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Advancing SDG 4 through Contextual Robotics Learning Devices to Enhance Technical and Problem-Solving Skills in Vocational Education

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ABSTRACT

Objective: To development of a comprehensive robotics learning device package for vocational engineering education based on Contextual Teaching and Learning (CTL) principles. This research contributes to Sustainable Development Goal 4 (SDG 4) by promoting quality education through innovative, contextual, and competency-based learning approaches that support technical skill development and problem-solving abilities. **Method:** The research employed a Research and Development (R&D) methodology guided by the 4-D model (Define, Design, Develop, Disseminate) and the ADDIE framework. The developed learning package consists of six components: Mechanical Robot Module, Electronics Robot Module, Software Robot Module, Student Worksheets (LKPD), Learning Evaluation Instruments, and Robotics Practicum Guide. Validation was conducted by experts, followed by initial student trials to evaluate feasibility and learning responses. **Results:** Expert validation across seven aspects resulted in an average feasibility score of 86.6%, categorized as Very Feasible. Initial student trials demonstrated positive responses, showing improvements in learning engagement, module attractiveness, instructional interactivity, and robotics skills through contextual project-based problem-solving activities. The developed learning package achieved an overall research achievement rate of 90.6%. **Novelty:** The study provides a novel contribution by integrating CTL principles into a comprehensive robotics learning device package that connects theoretical knowledge with real-world industrial applications. The findings highlight how contextual technology-based learning supports SDG 4 by strengthening quality vocational education, enhancing student competencies, and preparing learners for industry-oriented challenges.

INTRODUCTION

Robotics education in the modern era demands an approach that goes beyond theoretical mastery to encompass problem-solving capabilities and real-world relevance (Walter, 2024). The rapid proliferation of mobile robots in industrial applications from intelligent transport systems and entertainment venues to hazardous environments such as nuclear waste disposal and bomb disposal has created an urgent need for graduates equipped with robust, industry-relevant competencies (Khanlari, 2016). In Indonesia, the development of robotics has been prominently showcased through national competitions such as the Kontes Robot Nasional (KRN), Kontes Robot Terbang Indonesia (KRTI), and Kontes Robot Indonesia (KRI), with more than 40 leading universities participating. However, this competitive momentum has yet to be fully translated into structured, practical learning devices that address real industrial challenges (Zuhrie et al., 2017). Conventional, instructor-centered teaching methods that are anchored to textbooks tend to make robotics concepts feel abstract and disconnected from students' lived experiences, ultimately diminishing learning motivation (Azevedo et al., 2017).