

The Significance of Integrating Engineering Design-Based Instruction in STEM Education

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*“Engineering is the closest thing to magic that exists in the world.”
-Elon Musk*

ENGINEERING design-based learning activities can successfully spark students’ interest in real-world issues by motivating them to apply their disciplinary knowledge in mathematics, science and more to analyze and solve problems identified (Uzel & Bilici, 2022). Generally speaking, problem identification and problem solving are the two primary steps in the engineering design process. Researchers assert that engineering design-based instruction (EDBI) is a novel paradigm of teaching, particularly valuable in inquiry-based instructional practices (Cooper et al., 2015). Research finds that the enactment of EDBI for addressing open, practical issues is substantially beneficial for increasing the problem-solving and design abilities of primary and secondary students (Crotty et al., 2017; Capobianco et al., 2018), and that EDBI implementation in STEM education can significantly improve students’ attitudes towards the STEM curriculum, promote their academic success, and support their 21st-century skills development (Moore et al., 2015).

Educators and researchers have actively engaged in practical explorations of applying EDBI to STEM education, especially to the science curriculum. For example, Aydoğan and Çakıroğlu (2022) experimented with using EDBI to help secondary school students to develop proper understanding of the nature of engineering for eliminating their misunderstandings and biases towards engineering and related professions and to enhance their interest in STEM study. Marulcu and Barnett (2013) integrated EDBI into fifth-grade science teaching by using LEGO materials to aid students in developing knowledge of basic mechanical theory and other scientific concepts. On the other hand, research also finds that engineering design is a complicated process, and that EDBI is subject to the

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influence of multiple factors. For instance, Aranda et al. (2018) discovered that even under the same EDBI modality, the variations in the teacher's dialogue tactics, classroom conversation patterns, and inter-student interactions may lead to different levels of student in-class engagement and learning outcomes. Hence, they recommended teachers to provide an environment that enables students to express their ideas, ask questions, and receive rich responses to their questions, which assists their construction or reconstruction of their understanding. According to Love et al.'s (2024) study, factors, including the number of course enrollments, the percentage of students with disability, the number of course preps, and the usage of tools with potential safety hazards, were associated with the incidence of accidents in EDBI. This finding serves as a caution to teachers that emergency plans and first aid training are imperatives for EDBI enactment.

Despite the widespread scholarly interest in the integration of EDBI into STEM education, there remains challenges in establishing it as a formal component of the school curriculum. The authors of *The Effect of Engineering Design-Based Instruction On 6th-Grade Students' Astronomy Understandings* in this issue adopted EDBI in their 6th-grade astronomy instruction and validated the effectiveness of the eight-week program. The research findings of the study reveal that the application of EDBI can significantly improve students' comprehension of core astronomical concepts (Başpınar et al., 2024). The study provides implications for how to incorporate EDBI into the current STEM curriculum, albeit that it has only investigated EDBI's promotive effects on the students' conceptual understanding without looking into its impact on other cognitive capacities of the students, such as critical thinking and creativity.

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