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Physics Learning with the Problem Based Learning (PBL) Model Based on Electronic Liveworksheets to Improve Critical Thinking Skills

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ABSTRACT

Objective: This study aims to determine the effectiveness of the Problem-Based Learning (PBL) model based on electronic liveworksheets in improving students' critical thinking skills. **Method:** This research employed a quantitative quasi-experimental design with a pre-test and post-test control group. The study subjects were 64 eleventh-grade students from SMA Negeri 1 Bluluk, divided into an experimental class (PBL with electronic liveworksheets) and a control class (conventional PBL), each consisting of 32 students. Research instruments included learning implementation observation sheets, critical thinking skills test questions, and student response questionnaires. Data were analyzed using prerequisite tests (normality and homogeneity) and hypothesis tests (paired t-test, N-Gain, and Effect Size). **Results:** The results showed that the learning implementation reached a "Very Good" category with a percentage of 93.2%. The experimental class demonstrated a higher improvement in critical thinking skills with an N-Gain value of 0.50 (medium category) and an Effect Size of 0.70 (medium category), both of which were greater than those of the control class. Student responses to the use of electronic liveworksheets were also very positive, with all aspects receiving percentages above 85%. **Novelty:** The novelty of this research lies in the successful integration of the PBL model with electronic liveworksheets, which effectively overcomes the limitations of conventional PBL, such as time inefficiency and delayed feedback. This integration provides an interactive dimension and instant feedback that significantly increases student motivation, engagement, and critical thinking skills, making it an innovative and relevant solution for 21st-century learning.

INTRODUCTION

In the digital era, physics learning faces significant challenges in integrating technology into the teaching and learning process while simultaneously developing students' critical thinking skills. Technology is expected to function not only as a simple tool but also as an effective learning medium to enhance understanding of complex scientific concepts. One fundamental concept in physics that often confuses students is the difference between temperature and heat. Many students have difficulty distinguishing between these two concepts and understanding their relationship (Alwan, 2019). This emphasizes the need for a learning approach that allows students to explore real-world phenomena, critically analyze data, and apply their understanding to everyday life.

Critical thinking skills are one of the essential 21st-century competencies that need to be developed. According to Facione (2011), critical thinking encompasses several key aspects, such as interpretation, analysis, evaluation, inference, explanation, and self-regulation. This competency is crucial in understanding physics concepts, including temperature and heat, as it helps students process information systematically, draw conclusions based on evidence, and build a deeper understanding. However, research