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The Effectiveness of Guided Inquiry Learning Model with Digital Simulations to Enhance Students' Critical Thinking Skills in Physics

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ABSTRACT

Objective: *This study aims to determine the effectiveness of the guided inquiry learning model integrated with digital simulation in enhancing students' critical thinking skills on the topic of harmonic oscillation.* ***Method:*** *A quasi-experimental method with a pretest-posttest control group design. The participants were two Grade XI classes at SMAN 1 Pacet: the experimental group received guided inquiry learning with digital simulations, while the control group received guided inquiry learning without simulations. Instruments used included critical thinking skill tests (pre-test and post-test), classroom implementation observation sheets, and student response questionnaires.* ***Results:*** *The results showed that the implementation of learning in the experimental class was in the "outstanding" category, with an average score of 3.62 (89.5%). The paired t-test analysis indicated a significant improvement between pre-test and post-test scores in both the experimental (p=0.000) and control (p=0.003) classes, with mean score differences of 32.90 and 20.20, respectively. The N-Gain value of the experimental class was 0.68 (medium category), which was higher than the control class's N-Gain of 0.39 (medium category). Student responses toward the learning approach were highly positive, with an overall average 0f 82% in the "outstanding" category.* ***Novelty:*** *This study highlights the novelty of integrating PhET digital simulations into guided inquiry learning to foster critical thinking in physics education, specifically in understanding harmonic oscillation.*

INTRODUCTION

In the era of globalization and rapid technological advancement, 21st-century skills have become essential competencies for every student. One of the most important skills to be developed is critical thinking. Critical thinking can be defined as the ability to analyze ideas in detail, distinguish them clearly, identify, evaluate, and further develop them into more mature forms (Eka et al., 2024). This skill is crucial to ensure that students are prepared to compete in the future and capable of solving complex problems.

In science education, particularly in physics, critical thinking is not only vital for understanding abstract concepts but also for fostering scientific reasoning in addressing real-life challenges. Developing critical thinking requires the integration of multiple components of higher-order thinking, which allows students to approach problem-solving better (Saputra, 2020). Students' low critical thinking skills are currently influenced by various factors, such as teacher-centered learning patterns that tend to emphasize memorization (Fitriani et al., 2024; Lintangesukmanjaya et al., 2024). The lack of stimulus through questions or activities that encourage analysis and problem-solving, and a learning culture that prioritizes quick and correct answers over in-depth thinking (Angwaomaodoko, 2024).

Furthermore, the habit of accessing information instantly through technology makes students less accustomed to filtering, studying, and critically processing data. Social