

# LEVERAGING AI TOOLS IN FIRST-YEAR PROGRAMMING EDUCATION: A CASE STUDY ON STUDENT PERCEPTIONS AND LEARNING EXPERIENCES AT A PRIVATE HIGHER EDUCATION INSTITUTION

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## Abstract

This study explores the integration of AI-powered tools in programming education, using the Technology Acceptance Model (TAM) to analyse students' perceptions and experiences. Through thematic analysis of focus group discussions with eight participants, the research identifies key themes, including initial perceptions of AI, its role in enhancing understanding and structuring code, ease of use, and its impact on problem-solving skills. While AI tools were found to enhance learning efficiency and boost confidence, concerns regarding over-reliance and ethical implications were raised. The study underscores the importance of structured AI integration, fostering critical thinking, and implementing ethical guidelines to promote responsible use. The findings provide valuable insights for educators on balancing AI's potential with traditional teaching methods to enhance student learning. Recommendations for future research include exploring the long-term effects of AI on programming education and increasing awareness of its ethical considerations.

**Keywords:** *Artificial Intelligence (AI) in education, AI tools for learning, first-year programming students, programming education, AI-Assisted Learning.*

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## 1. Introduction

The AI integration in South African higher education offers opportunities for personalised learning and data-driven decision-making but faces challenges like technological limitations, socio-economic disparities, and ethical concerns such as data privacy and algorithmic bias (Patel & Ragolane, 2024). Successful implementation requires collaboration between policymakers, educators, and technology providers. AI is reshaping education through adaptive learning systems and distance education, though infrastructure and expertise gaps remain (Funda & Piderit, 2024; Funda & Mbangeleli, 2024). In teacher and postgraduate education, AI enhances personalised learning, but ethical guidelines are crucial (Tarisayi, 2024; Goosen & Mugumo, 2024; Mbangeleli & Funda, 2024). In programming education, AI fosters problem-solving and interdisciplinary learning but requires oversight to prevent misuse (Brett et al., 2022; Saari et al., 2022). AI tools improve learning efficiency and engagement, especially for struggling students (Harry, 2023; Reunanen & Nieminen, 2024), with first-year students showing the most engagement (Lytvynova et al., 2024). This study explores first-year programming students' perceptions of AI tools, focusing on their impact on learning and ethical considerations (Rodriguez, 2012).

## 2. Literature review

The integration of AI in education, through technologies like chatbots and humanoid robots, enhances administrative efficiency and instructional quality (Chen et al., 2020). AI enables personalised learning, intelligent tutoring, and automated assessments, improving outcomes (Harry, 2023), but concerns around privacy, algorithmic bias, and ethics must be addressed.

AI supports learning through interactive tools and simulated environments, offering personalised feedback and responding to student needs (Fahimirad & Kotamjani, 2018). Adaptive learning systems and administrative tools provide data-driven, personalised experiences (Dhakal & Devkota, 2024). In engineering education, AI chatbots and image tools enhance concept understanding (Vidalis & Subramanian, 2023).

AI's role in hybrid teaching models improves engagement and instructional methods (Kshirsagar et al., 2022). Tools like intelligent tutoring systems streamline administration and enhance personalised education (Baichuan, 2024). While ChatGPT supports interactive learning, verifying AI-generated content

is crucial for academic integrity (Opara et al., 2023). AI tools such as MyEnglishLab and SuccessMaker prepare students for the evolving job market (Delgado et al., 2020).

In programming education, AI supports problem-solving and debugging but raises concerns about over-reliance and conceptual gaps (Liu & Li, 2024; Zviel-Girshin, 2024). AI-generated practice problems reduce anxiety and enhance comprehension (Reunanen & Nieminen, 2024). Tools like GitHub Copilot improve efficiency, but plagiarism concerns persist (Johanyák et al., 2023; Cotton et al., 2024).

AI integration in undergraduate curricula fosters programming and critical thinking (French et al., 2023), but ethical issues like plagiarism require clear policies (Madhu et al., 2023; Eke, 2023). Regulatory frameworks and ethical guidelines are essential for balancing AI's benefits with responsible use (Ihekweazu et al., 2024; Mubofu & Kitali, 2024). AI's impact on cognitive skills requires oversight to prevent over-reliance (Zhai et al., 2024).

Educators recognise AI's potential but emphasise academic integrity and independent problem-solving (Chavez et al., 2024). Ethical challenges like bias and job displacement highlight the need for critical engagement (Khatri & Karki, 2023). The Technology Acceptance Model (TAM) provides a useful framework for assessing AI adoption, with ease of use being key to engagement (Or, 2024). Ensuring AI tools are user-friendly and ethically deployed is crucial for the future of AI-driven education.

