

THE ARTIFICIAL INTELLIGENCE IMPACT ON STUDENTS' COMPETENCIES AND CRITICAL THINKING IN HIGHER EDUCATION

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Abstract

The rapid advancement of artificial intelligence (AI) is reshaping societal structures, yet higher education faces the challenge of integrating AI in ways that foster critical thinking and competence development. While students increasingly use AI tools to ease cognitive and workload demands, overreliance risks undermining independent analytical skills. Educational institutions must ensure that learning outcomes align with competent frameworks, emphasizing human-centered reasoning over AI-generated content. The EU Artificial Intelligence Act reinforces this responsibility by promoting ethical and responsible use of AI in education. First, this article provides an overview of studies conducted with students on the impact of AI use on learning programming. Second, it presents research on how lecturers in programming courses at universities of applied sciences introduce AI guidelines, encourage meaningful learning beyond mere reliance on AI, and foster critical thinking. Findings highlight the pivotal role of educators in designing strategies to support and assess student competencies within AI-enhanced learning environments.

Keywords: *Generative AI, critical thinking, development of competence, higher education studies.*

1. Introduction

The background of this article lies in the significance of critical thinking and competence development in higher education. The study aims to examine how AI's impact on students' critical thinking appears to programming lecturers. The article reviews previous studies on the development of students' critical thinking in programming courses. These studies provide insights into how students perceive the impact and relevance of AI use in their learning process and in fostering critical thinking.

In addition to these literature reviews, interviews were conducted with lecturers at universities of applied sciences. The purpose of these interviews was to explore lecturers' experiences regarding the effects of AI use on students' competence development and critical thinking during their first programming course.

The interviews also examined how lecturers inform students about the rules for AI use in a course, how they ensure that students genuinely learn rather than relying solely on AI-generated answers, and whether—and in what ways—students' critical thinking develops.

Based on interviews with lecturers and previous research with students, several factors have been identified that should be considered to promote critical thinking and competence development. This article summarizes these issues.

2. Generative AI and critical thinking

The rise of Generative AI tools such as ChatGPT and GitHub Copilot has introduced new possibilities for personalized learning, automated feedback, and adaptive instruction in higher education (Chen, Chen, & Lin, 2020; Crompton, Burke, Jordan, & Wilson, 2021). However, these benefits come with significant challenges for fostering critical thinking (CT). Generative AI often produces outputs that appear coherent and authoritative yet may contain inaccuracies or flawed reasoning, making CT essential for evaluating and validating information (Guo & Lee, 2023).

Critical thinking—defined as “purposeful, self-regulatory judgment” involving interpretation, analysis, evaluation, inference, and explanation (Facione, 1990; Ennis, 2011)—is a cornerstone of academic success and professional adaptability (Andreucci-Annunziata et al., 2023; Katsamakos et al., 2024). Without deliberate instructional strategies, reliance on AI can lead to superficial understanding and diminished problem-solving skills (Bennett & Abusaleem, 2024; Berg & Plessis, 202). Research emphasizes

that CT development requires active engagement with information, questioning assumptions, and applying knowledge in authentic contexts (Guo & Lee, 2023).

To address these challenges, educators should integrate Generative AI into curricula through structured activities that promote reasoning and reflection. Examples include requiring students to justify AI-generated solutions, compare outputs with human-created alternatives, and identify potential errors or biases (van den Berg and du Plessis, 2023). Assessment practices such as explanation-based tasks and project portfolios can further encourage students to demonstrate conceptual understanding rather than depend solely on automated tools (Zawacki-Richter et al., 2019). Ultimately, the goal is to leverage AI as a catalyst for deeper learning rather than a shortcut, ensuring that technological convenience does not compromise intellectual rigor.

3. Results from earlier research on students' experiences

This section synthesizes findings from prior research conducted with students. One study posed the following research questions: “In what ways can learning activities in an introductory programming course be redesigned to foster critical thinking practices when utilizing AI tools for coding?” and “What changes do these interventions bring about in students’ programming practices?” (Styve et al., 2024). The study explored how modern AI tools can be integrated into introductory programming courses in higher education, emphasizing their responsible and critical use. Students learned both the benefits and limitations of these tools as well as their own responsibility as programmers. The results show that AI tools and critical thinking can be combined in the curriculum, but additional measures are needed to strengthen students’ reasoning skills.

