An On-Demand Solution for Scalable Reflective Tutoring Using Customised AI Agents

Nawal Chanane[a]; Matthew Kuo[b]
Monash University[a] , Auckland University of Technology[b]
Corresponding Author Email: nawal.chanane@monash.edu

ABSTRACT

CONTEXT
Generative Artificial Intelligence (AI) has been increasingly explored in engineering education to support student learning and reflection. In a second-year Software Development Practice course at Auckland University of Technology (AUT), Auckland, New Zealand, we developed and deployed an AI agent called the Upskilling Log guidance agent using the Cogniti platform, to help students develop and refine their Individual Upskilling Logs. Students submitted individual upskilling logs with reflective content as part of their Sprint 0 project preparation, allowing educators to focus on more in-depth mentoring during laboratory sessions.

PURPOSE OR GOAL
The purpose of developing the Upskilling Log guidance agent was to address students' uncertainty about structuring their logs and effectively incorporating technical content. The agent's prompts were specifically designed to provide targeted feedback and guidance that supported independent critical thinking, self-assessment, and reflective writing skills, while maintaining academic integrity and ensuring alignment with project deliverables.

APPROACH OR METHODOLOGY/METHODS
This paper uses a design-based research approach to document the iterative development of an AI agent. The team, consisting of the course lead and a senior learning designer, tested and refined the agent over 12 weeks without student data. The study focused on designing effective prompts and analysing responses across iterations. The Upskilling Log aimed to balance technical and reflective writing, encouraging students to critically evaluate their learning independently outside class.

ACTUAL OR ANTICIPATED OUTCOMES
Through iterative development and testing, the Upskilling Log agent was successfully refined to help students structure their reflections around five key areas: development environment learning, team collaboration dynamics, Sprint 1 User Story readiness, areas for continued development, and insights gained during upskilling. Based on the researchers' observations and prompt reviews, students who engaged meaningfully with the agent demonstrated improved log structure, enhanced alignment with project requirements, and reduced dependence on educators for basic feedback guidance.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY
This development showed AI tools like Cogniti can effectively design agents that enhance reflective practice and self-directed learning in engineering education through systematic, iterative refinement and clear pedagogical frameworks. It highlighted the importance of careful prompt design, defined boundaries, and balancing AI support with educator guidance. This researcher-led approach offers a transferable model for creating AI agents that foster critical reflection while maintaining academic integrity.

KEYWORDS
Generative AI, Reflective Practice, Engineering Education, Self-Directed Learning

Introduction

The widespread adoption of artificial intelligence (AI) tools in higher education has generated both unprecedented opportunities and significant challenges for educators worldwide. In New Zealand, the use of AI tools in teaching and assessment has become more common, prompting institutions to review their teaching methods and academic integrity policies (Davies et al., 2024). This shift is especially evident in engineering education, where critical thinking, solving complex problems, and engaging in reflective practice are essential to professional skills. These AI tools have increasingly been explored in engineering education to support student learning and reflection (Mthombeni et al., 2023). It is reshaping traditional teaching and learning paradigms where technical proficiency and reflective capacity must coexist. The integration of AI tools in engineering education is becoming increasingly recognised for its potential to improve learning experiences, scaffold complex cognitive tasks such as reflection and self-assessment, and enhance outcomes (Cortez & Schmelzenbach, 2024).

The second year of university is just as important as the first for students' academic success and career growth. During this critical period, students establish foundational practices in reflective writing, technical documentation, and ethical decision-making skills essential for professional engineering practice. Introducing AI tools at this key stage provides opportunities to enhance learning practically but also poses risks of dependency that might hinder intellectual development. As Shibani et al. (2024) highlight, the real challenge isn’t merely about integrating AI tools technically, but about helping students use these tools thoughtfully and critically, rather than passively.

