Guidelines for Integrating Generative AI Into Programming Education at The Diploma Level in Malaysian Polytechnics: Balancing Benefits and Risks

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Abstract. The integration of Generative Artificial Intelligence (GAI) in programming education offers significant benefits, including personalized learning, real-time feedback, and debugging support. However, improper use may lead to over-reliance, reduced problem-solving skills, and academic integrity concerns. This study develops structured guidelines for AI integration in diploma-level programming education at Malaysian Polytechnics, ensuring AI enhances learning without replacing fundamental programming competencies. A Systematic Literature Review (SLR), Semi-Structured Interviews with Educators, and Focus Group Discussions (FGDs) were conducted to identify best practices, challenges, and ethical considerations. Findings indicate that while AI improves learning efficiency and engagement, students often misinterpret AI-generated code or rely on AI without understanding programming concepts. Educators struggle with assessing AI-assisted work and ensuring academic integrity, necessitating revised assessments and AI literacy training. This paper proposed guidelines focusing on students using AI as a support tool rather than a substitute, educators integrating AI responsibly, and institutions establishing clear AI policies on ethics, data privacy, and assessment methods. A balanced approach, combining AI with traditional teaching and active learning strategies, is essential for maintaining critical thinking and programming skills. Future research should focus on pilot implementation of these guidelines, longitudinal studies on AI's impact, and AI-specific assessment development. By adopting these recommendations, Malaysian Polytechnics can effectively integrate AI into programming education, maximizing benefits while mitigating risks.

Keywords: generative AI, programming education, AI integration, academic integrity, AI literacy

INTRODUCTION

The rapid evolution of Generative Artificial Intelligence (GAI) is transforming programming education, particularly at the diploma level in Malaysian Polytechnics. AI- powered tools provide personalized learning, real time feedback, and problem-solving support, making programming education more interactive and accessible. By enabling tailored support and automation, GAI can improve student engagement and learning outcomes, helping them grasp complex programming concepts more effectively. However, these advancements also introduce challenges. Over-reliance on AI tools may weaken problem-solving skills and computational thinking, as students may copy AI-generated code without fully understanding its logic. Additionally, concerns related to academic integrity, data privacy, and ethical AI use must be carefully considered. Without structured integration, AI risks becoming a substitute rather than a complement to fundamental programming education, potentially undermining students' critical thinking abilities and job readiness. This paper aims to develop structured guidelines for. effectively integrating GAI into programming education at Malaysian Polytechnics. These guidelines provide actionable strategies for both educators and students, ensuring AI is used as a learning tool rather than a shortcut.

Focusing on fundamentals of programming at the diploma level, this study addresses the lack of AI implementation frameworks in Malaysia's polytechnic system. AI should complement rather than replace traditional teaching methods, fostering computational thinking, problem-solving skills, and ethical AI use. By establishing clear guidelines, educators can harness AI's benefits while mitigating its risks, ensuring responsible and effective AI adoption in programming education.

LITERATURE REVIEW

The integration of Generative Artificial Intelligence (GAI) in programming education has the potential to revolutionize learning experiences, providing real-time feedback, code generation, and debugging support. AI powered tools enhance personalized learning by tailoring content to students' individual needs, promoting self-paced study and adaptive learning pathways (Hartley et al., 2024). Liu et al. (2024) highlight that GAI significantly enhances student engagement and learning outcomes by offering personalized, real-time feedback that directly addresses individual learning needs. Moreover, Sal Khan, founder of Khan Academy, emphasizes that GAI's personalized tutoring capabilities can democratize education, making high-quality learning resources accessible to students regardless of their background.

In programming education, GAI assists students by generating relevant examples, debugging code, and offering tailored solutions, providing them with interactive opportunities to refine their coding skills. These capabilities make AI a valuable supplementary tool for programming students, enabling them to practice problem-solving in a guided and structured manner. However, despite these benefits, effective implementation strategies are necessary to prevent misuse and over-reliance on AI tools. GAI integration in C-language programming offers multiple advantages, particular lying enhancing student engagement, reducing frustration, and improving comprehension. AI powered tools provide instant feedback, enabling students to quickly identify and correct errors, thus promoting an iterative learning process (Liu et al., 2024). AI-driven learning environments also enhance debugging support, helping students diagnose syntax and logical errors more effectively (Silva et al., 2024). Additionally, GAI enables adaptive learning by offering personalized recommendations based on a student's proficiency level, ensuring that learners receive appropriate guidance at their specific stage of learning (McDonald et al., 2025). Such AI-driven customization enhances the learning experience, making complex programming concepts more approachable and interactive for students at varying skill levels.

