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Integrating interactive simulations to enhance conceptual understanding in introductory physics courses – a case study

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ABSTRACT

This study investigates the impact of interactive simulations as a pedagogical tool in introductory physics courses for first-year undergraduate engineering students at the Polytechnic University of Tirana. The primary objective of this tool is to enhance conceptual understanding and student active engagement by integrating virtual simulations besides traditional teaching methods. In order to assess their effectiveness, a study was conducted involving two groups of students enrolled in two different study programs with the same physics subject syllabus: a control group, which followed a traditional lecture-based approach, and an experimental group, where interactive simulations played a central role in classroom activities. The study focused on electromagnetism, taught on second semester of the first year. The data were collected through an end-of-semester test as well as continuous teacher observations throughout the semester. Findings through the test results and observations indicated that the group that was actively engaged with simulations demonstrated stronger conceptual retention and problem-solving abilities compared to the control group which was taught exclusively through traditional methods. Moreover, observations showed that students in the experimental group had greater motivation and a more intuitive grasp of abstract concepts, suggesting that simulations help bridge the gap between theory and practice. Key factors that made this approach successful include the thoughtful design of simulations, which challenged students at the right level, the opportunity to work together and exchange ideas, and the guidance provided by instructors to help them navigate complex concepts. These elements worked together to create a more engaging and supportive learning environment, allowing students to develop a deeper and more intuitive understanding of the material.

Keywords: motivation, physics, self-discipline, traditional teaching, virtual simulations