

23 - 25 October 2026

Geneva , Switzerland

From Coding to Human–AI Collaboration: Rethinking Programming Education in the Age of Generative AI

Dr. Patrícia Szabó

University of Pannonia, Hungary

Abstract

Hypothesis: The widespread adoption of generative AI fundamentally changes the competencies required from software developers, making current programming-focused university curricula increasingly misaligned with industry needs.

The rapid development of generative artificial intelligence (GenAI) is transforming software development and challenging established assumptions about the competencies required from future computing professionals. AI-assisted development tools are increasingly capable of generating, explaining, debugging, refactoring, testing, and documenting code, raising an important educational question: if an increasing proportion of code-production activities can be supported or automated by AI, should higher education continue to teach programming in the same way?

This research presents a structured interdisciplinary literature review examining the implications of generative AI for programming and computing education. The review synthesizes recent literature across five interconnected domains: AI in Software Engineering, AI in Higher Education, Future Skills, Computing Education, and Human–AI Collaboration. Attention is given to empirical studies and systematic reviews published following the emergence of widely accessible generative AI systems. The analysis focuses on three questions: (1) which traditional software-development activities are increasingly supported by GenAI; (2) which human competencies become more important in AI-assisted development environments; and (3) whether current approaches to programming education remain aligned with these emerging professional requirements.

The reviewed literature suggests that GenAI should not be understood simply as a replacement for software developers. Evidence concerning productivity remains context-dependent: while controlled

research has demonstrated substantial productivity improvements in some programming tasks, other studies involving experienced developers working on complex, familiar codebases have reported productivity losses. At the same time, research on software-development practice indicates a broader transformation of developer workflows toward AI-assisted problem solving, code generation, evaluation, and collaboration.

The educational literature reveals a related tension. GenAI can provide immediate feedback, code explanations, debugging assistance, personalized support, and new opportunities for learning. However, recent reviews also identify risks associated with over-reliance on generated solutions, including reduced engagement with problem-solving processes, threats to assessment validity, and potential weakening of foundational programming and higher-order thinking skills. Consequently, the emergence of GenAI creates an educational paradox: students may need to write less code manually in future professional environments while simultaneously requiring deeper conceptual knowledge to evaluate, validate, correct, and take responsibility for AI-generated software.

Based on the literature synthesis, this paper argues that the central challenge for computing education is therefore not whether programming should disappear from university curricula, but how the purpose of programming education should change when code generation becomes increasingly automated. Future curricula should retain foundational programming, algorithms, computational thinking, and software-engineering principles while placing substantially greater emphasis on problem formulation, system design, AI literacy, verification and validation, security, critical evaluation, and effective human–AI collaboration.

The research concludes that generative AI should be understood not merely as another educational technology to be incorporated into existing programming courses, but as a potential catalyst for a broader redesign of computing education. The emerging objective may no longer be primarily to educate students who can produce code independently, but to educate computing professionals capable of understanding complex problems, directing AI-supported development processes, critically evaluating generated solutions, and maintaining human responsibility for increasingly AI-mediated software systems.

Keywords: Computing Education; Generative Artificial Intelligence; Human–AI Collaboration; Higher Education; Programming Education