Despite its potential, AI integration in programming education presents several concerns that educators and institutions must address. One of the primary risks is over-reliance on AI- generated solutions, where students may copy AI-generated code without fully understanding its logic, ultimately hindering their ability to develop independent problem-solving skills (Denny et al., 2024). Additionally, GAI automation may reduce students' critical thinking and debugging abilities, as learners may passively accept AI-generated responses rather than actively engaging in problem resolution (Sheard et al., 2024). Furthermore, academic integrity concerns arise as AI-generated solutions increase plagiarism risks, making it difficult for educators to accurately assess student learning (Prather et al., 2024). Ethical considerations regarding data privacy and AI biases are equally crucial. AI models occasionally produce incorrect, misleading, or biased outputs, which may reinforce misconceptions and lead students down unproductive learning paths (Liang et al., 2024).

Beyond technical challenges, GAI's impact on students' emotional and career perspectives is a growing concern. Some students report anxiety regarding job security, fearing that as AI becomes more advanced, it may reduce the demand for human programmers (Denny et al., 2024). This fear highlights the importance of balancing AI integration with the continued development of fundamental programming skills, ensuring students remain competent and adaptable in a rapidly evolving job market. To effectively integrate GAI into education, institutions must establish clear policies and structured guidelines for its responsible use. Jin et al. (2025) emphasize that universities must develop comprehensive policies outlining the roles and responsibilities of students, faculty, and administrators in GAI adoption. These policies should promote ethical AI use, ensure academic integrity, and provide clear data security measures to protect students' information. Miao & Kelly (2024) advocate for the integration of AI literacy into curricula, ensuring that students not only learn how to use AI tools but also understand their societal implications.

AI literacy should include critical evaluation of AI-generated content, understanding its limitations, and recognizing ethical concerns such as bias and privacy risks. Additionally, as AI tools become more widespread, students must be educated on responsible AI use, avoiding over-reliance and developing essential programming competencies alongside AI support. Educators play a crucial role in ensuring AI is used as an enhancement rather

than a replacement for traditional teaching methods. Chan & Tsi (2024) suggest that teachers should embrace GAI as a support tool that enhances, rather than substitutes, classroom instruction. Guiding students in AI use helps them balance AI-generated assistance with independent thinking and creativity, ensuring that they engage critically with AI-generated content instead of blindly relying on AI solutions. Moreover, institutions must provide training for educators to help them effectively integrate AI into their teaching strategies. By equipping teachers with the skills to manage AI-assisted learning, institutions can maximize the benefits of AI while minimizing its risks. For students, understanding that AI is a learning aid rather than a shortcut is essential in ensuring that they develop strong programming foundations, analytical skills, and ethical awareness.

While AI adoption in programming education is growing globally, studies on AI integration in Malaysian Polytechnics remain limited. The Malaysian Technical and Vocational Education and Training (TVET) framework emphasizes practical, hands-on learning, requiring AI implementation strategies that align with Malaysia's education policies. Given this context, there is an urgent need for context-specific AI guidelines tailored to diploma-level programming education in Malaysia. By developing clear pedagogical strategies, ethical guidelines, and assessment frameworks, Malaysian Polytechnics can leverage AI effectively while ensuring that students build foundational programming competencies rather than merely relying on AI-generated solutions. As a conclusion, AI has immense potential to enhance programming education, but its integration must be strategically planned and carefully monitored. While GAI fosters engagement, personalized learning, and efficiency, the challenges of over-reliance, academic integrity, and ethical considerations must be addressed. The role of educators and institutions is crucial in ensuring that AI tools are used responsibly and that students develop the necessary problem-solving and critical thinking skills to thrive in a rapidly evolving digital landscape.