### 3. Methodology

This qualitative study explored first-year students' experiences with AI tools in programming education, using the Technology Acceptance Model (TAM) as the theoretical framework. TAM helped analyze students' perceptions of AI based on its perceived usefulness, ease of use, and external factors influencing adoption. Eight students from a private higher education institution, all experienced with AI tools like ChatGPT, Gemini AI, and NinjaTech AI, participated. Data was collected through a focus group discussion covering AI's impact on learning, debugging, problem-solving, and ethics. Thematic analysis was performed using ATLAS.ti to identify recurring patterns in responses. Ethical considerations ensured participant anonymity, voluntary participation, and the right to withdraw.

### 4. Findings

TAM was employed as the theoretical framework for this study to explore how students perceive and utilise AI tools in programming education. A thematic analysis was carried out on data gathered from focus group discussions, using ATLAS.ti to identify key themes.

Table 1. Themes.

Theme	Code	Description	Example Quotes
Initial Perceptions of AI in Programming	First Impressions of AI	Participants' initial reactions ranged from enthusiasm to caution.	"AI tools are very helpful" "Somewhat helpful, but requires responsible use."
	AI as a Disruptive Force	Some were excited by AI's capabilities, while others worried about its impact on traditional programming.	"I was quite shocked at how much it could do and how scary it actually is that it can take over programmers' jobs."
AI's Role in Understanding and Structuring Code	Perceived Accessibility	AI tools were easily accessible, requiring only an internet connection.	"It was very easy to use—just needed Wi-Fi."
	AI for Conceptual Learning	AI helped students grasp difficult programming concepts like inheritance, object-oriented programming, and syntax.	"Helped me understand inheritance and how to extend classes."
	AI for Code Structuring	AI assisted in layout, syntax understanding, and organising code efficiently.	"Helped with structuring code and layout when I didn't know where to start."
	AI for Debugging & Explanation	AI tools provided insights into debugging errors and explaining code structure.	"It comments next to the code, telling me what it does." "ChatGPT explains why my lecturer did things a certain way."
Ease of Use and Accessibility	Ease of Integration	AI was easy to incorporate into study routines.	"It was simple to use; if one AI tool failed, I switched to another."
	Technical Barriers	AI tools sometimes failed to respond, had internet dependency, or struggled with attachments.	"Having a stable internet connection was a challenge." "Sometimes ChatGPT fails to respond."
	Workarounds for AI Issues	Participants used alternative AI tools when one failed.	"I tried other AI tools like Gemini when ChatGPT wasn't working."
Impact on Learning and Problem-Solving Skills	Boost in Confidence & Efficiency	AI increased confidence and helped students complete tasks faster.	"Definitely sped up my learning with excellent depth of explanation." "It was time-efficient and made my tasks quicker."

	AI for Problem-Solving	AI enhanced problem-solving skills by breaking down complex tasks.	"AI provided insight into extracting attributes and methods."
	Reduced Critical Thinking	Some students worried about over-reliance, leading to weaker problem-solving skills.	"AI does the problem-solving for you, making you think less." "Not to rely on AI all the time."
	Industry Perspective	AI-generated code foundations reflect how developers work in real-world programming environments.	"AIs create a good foundation of code for us developers to work on and improve."
Challenges and Limitations of AI Use	Technical Issues	AI tools failed at times, giving errors, outdated responses, or struggling with document uploads.	"ChatGPT sometimes provided outdated information." "Error messages when trying to analyse attachments."
	Bias in AI Responses	AI sometimes gave biased or incomplete answers.	"I noticed bias, so I asked AI to give me both sides of the argument."
	Dependence on Internet & Software Availability	AI tools required consistent internet access and were unreliable at times.	"Having a stable internet connection was necessary."
Ethical Use and Responsible Learning	Avoiding Over-Reliance on AI	Some students acknowledged they initially depended too much on AI before adjusting their usage.	"At first, I relied too much, but then I realised I needed to actually learn."
	AI as a Learning Aid, Not a Replacement	AI should be used for guidance, not as a shortcut.	"Highly recommend AI, but it can be abused." "It should help start building code, not replace effort."
Attitudes Toward AI in Future Programming Courses	Widespread Support for AI Use	All participants recommended AI for programming students.	"Yes, I would recommend it, but with limits."
	Concerns About Overuse	A few participants warned against excessive AI reliance.	"Do not overuse it, use it wisely."
	Suggestions for Course Design	AI should be integrated into programming courses with guidelines.	"If AI is used in programming courses, there should be clear limits and rules."
Recommendations for AI Integration in Programming Courses	Structured AI Guidelines	AI should be used in moderation, especially for beginners.	"AI should be a supplementary tool, not the main resource."
	Workshops for Responsible Use	Students should receive AI training before using it in coursework.	"I would recommend AI, but workshops should be held first to teach students how to use it effectively."
Future of AI in Education and Industry	AI in Professional Environments	AI is widely used in industry for automation and efficiency.	"In industry, AI is widely accepted and useful for business processes."
	Developing AI Awareness in Students	Students should be taught when to use AI and when to rely on their own skills.	"AI creates a foundation of code for developers, but they must refine it."

