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# Intelligent Virtual Environment in STEM Education: A Systematic Literature Review for Sustainable Digital Learning

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## ABSTRACT

**Objective:** This study aims to analyze the development and application of Intelligent Virtual Environment (IVE) in STEM education to support sustainable digital learning. The study focuses on identifying research trends, technologies used, and the impact of immersive digital environments on STEM learning outcomes. **Method:** This research employed a Systematic Literature Review (SLR) approach to synthesize relevant studies published in the last five years. Articles were collected from several academic databases, including Scopus, Web of Science, ScienceDirect, IEEE Xplore, and Google Scholar. The selection process followed the PRISMA framework to ensure systematic identification, screening, eligibility assessment, and inclusion of relevant studies. A total of 15 articles were selected based on inclusion criteria related to immersive technologies, artificial intelligence, and virtual learning environments in STEM education. The selected studies were analyzed to identify research trends, technological approaches, and reported learning outcomes. **Result:** The results show that Intelligent Virtual Environment technologies, particularly those integrating virtual reality, augmented reality, and artificial intelligence, have been widely applied in STEM learning. These technologies improve conceptual understanding, student engagement, and interactive learning experiences. The findings also indicate that immersive learning environments support visualization of complex scientific concepts and encourage active learning through simulation and exploration. **Novelty:** This study provides a comprehensive synthesis of recent research on Intelligent Virtual Environment in STEM education and highlights its role in advancing sustainable digital learning. The review also identifies current research trends and future research directions for integrating immersive technologies and artificial intelligence in STEM education.

## INTRODUCTION

Digital transformation in education has become one of the most significant changes in the 21st century learning system. Developments in information technology, artificial intelligence, and immersive technology have driven the emergence of various learning innovations that aim to improve the quality of learning experiences and expand access to more inclusive and adaptive education. Modern education no longer focuses solely on the transfer of knowledge, but also emphasizes the development of critical thinking, problem-solving, collaboration, and digital literacy skills, which are essential competencies in facing today's global challenges. Therefore, the integration of digital technology in learning has become a strategic approach to improving the quality of education in the era of digital transformation.

Various studies show that the use of digital technology can increase student engagement, enrich the learning experience, and create a more interactive learning process compared to traditional learning methods. Virtual and interactive simulation-based learning technologies allow students to explore concepts in a more visual and contextual manner, thereby improving conceptual understanding and learning motivation (Radianti et al., 2020; Makransky & Petersen, 2021). In addition, immersive