METHODOLOGY

This study employs a qualitative research approach to develop structured guidelines for integrating Generative Artificial Intelligence (GAI) into diploma-level programming education in Malaysian Polytechnics. The research design consists of three phases: Systematic Literature Review (SLR), Semi-Structured Interviews, and Focus Group Discussions (FGDs). The SLR identifies best practices and challenges; interviews provide expert insights, and FGDs validate the guidelines to ensure practical applicability. A systematic review was conducted to analyze 15 academic papers focusing on AI- assisted programming education. The papers were selected from peer-reviewed journals and conference proceedings, using databases such as IEEE Xplore, ACM Digital Library, and Scopus. Inclusion criteria focused on studies discussing GAI in programming education, challenges in AI adoption, and strategies for responsible AI integration. The findings from this phase formed the foundation for the development of guidelines. The review aimed to: 1. Identify common trends in AI adoption for teaching and learning programming. 2. Highlight key challenges such as over-reliance, ethical concerns, and assessment issues.

To gain practical insights, semi-structured interviews were conducted with 10 programming instructors from various Malaysian polytechnics. The selection followed a purposive sampling approach, ensuring participants had experience with teaching programming and exposure to AI tools. The interviews were conducted online and in person, recorded with consent, and transcribed for thematic analysis. Recurring themes and key insights were extracted to inform the development of the guidelines. The interviews aimed to explore: 1. Current AI usage in programming courses. 2. Challenges in integrating AI tools in diploma-level programming education. 3. Best practices and strategies for AI-assisted learning. 4. Ethical concerns and academic integrity issues. To validate the guidelines, two FGDs were conducted—one with educators (n=5) and another with students (n=5) from diploma-level programming courses. The goal was to assess the feasibility, clarity, and practicality of the proposed guidelines. Participants were asked to: 1. Evaluate whether the guidelines align with actual classroom practices. 2. Identify potential challenges in implementation. 3. Suggest improvements or modifications. The discussions were recorded, transcribed, and analyzed using thematic analysis. Feedback from participants was incorporated to refine the guidelines, ensuring they are practical, effective, and relevant to the Malaysian Polytechnic context. Ethical guidelines were strictly followed throughout the study. Informed consent was obtained from all participants before data collection, and identities were anonymized to maintain confidentiality. The study adhered to institutional ethical review board guidelines to ensure responsible and ethical research practices. By combining SLR, expert interviews, and FGDs, this study ensures that the proposed guidelines are research-based, practitioner informed, and validated for practical implementation. This multi-phase approach enhances the credibility, reliability, and relevance of the recommendations, supporting effective and responsible AI integration in diploma level programming education.

PROPOSED GUIDELINES FOR AI INTEGRATION IN PROGRAMMING EDUCATION

Based on insights from the Systematic Literature Review (SLR), Semi- Structured Interviews, and Focus Group Discussions (FGDs), this study proposes structured guidelines for integrating Generative AI (GAI) into diploma level programming education at Malaysian Polytechnics. These guidelines are categorized into three areas: students, educators, and ethical & institutional considerations, ensuring that AI enhances learning while maintaining fundamental programming skills as shown in the following Table 1.

TABLE 1: Proposed Guidelines for AI Integration in Programming Education

Target Group	Guidelines	Key Actions
Students	**Use AI as a Support Tool, not a Replacement**	Solve problems independently before using AI for debugging and optimization to avoid over-reliance.
	Cultivate Creativity and Critical Thinking	Modify and analyze AI-generated code; engage in project- based learning to develop original solutions.
	Develop AI Literacy	Understand AI limitations, biases, and ethical implications; critically evaluate AI-generated content.
	Practice Ethical AI Use	Cite AI-generated content, adhere to academic integrity policies, and avoid plagiarism.
	Manage Mental Health and AI Induced Anxiety	Maintain a healthy balance between AI-assisted and independent learning to reduce pressure and stress.
Educators	**Integrate AI Thoughtfully into the Curriculum**	Use AI to complement teaching without replacing student engagement; design assignments that encourage analysis and improvement of AI- generated code.
	Promote Responsible AI Use	Establish ethical AI guidelines, emphasizing academic integrity and citation practices.
	Foster Human-AI Synergy	Guide students in critically evaluating AI-generated solutions rather than passively accepting them.
	Redesign Assessments to Reduce AI Over- Reliance	Implement live coding assessments, oral defenses, and debugging exercises to ensure student comprehension.
Institutions	**Support Ongoing AI Education**	Provide continuous AI training for educators to enhance AI literacy, pedagogical best practices, and ethical AI integration.
	Establish Clear Institutional Policies on AI Usage	Define acceptable and unacceptable AI use in coursework; outline consequences for misuse, including plagiarism.
	Promote AI Literacy Across the Curriculum	Embed AI literacy in programming courses, covering AI functionality, limitations, and ethical concerns.
	Ensure Student Data Privacy and Security	Use AI tools that comply with data protection standards; educate students on how AI processes and stores data.

