Laboratory activities play a crucial role in physics education by providing opportunities for students to apply theoretical knowledge through experimentation. However, limitations such as inadequate equipment, time constraints, and safety issues often hinder optimal laboratory learning experiences.

Virtual instrumentation-based learning media offers an alternative solution by simulating laboratory equipment and experimental procedures in a digital environment. Through virtual experiments, students can develop scientific reasoning skills, including critical analysis, logical thinking, and evidence-based conclusion making.

2. Research Method
This research employed a quasi-experimental design with a one-group pre-test and post-test model. The participants were 30 undergraduate students enrolled in a basic physics laboratory course.

The virtual instrumentation media was developed to simulate fundamental physics experiments such as motion analysis and electrical measurements. Students interacted with the media during structured learning sessions.

3. Results and Discussion

The findings indicate a marked improvement in students' scientific reasoning skills. The average pre-test score increased from 45.2 to 80.1 in the post-test, resulting in an N-gain value of 0.64, categorized as high improvement.

Students demonstrated enhanced ability in formulating hypotheses, analyzing experimental data, and drawing logical conclusions. These results suggest that virtual instrumentation effectively supports inquiry-based learning in physics laboratories.

4. Conclusion

Virtual instrumentation-based learning media significantly improves students' scientific reasoning skills in basic physics experiments. The integration of such media provides flexible, safe, and effective alternatives to traditional laboratory practices.

References

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