Chapter 7
AI-Based Tutoring Systems in Education:
A Systematic Literature Review on Personalized Learning, Intelligent Agents, and Learning Analytics

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ABSTRACT

This systematic literature review examines the current state of AI-based tutoring systems in education, focusing on their roles in personalized learning, intelligent agent integration, and learning analytics within classroom instruction. A thorough analysis of 30 relevant studies reveals that AI-based tutoring systems significantly enhance educational outcomes by adapting learning experiences to individual needs through tailored feedback and customized learning trajectories, leading to improved student engagement and performance. Intelligent agents are central to these systems, providing social-emotional support, interactive feedback, and fostering motivation and deeper understanding. Learning analytics further support educators by enabling real-time monitoring of student progress, facilitating data-driven instructional adjustments, and ensuring timely, personalized support. Despite the progress, the study

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identifies ongoing challenges, particularly concerning ethical data use, scalability, and the need for integrating socio-emotional learning components.

1. INTRODUCTION

Artificial Intelligence (AI) has become a transformative force in education, providing new ways to engage students, personalize learning, and support teachers (Ahmed & Ganapathy, 2021). AI-based tutoring systems, in particular, have garnered attention for their ability to deliver tailored instruction through adaptive algorithms, learning analytics, and intelligent agents, significantly enhancing traditional educational methods (Koedinger et al., 2013). These systems not only help students learn at their own pace but also provide educators with valuable insights to optimize classroom management and support each student's unique learning journey (Crompton & Burke, 2023).

One of the most promising aspects of AI-based tutoring systems is their capacity for personalized learning. By analyzing individual progress and preferences, these systems adapt content, feedback, and learning trajectories to fit students' needs, leading to improved engagement, motivation, and academic performance (Walkington & Bernacki, 2014; Alharbi & Cristea, 2021). Adaptive learning technologies, such as those described by Aleven et al. (2016), adjust instructional pacing and complexity, enabling students to grasp complex topics with personalized support.

Another critical component of AI-based tutoring systems is the use of intelligent agents that simulate human-like interactions. These agents act as virtual facilitators, social companions, or even emotional support providers, enhancing the learning experience by making it more interactive and responsive to individual students' emotional and social needs (Dinçer & Doğanay, 2017; Nye, 2016). Such agents can foster socio-emotional connections, provide timely feedback, and even help students develop self-regulation skills, thereby promoting both academic and personal growth (Schroeder, Adesope, & Gilbert, 2013).

Furthermore, the integration of learning analytics within AI-based tutoring systems has revolutionized how educators manage classroom instruction. Learning analytics tools provide real-time data on student performance and engagement, enabling teachers to make data-driven adjustments and provide targeted support where needed (Bull et al., 2018). Systems like MTFeedback and MTDashboard have shown to be effective in enhancing group-based learning by tracking collaborative activities and providing insights into student interactions (Lawrence et al., 2022). These analytics capabilities empower educators to create adaptive learning environments that respond to the dynamic needs of their students (Mousavinasab et al., 2021).