A Non-Parametric Analysis of Engineering Competencies in Primary and Lower Secondary Students via a Project-Based Learning Framework: A Case Study of the iDektep Program

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Abstract:

This study aims to develop engineering competencies in primary and lower secondary school students through project-based learning grounded in a competency-based education (CBE) framework. The instructional model emphasizes problem-solving, systems thinking, and hands-on learning. The iDektep initiative, a project under the Faculty of Engineering at Kasetsart University, was employed as a case study. Engineering skill development in children aged 7–15 is essential for preparing them for a technology-driven world, fostering creativity and innovative design thinking from an early age. The study identified eight core engineering competencies: systems thinking (SK01), creative thinking (SK02), design and user experience (SK03), analytical thinking (SK04), programming (SK05), technological literacy (SK06), leadership (SK07), and resilience (SK08). The competency development process showed statistically significant improvements in students' performance. Using the The Mann–Whitney U test, no significant differences were found across gender in all eight competencies. When comparing students across five learning cohorts in the "Level 1: Fundamental Digital Robot" program, and across age groups (6–9, 10–12, and 13–15 years) by using The Kruskal–Wallis Test, results indicated that design and user experience (SK03) and programming (SK05) skills did not differ significantly at the 0.01 significance level. This suggests that the learning approach effectively enhances design and programming skills regardless of age group or cohort, and that both male and female students can successfully develop all eight competencies. However, further refinement of learning activities is recommended, particularly to strengthen analytical thinking and other underdeveloped skills.

Keywords:

Engineering Competencies, Project-Based Learning, Competency-Based Learning, Robotics Education.