Students found GitHub Copilot helpful for routine tasks and code creation, but it does not replace a human co-programmer – rather, it complements one. ChatGPT performed reasonably well in code reviews but should be used only as a supplement to human reviews. Using AI tools requires students to understand the basics of programming languages to evaluate generated code. Assessment methods such as Project-based portfolios were found to better adapt to the AI era than traditional exams. Generative AI can produce seemingly trustworthy but incorrect information, making critical thinking the best tool for distinguishing reliable content from questionable sources. The study demonstrated that assignments can be designed to foster critical thinking when using AI tools, and this approach can be applied to other subjects as well.

Another study examined changes in students’ critical thinking (CT) practices after using Generative AI. This research aimed to evaluate shifts in students’ CT practices before and after the Generative AI lab and the submission of Phase 2 of the project. The method involved pre- and post-surveys. Standardized CT tests were not used; instead, the focus was on developing CT culture and practices. A key finding was that 12 statements led to the expected behavioral change, while seven did not. More detailed information can be found in the original article. (Naeem et al., 2025.)

These previous studies conducted by students concluded that critical thinking requires time and repeated interventions. Employers emphasize the lack of CT skills, underscoring their importance in the era of Generative AI. Misuse of Generative AI tools in higher education is a concerning issue, and educators are seeking ways to ensure that students use these tools responsibly without compromising the integrity of assessments or their fundamental understanding. Furthermore, it is essential to foster critical thinking, which can be achieved by creating active learning activities that incorporate Generative AI tools within the web programming curriculum and assessments.

4. Summary of interview findings with programming lecturers

This section synthesizes insights from interviews conducted with five information technology lecturers at Haaga-Helia University of Applied Sciences. All participants teach programming to IT students during their introductory programming course. The purpose of these interviews was to explore how students’ skill development and critical thinking evolved amid the increasing prevalence of artificial intelligence (AI) and whether notable changes have occurred compared to previous practices. Additionally, the lecturers were asked how they communicate responsible AI usage at the start of the course, how they ensure students do not rely on AI without understanding its outputs, and whether assessment methods have been adapted in response to AI integration.

4.1. Ensuring competence in the era of AI

Lecturers acknowledge that preventing the uninformed use of AI is challenging, particularly in large cohorts. Nevertheless, several strategies are employed to monitor and validate student competence:

- **Supervised Examinations and Interim Tests:** Final examinations are typically proctored and often conducted on paper, which quickly reveals if a student has over-relied on AI-generated solutions.
- **Explanation Tasks:** In some courses, students are required to explain code, enabling lecturers to assess genuine understanding.
- **Continuous Guidance and Feedback:** Ongoing instruction and formative feedback throughout the course help mitigate excessive dependence on AI.

Lecturers emphasize the importance of reminding students that overuse of AI may have adverse consequences during supervised assessments.

4.2. Impact of AI on skill development and critical thinking

While experiences vary, a shared concern emerges: AI use may diminish students' ability to apply learned concepts. Competence levels among students differ significantly. Some individuals continue to excel, whereas a substantial proportion underperforms in assignments and final examinations. AI reliance often manifests in overly complex code solutions that students cannot troubleshoot independently. Consequently, application skills suffer, and programming proficiency remains superficial when students depend excessively on AI. This becomes particularly evident in proctored examinations where AI tools are unavailable. The development of critical thinking is also perceived as problematic. Lecturers report encountering submissions with solutions that deviate markedly from taught methodologies—frequently indicative of AI involvement. When questioned, students do not consistently disclose their use of AI.

4.3. Adaptations in assessment practices

Although supervised, in-person examinations have retained their reliability, online teaching introduces new challenges. To address these, lecturers have implemented additional measures. In cases of suspected AI use during remote assessments, students may be asked to justify their responses; failure to provide a satisfactory explanation can result in a failing grade. Most lecturers continue to favor traditional paper-based examinations, where AI use is infeasible, as these effectively reveal overreliance on AI during the course. The primary challenge in online education lies in the impossibility of complete remote supervision. A proposed solution requires remote students to complete examinations on campus under controlled conditions.

