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Designing Joyful Fraction Learning Using PhET Simulation to Support SDG 4 in Primary Schools

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ABSTRACT

Objective: To develop and evaluate the effectiveness of PhET Simulation-based learning media in creating joyful mathematics learning, particularly for teaching fractions to primary school students, while supporting the implementation of SDG 4 (Quality Education). **Method:** Research and Development (R&D) approach using the Four-D (4D) development model, consisting of the define, design, develop, and disseminate stages. Data were collected through observation, evaluation, and reflection. The participants were 20 fourth-grade students from a public elementary school in Pekanbaru. The effectiveness of the developed learning media was assessed based on students' engagement and learning experiences during the implementation. **Results:** The findings revealed that the PhET Simulation-based learning media effectively enhanced students' interest and active participation in mathematics learning. Students reported feeling more motivated and challenged during the learning process. Furthermore, the interactive visualization provided by the simulation enabled students to better understand fraction concepts by transforming abstract mathematical ideas into concrete learning experiences. **Novelty:** Introduces a joyful learning approach by integrating PhET Simulation into fraction instruction for primary school students. The research demonstrates that interactive simulation-based learning media can improve conceptual understanding and student engagement, providing an innovative instructional strategy to support quality mathematics education in primary schools.

INTRODUCTION

Nowadays, technical innovations are becoming more complex and advanced (Appio et al., 2019; Baykara et al., 2015; Hossain et al., 2022; Lu et al., 2024). They have addressed every area of human existence, including education. Technology in the sphere of education is regarded as vital since it will improve learning activities (Nepo, 2017). Technology can help students optimize their potential and progress, preventing them from falling behind in learning activities. However, as technology has advanced, it has not been extensively used equitably in Indonesian education and learning, particularly mathematics (Mailizar et al., 2020). Mathematics is a discipline of science that examines abstract things and, as a result, emphasizes how people think (Antonio & Prudente, 2024; Koparan et al., 2023; Thanheiser, 2023). Mathematics education aims to help students improve their skills and use them in real-life situations (More, 2018).

Fractions are one of the contents taught in mathematics classes. Fractions are a difficult subject for elementary school students to grasp because their knowledge of natural numbers cannot be instantly applied to understanding fractions (Oktasari et al., 2022). Students must be able to have conceptual changes or praxeological changes (Afriyani et al., 2018; Prediger, 2011). According to Charalambous and Pitta-Pantazi, the fraction construction consists of five constructions: part-whole, ratio, operator, quotient, and measure. The part-whole concept refers to an object that is continuously divided into