


Chapter 11

Pedagogical Framework for Developing Students' Python Programming Competencies Using Intelligent Systems

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ABSTRACT

This chapter explores the use of intelligent learning systems to develop students' Python programming competencies in higher education. The research highlights how these systems provide automated assessment, personalized feedback, and gamified learning experiences that foster programming literacy, learner independence, and motivation. By demonstrating the effectiveness of intelligent systems in enhancing

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Python programming competencies, this chapter underscores the transformative role of artificial intelligence and machine learning in education. The results of this study clearly demonstrate that integrating intelligent learning systems into Python programming education significantly improves both the quality and efficiency of the learning process. The use of intelligent systems transforms traditional instructional models into adaptive, interactive, and learner-centered environments that align with the pedagogical demands of the digital age.

INTRODUCTION

In the twenty-first century, the rapid development of information and communication technologies (ICT) has had a profound impact on all sectors of society, including education. The increasing digitalization of modern economies has placed new demands on educational institutions to prepare specialists who are not only technically proficient but also capable of critical thinking, problem-solving, and adaptive learning. Among these emerging competencies, programming literacy has become a fundamental component of the digital skill set required in the contemporary workforce. Programming is now regarded not merely as a technical activity but as a universal cognitive skill that enables individuals to design, analyze, and implement solutions across diverse domains, such as artificial intelligence (AI), big data analytics, cybersecurity, cloud computing, and the Internet of Things (IoT).

The growing importance of programming education has prompted higher education institutions worldwide to reassess their curricula and instructional strategies. Traditional lecture-based and teacher-centered approaches often fail to address the diverse learning needs of students, particularly in large classes or online learning environments. As a result, there is an increasing need to adopt innovative pedagogical models and intelligent technologies capable of personalizing learning, automating assessment, and delivering timely feedback to enhance the overall learning experience.

Despite its accessibility, Python education continues to face several challenges. Traditional instructional methods, which rely heavily on lectures, manual code review, and static assessments, are often time-consuming and lack scalability. Instructors must devote substantial effort to evaluating assignments and providing individualized feedback, a task that becomes increasingly difficult as class sizes grow. Additionally, students learning under these conventional approaches often receive delayed or insufficient feedback, which can lead to frustration and diminished motivation. This mismatch between instructional demands and pedagogical capacity highlights the need for intelligent learning technologies that can effectively support both instructors and learners throughout the educational process.

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