Guidelines For Students

Students should view AI as a learning aid rather than a shortcut. Before consulting AI, they should attempt to solve problems independently, using AI only for debugging, optimization, or alternative perspectives (Denny et al., 2024). This approach prevents over-reliance and fosters critical thinking and problem-solving skills. AI-generated solutions should be used as a reference, not a final answer. Students should modify, experiment, and

analyze AI generated code to deepen their understanding (Frechette, 2024). Engaging in creative coding exercises and project-based learning enhances their ability to develop original solutions. Understanding how AI tools function, their limitations, biases, and ethical implications is essential for responsible use (Liang et al., 2024). Students should critically evaluate AI-generated content and cross-check it with course materials and documentation (Miao & Kelly, 2024). Students must cite AI-generated code when used in assignments and adhere to academic integrity guidelines (Sheard et al., 2024). They should also be mindful of data privacy risks and avoid misusing AI for plagiarism or unethical purposes (Jin et al., 2025). AI tools should enhance confidence, not cause stress. Some students may feel pressured by AI's speed and accuracy, leading to anxiety (Denny et al., 2024). Educators should encourage students to develop a healthy balance between AI-assisted and independent learning. Guidelines For Educators AI should complement traditional teaching methods rather than replace them (Chan & Tsi, 2024). Educators should design assignments that incorporate AI in a way that promotes learning without diminishing student engagement. For example, students could be tasked with analyzing and improving AI-generated code instead of merely copying it. Clear guidelines for ethical AI use should be established to ensure students understand academic integrity policies (Jin et al., 2025). Educators must emphasize proper citation practices, responsible AI usage, and awareness of AI biases and limitations. AI provides personalized feedback, but educators must remain central to the learning process (Miao & Kelly, 2024). Teachers should guide students in evaluating AI-generated solutions critically, encouraging problem-solving and in-depth understanding rather than passive acceptance of AI outputs. Traditional assessments should be restructured to prevent students from submitting AI-generated work without comprehension (Sheard et al., 2024). Effective strategies include: 1. Live coding assessments to test independent problem-solving skills. 2. Oral defenses, where students explain AI-generated solutions. 3. Debugging tasks, requiring students to analyze and correct AI-generated errors (Silva et al., 2024). Educators should receive continuous training on AI tools to effectively integrate them into programming courses (Frechette, 2024). Faculty development programs should focus on AI literacy, pedagogical best practices, and ethical AI usage.

Ethical And Institutional Considerations

Polytechnics should establish clear AI usage policies, defining acceptable and unacceptable applications in coursework. These policies must outline consequences for AI misuse, including plagiarism (Jin et al., 2025) and require students to cite AI-generated content appropriately (Miao & Kelly, 2024). Implementing these guidelines ensures responsible AI integration while maintaining academic integrity. AI literacy should be embedded into programming courses, covering how AI works, its limitations, and ethical concerns like bias, misinformation, and privacy risks. Additionally, students must understand AI’s impact on future career opportunities (Sergeyuk et al., 2024), enabling them to critically evaluate AI-generated content and use AI tools effectively in academic and professional settings. Institutions must prioritize student data privacy by using AI tools that comply with strict data protection standards (Miao & Kelly, 2024). Students should be educated on how AI processes and stores data and follow best practices for safeguarding personal information (Liang et al., 2024). These measures ensure a secure and responsible AI integrated learning environment. The integration of Generative AI in programming education presents both opportunities and challenges. By following these structured guidelines, educators can leverage AI effectively while ensuring that students develop critical thinking, problem-solving, and ethical AI usage skills. Institutions must also play a key role in policy-making, AI literacy promotion, and data security to create a balanced and responsible AI-driven learning environment in Malaysian Polytechnics.

RESULTS AND DISCUSSION

This section presents the findings based on the Systematic Literature Review (SLR), Semi- Structured Interviews with Educators, and Focus Group Discussions (FGDs). The discussion integrates these findings to provide insights into the effectiveness, challenges, and best practices for integrating Generative AI (GAI) into programming education at the diploma level in Malaysian Polytechnics.