4.4. Key message

AI is not merely a technological aid—it fundamentally reshapes learning dynamics and challenges established assessment practices. According to lecturers, excessive reliance on AI can impair critical thinking and application skills. Consequently, supervised examinations, explanation-based tasks, and continuous guidance have become essential strategies for safeguarding the authenticity of student competence.

5. Methods

The background literature for this article includes general perspectives on critical thinking, its development in higher education, and, more specifically, within programming studies. Additionally, the review covers artificial intelligence in general, its application in higher education, and its role in programming education.

This study employed a literature review of previous research. The primary purpose of the literature review is to map and evaluate existing studies, position the new research within its context, and justify the need for further investigation. It helps to understand what has already been studied on the topic and to identify the key questions and themes of the research. (Ferrari, 2015). The chosen format for the literature review is a descriptive literature review, which focuses on presenting and analyzing the topic. A research question guides a descriptive literature review and provides a qualitative answer based on the selected material. It aims to understand and describe the phenomenon, its background, and its significance. (Aveyard, 2019) Several studies examining the development of students' critical thinking when using artificial intelligence as a learning aid were reviewed to provide background for the investigation conducted with computing lecturers.

The research method for the lecturers' study was semi-structured interviews (Albaret & Deas, 2023; Magaldi & Berler, 2020; Fylan, 2005). The interviews were conducted via Microsoft Teams, recorded, and transcribed. This article presents a synthesized summary of the transcribed results, highlighting the key findings. The summary was prepared to ensure that individual interviewees cannot be identified.

6. Discussion

Prior studies indicate that integrating AI tools into programming education offers potential benefits but also introduces significant challenges. Research shows that AI can support learning when combined with critical thinking activities; however, students must understand programming fundamentals to evaluate AI-generated code effectively. Tools such as GitHub Copilot and ChatGPT proved helpful in routine tasks and code reviews, but they cannot replace human collaboration. Assessment methods like project-based portfolios appear more suitable than traditional exams in the AI era. Another study revealed that fostering critical thinking requires time and repeated interventions, as behavioral changes were only partially achieved. Employers continue to emphasize the importance of critical thinking, underscoring the need for responsible AI use and innovative teaching strategies. Overall, these findings highlight the need to design active learning activities and assessments that integrate AI tools without compromising conceptual understanding or academic integrity.

Interviews with five IT lecturers at Haaga-Helia University of Applied Sciences reveal that AI integration in programming education introduces both opportunities and challenges. While AI tools can support learning, excessive reliance often undermines students' ability to apply concepts and develop critical thinking. Lecturers report that some students struggle with troubleshooting and produce overly complex code, indicating superficial understanding. To safeguard competence, educators employ strategies such as supervised paper-based exams, explanation tasks, and continuous feedback. However, remote assessments remain problematic due to limited supervision, prompting proposals for on-campus examinations. Overall, lecturers stress that responsible AI use must be clearly communicated and that assessment practices must be adapted to ensure authentic skill development and maintain academic integrity.

7. Conclusions

Integrating AI into higher education offers clear benefits, but also poses challenges for authentic learning and assessment. Results from previous research and interviews with lecturers indicate that excessive reliance on AI can weaken students' programming skills and critical thinking, leaving them vulnerable in supervised environments where AI tools are not available. To mitigate these risks, institutions need to embed critical thinking in AI-enabled learning environments through iterative interventions, clear guidelines for responsible use of AI, and authentic assessments such as explanation-based assignments and project portfolios.

Students have a responsibility to develop their critical thinking skills and competencies throughout their higher education studies. They need to internalize this responsibility to ensure their competence upon graduation meets the standards set by higher education institutions. Lecturers, in turn, are responsible for ensuring that students' skills meet the learning outcomes set by higher education institutions and that their critical thinking reaches the required level. Achieving these goals requires higher education institutions to adopt new approaches to ensuring competence development and innovative methods for assessing it.

Future research should focus on scalable strategies for the responsible integration of AI across disciplines and examine its long-term impact on students' cognitive development and employability.

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