## 5. Discussion

The study offers valuable insights into students' perceptions of AI tools in programming education. Participants found tools like ChatGPT, Gemini AI, and NinjaTech AI helpful for learning, debugging, and grasping complex concepts like inheritance and object-oriented programming, which aligns with research on AI's role in personalised learning and real-time feedback (Liu & Li, 2024; Zviel-Girshin, 2024). While AI tools improved comprehension and code structure, challenges emerged, such as concerns about over-reliance potentially weakening critical thinking and problem-solving skills (Zhai et al., 2024; Eke, 2023). Technical issues, including unreliable internet and occasional inaccuracies, were also noted (Delgado et al., 2020; Cotton et al., 2024). Ethical considerations were highlighted, with participants recognising the risks of AI misuse and emphasising the need for responsible use to prevent academic dishonesty (Madhu et al., 2023; Khatri & Karki, 2023).

### 5.1. Answer to research questions

**Main Research Question:** How do first-year programming students at a private higher education institution perceive and utilise AI tools to support their learning, and what factors influence the effective and ethical use of these tools?

#### Sub-questions:

1. How do first-year programming students perceive the usefulness of AI tools for learning programming concepts, specifically advanced inheritance?
2. What challenges do students encounter when using AI tools in their programming studies, and how do they address these challenges?
3. In what ways do AI tools impact students' problem-solving skills, confidence, and understanding of foundational programming concepts?
4. How do students' attitudes and experiences with AI tools influence their approach to learning programming effectively and ethically?

5. What are the factors that encourage or discourage responsible use of AI tools in programming education?

This study explores how first-year programming students at a private higher education institution perceive and utilise AI tools, such as ChatGPT and Gemini AI, to support their learning, particularly in advanced programming concepts. While students found AI tools helpful for learning and problem-solving, boosting confidence and efficiency (Liu & Li, 2024), concerns about over-reliance and reduced critical thinking emerged (Zhai et al., 2024). Ethical issues also arose, with students recognising the importance of responsible AI use and suggesting clearer guidelines (Madhu et al., 2023; Khatri & Karki, 2023). The research also investigates how students address challenges with AI, such as unreliable responses and over-reliance, and how these tools impact problem-solving skills, confidence, and understanding of core programming concepts. Students' perceptions of AI influence their learning approach, with those viewing AI as a supplement to traditional methods showing greater improvement. The study highlights factors that encourage or discourage responsible AI use, including AI literacy training, instructor feedback, and clear ethical guidelines (Chavez et al., 2024; Johanyák et al., 2023; Khatri & Karki, 2023). The findings underscore the need for ethical AI practices to maintain educational integrity.

## 6. Recommendations

Best practices for integrating AI into programming education include a gradual introduction of AI tools, particularly in beginner courses, with clear usage guidelines to complement traditional learning (Vidalis & Subramanian, 2023). Students should receive hands-on training to use AI responsibly for learning and debugging before applying it to assignments (Reunanen & Nieminen, 2024), while educators must select reliable, updated tools to avoid technical issues (Fahimirad & Kotamjani, 2018). To foster critical thinking, educators should encourage independent problem-solving, promote reflection on AI-generated solutions, and facilitate group discussions and peer reviews to enhance collaboration and reduce over-reliance on AI (Zhai et al., 2024; Kshirsagar et al., 2022; Mubofu & Kitali, 2024). Ethical guidelines are crucial, with clear boundaries on AI use to prevent plagiarism and over-reliance, along with workshops that promote responsible use and ethical awareness, including the potential biases in AI responses (Cotton et al., 2024; Madhu et al., 2023; Opara et al., 2023; Mubofu & Kitali, 2024).

## 7. Conclusion

This study examined student perceptions of AI tools in programming education, revealing that while students value AI for learning and problem-solving, they recognise the need to balance AI use with independent thinking. These findings align with previous research highlighting both the benefits and risks of AI. For educators, AI can be effective if integrated with clear guidelines, critical thinking encouragement, and ethical standards to ensure academic integrity. Future research should focus on AI's long-term impact on learning outcomes, the effectiveness of different tools, and how AI can support underrepresented groups in STEM.

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