Findings From Systematic Literature Review (SLR)

The SLR findings confirm that AI-assisted learning improves learning efficiency by providing real-time feedback, debugging support, and personalized learning pathways (Sergeyuk et al., 2024). AI enables students to identify and correct errors faster than traditional learning methods, reducing frustration and enhancing

engagement. However, guidance from educators remains essential to ensure students understand AI-generated content rather than blindly relying on it. Despite AI's benefits, the literature highlights several challenges for students. Many students misinterpret AI-generated code, assuming it is always correct, and fail to analyze its logic critically (Prather et al., 2024). Over-reliance on AI reduces problem-solving skills and computational thinking, which are crucial in programming education. Additionally, AI tools sometimes produce biased or incorrect outputs, leading to misconceptions if students do not verify AI-generated responses (Liang et al., 2024). For educators, assessing AI-assisted assignments presents significant challenges. The literature emphasizes that traditional assessment methods do not effectively measure students' true understanding when AI tools are extensively used (Sheard et al., 2024). Academic integrity concerns arise when students submit AI-generated work without proper attribution, making it difficult for educators to distinguish between student effort and AI assistance (Jin et al., 2025). The most effective AI integration strategies involve blending AI with active learning techniques, where students are encouraged to question, modify, and justify AI-generated solutions rather than simply accepting them (McDonald et al., 2025).

Insights From Semi-Structured Interviews with Educators

Interviews with 10 programming instructors from Malaysian Polytechnics provided practical insights into AI's impact on teaching. Most educators acknowledged AI's potential to improve student engagement and simplify programming concepts. However, they expressed concerns about students bypassing fundamental learning steps by relying on AI for solutions rather than developing their own problem-solving skills. Educators also found assessing AI-assisted work increasingly difficult, as AI-generated solutions often appear well structured and error-free, making it challenging to determine whether students truly understand the code. Some instructors had already started modifying assessments, incorporating oral explanations and debugging exercises to ensure students can demonstrate their knowledge beyond AI-generated outputs. Another major concern raised was the lack of institutional policies on AI usage in education. Instructors emphasized the need for clear guidelines on AI citation, ethical use, and assessment adaptations to prevent misuse and academic misconduct. They also suggested that educators require AI literacy training to help them effectively integrate AI into their teaching while maintaining rigorous assessment standards.

Validation From Focus Group Discussions (FGDs)

To validate the proposed AI integration guidelines, two FGDs were conducted: one with five educators and another with five diploma-level programming students. These discussions focused on evaluating the practicality of the guidelines and identifying potential challenges in implementation. Educators generally supported the guidelines, particularly the emphasis on structured AI integration and redesigned assessment methods. However, they recommended more specific guidance on balancing AI use with active learning, ensuring students engage with manual problem-solving before using AI tools. Some educators also emphasized that AI literacy training should be mandatory for both teachers and students, ensuring ethical and responsible AI usage in programming education. Students provided mixed reactions to AI integration. While they appreciated AI's ability to simplify complex programming concepts, some admitted that they struggled to critically evaluate AI-generated code. Many students relied on AI without fully understanding its output, confirming concerns raised in the literature and interviews. However, they welcomed guidelines that encourage responsible AI use and requested more training on AI literacy and debugging techniques to help them navigate AI-generated content effectively. Based on FGD feedback, minor refinements were made to the guidelines: 1. Stronger emphasis on AI literacy training in both student and educator guidelines. 2. Clearer strategies for balancing AI with traditional learning (e.g., requiring students to attempt problems manually before using AI). 3. Further refinement of assessment methods, ensuring that students not only submit AI- assisted work but also demonstrate comprehension through explanations and modifications. Findings from the SLR, interviews, and FGDs confirm that AI is most effective when complementing, not replacing, traditional teaching methods. Structured integration—where students first attempt programming tasks manually before using AI—preserves problem- solving skills while leveraging AI for debugging, optimization, and concept reinforcement. AI should serve as a learning aid, not an automatic solution provider. The results also emphasize the importance of AI literacy training. Both educators and students must understand AI's limitations, biases, and ethical concerns to use it effectively. Without this training, students risk passive learning, and educators face challenges in assessing genuine understanding. Institutions must establish clear AI policies to uphold academic integrity and responsible AI use. A balanced approach—combining AI with active learning, structured assessments, and institutional policies— ensures that AI enhances education without undermining core programming competencies. The validated guidelines provide a framework for effective AI integration in Malaysian Polytechnics, ensuring a sustainable and responsible AI-driven education model.

