Chapter 15
STEAM Integration and Engineering:
Lessons From Transformative Approaches

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ABSTRACT

This study explores the theoretical roots and practical applications of STEAM (science, technology, engineering, arts, mathematics) integration in modern engineering education. The chapter emphasizes the importance of the arts in fostering creativity and innovation in technically oriented fields as well as the shift from STEM to STEAM. The study examines emerging technologies such as artificial intelligence (AI), virtual and augmented reality (VR/AR), and 3D printing for their potential to revolutionize educational methods by providing immersive and personalized learning environments that demystify complex scientific concepts. It also highlights challenges in assessing STEAM curricula by proposing new metrics for evaluating technical and creative skills, while considering how engineering impacts sustainability, equity, and diversity. In this chapter, interdisciplinary approaches such as project-based learning (PBL) and inquiry-based learning (IBL) are emphasized to prepare students for a technologically advanced, interconnected world.

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INTRODUCTION

Defining STEAM Education

STEAM education is emerging as an innovative educational approach that breaks down traditional boundaries between disciplines and cultivates a deeper understanding and more application-based learning of science, technology, engineering, art, and mathematics. The STEAM interdisciplinary learning model responds to the growing need to develop 21st-century skills in an increasingly complex and interconnected world (Perignat & Katz-Buonincontro, 2019). Through the integration of the arts into the traditional STEM framework, STEAM education enhances creativity, critical thinking, and innovation, thus preparing students for the challenges of the future (Liao, 2016). The STEAM approach aligns with the integration of technology into education and enables students to create immersive and engaging learning experiences through the use of digital tools and platforms.

The integration of innovative technologies into STEAM education has recently transformed the educational landscape, enabling students to engage in interactive simulations of complex scientific concepts and making abstract concepts more relatable and understandable (Henriksen, 2014). Among the most popular technologies in STEAM education are artificial intelligence (AI), virtual and augmented reality (VR/AR), 3D printing, and the Internet of Things (IoT). AI is leveraged to create personalized learning experiences and adaptive curricula, enhancing student engagement and outcomes (Holmes et al., 2019). VR and AR technologies are revolutionizing the way students interact with complex concepts, providing immersive experiences that bring abstract ideas to life (Radianti et al., 2020). 3D printing has become an invaluable tool in STEAM classrooms, allowing students to prototype and materialize their ideas, thus bridging the gap between digital design and physical creation (Trust & Maloy, 2017). The IoT is enabling interactive learning environments that are transforming traditional educational methodologies. The IoT enables interactive learning environments that transform traditional educational methodologies. Meylani (2024) demonstrates how IoT can enhance student engagement by collecting and analyzing real-time data, allowing students to gain a deeper understanding of interconnected systems and environmental factors through more personalized learning experiences. Additionally, coding and robotics have become integral components of many STEAM programs, promoting computational thinking and problem-solving skills (Ching et al., 2018). These technologies, when integrated thoughtfully into STEAM curricula, not only enhance learning experiences but also prepare students for the rapidly evolving technological landscape they will encounter in their future careers.