CONCLUSION

Generative AI has immense potential to enhance programming education, providing personalized learning, real-time feedback, and debugging support. However, structured implementation is essential to ensure AI serves as a learning aid rather than a replacement for fundamental programming skills. Educators must take an active role in guiding AI use, helping students develop critical thinking, problem-solving abilities, and ethical awareness when using AI-assisted tools. The proposed guidelines offer a balanced approach to AI integration, ensuring that students, educators, and institutions leverage AI effectively while maintaining academic integrity, fostering creativity, and promoting AI literacy. By following these recommendations, Malaysian Polytechnics can create an AI-enhanced learning environment that prepares students for the evolving digital landscape while preserving the core competencies of programming education.

Future Research Directions

Future research should focus on the pilot implementation of AI guidelines in Malaysian Polytechnics to assess their practicality and impact in real classroom settings. Conducting controlled trials will help determine how AI tools influence student engagement, problem- solving abilities, and code comprehension. These studies will also highlight potential challenges in AI adoption, allowing educators to refine strategies for effective integration. Additionally, longitudinal studies are needed to examine the long-term effects of AI on student learning outcomes. Research should investigate whether AI-assisted learning enhances or diminishes problem-solving skills over time, how it affects students' ability to debug and analyze code, and whether it influences academic integrity and independent thinking. Understanding these trends will provide valuable insights for curriculum adjustments and policy development. Another critical area is the development of AI-specific assessment methods for programming courses. Traditional evaluation methods may not accurately reflect students' understanding when AI-generated solutions are involved. Future research should explore alternative assessment strategies, such as process-based evaluations, oral explanations of AI- generated code, and debugging exercises, to ensure students demonstrate genuine comprehension and coding proficiency. By addressing these areas, future research can provide evidence-based improvements to AI implementation, ensuring that programming education remains effective, ethical, and aligned with technological advancements.

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REFERENCES

F. Almasri, "Exploring the Impact of Artificial Intelligence in Teaching and Learning of Science: A Systematic Review of Empirical Research," *Res. Sci. Educ.*, pp. 977–997, 2024.
C. K. Chan and L. H. Tsi, *Stud. Educ. Eval.* **83**, 101395 (2024).
C. E. Coello, M. N. Alimam, and R. Kouatly, *Digital* **4**, 114-125 (2024).
P. Denny *et al.*, "Prompt Problems: A New Programming Exercise for the Generative AI Era," in *Proceedings of the 55th ACM Technical Symposium on Computer Science Education (SIGCSE 2024)* (Association for Computing Machinery, Portland, OR, USA, 2024), pp. 1–7.
P. Denny *et al.*, *Commun. ACM* **67**, 56-57 (2024).
K. Hartley, M. Hayak, and U. H. Ko, *Educ. Sci.* **14**, 1-12 (2024).
Y. Jin *et al.*, *Comput. Educ. Artif. Intell.* **7**, 100348 (2025).

J. T. Liang, C. Yang, and B. A. Myers, "A Large-Scale Survey on the Usability of AI Programming Assistants: Successes and Challenges," in *2024 IEEE/ACM 46th International Conference on Software Engineering (ICSE)* (ACM, Lisbon, Portugal, 2024).
S. Liu *et al.*, *J. Comput. Sci. Coll.* **39**, 210-211 (2024).
N. McDonald *et al.*, *Comput. Hum. Behav. Artif. Hum.* **3**, 100121 (2025).
F. Miao and S. Kelly, "AI Competency Framework for Students," United Nations Educational, Scientific and Cultural Organization, Paris, France, 2024.
J. Prather *et al.*, "The Widening Gap: The Benefits and Harms of Generative AI for Novice Programmers," in *Proceedings of the 2024 ACM International Computing Education Research Conference (ICER 2024)* (ACM, Melbourne, VIC, Australia, 2024).
A. Sergeyuk, Y. Golubev, T. Bryksin, and I. Ahmed, *Inf. Softw. Technol.*, Preprint (2024).
J. Sheard, P. Denny, A. Hellas, J. Leinonen, L. Malmi, and Simon, "Instructor Perceptions of AI Code Generation Tools – A Multi-Institutional Interview Study," in *Proceedings of the 55th ACM Technical Symposium on Computer Science Education (SIGCSE 2024)* (Association for Computing Machinery, Portland, OR, USA, 2024), pp. 1223–1229.
C. A. Silva, F. N. Ramos, R. V. Moraes, and E. L. Santos, *Sustainability* **16**, 1245 (2024).