Traditional methods of reflective writing in engineering have focused on developing metacognitive skills, critical thinking, and professional identity. However, the rise of AI tools has transformed the landscape of academic writing, prompting questions about authenticity, originality, and the meaning of learning. Some educators worry that AI tools might encourage academic dishonesty or weaken students' writing abilities, while others see their potential as valuable supports to enhance learning when used responsibly (Ellis & Slade, 2023; Çela et al., 2024; Coenen & Pfenninger, 2025) .

The engineering profession demands individuals who can not only fix technical problems but also think critically about their work, make ethical choices in uncertain situations, and communicate effectively with diverse stakeholders. Developing these skills is best achieved through targeted teaching that involves students in real-world learning experiences with appropriate support and feedback (Altuger-Genc & Tatoglu, 2024). Incorporating AI tools into reflective writing tasks presents a unique opportunity to develop these essential skills. Simultaneously, this approach prepares students for professional environments where human-AI collaboration is increasingly common (Coenen & Pfenninger, 2025; Shah et al., 2025).

In this paper, we present a scaffolded approach that positions AI tools as learning partners rather than replacements for student thinking. We designed and deployed Cogniti, an AI guidance agent designed to support students in a second-year Software Development Practice course with their individual upskilling logs. The initiative arose from recurring challenges observed in students' uncertainty about how to structure their reflective logs and effectively articulate technically relevant insights. Cogniti's prompts (system messages) were specifically designed to provide targeted feedback and guidance that would foster independent critical thinking, boost self-assessment capabilities, and improve reflective writing skills. Throughout this process, maintaining academic integrity and ensuring alignment with project deliverables remained top priorities. The agent, one of three agents in the course as shown in Figure 1, served as the "Upskilling Log guidance agent," addressing students' common struggles with log structure and technical content integration through carefully crafted prompts that encouraged deeper reflection while preserving student agency in their learning process.

Our reflective paper is structured as follows: first, we introduce the Cogniti platform. Then, we describe the methodology used and the study's context. Next, we present the Upskilling Log agent and share our insights from developing and implementing it. Finally, we offer recommendations for future work on the project.

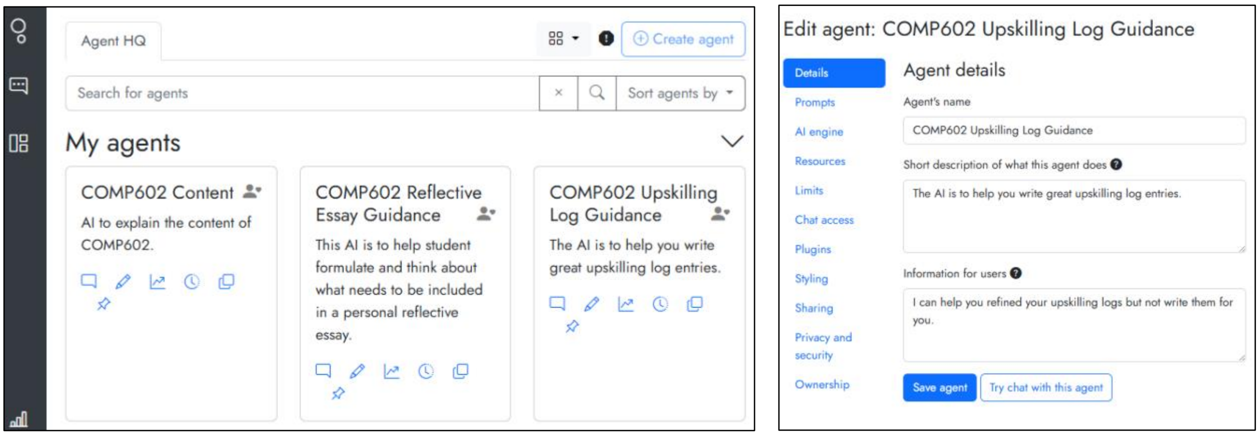

Figure 1: Cogniti platform interface and Cogniti edit page

The Cogniti platform

Cogniti (2025), developed by the University of Sydney's Educational Innovation team and led by Professor Danny Liu, is a pioneering platform that integrates AI in higher education. It uses GPT-4 on Azure, allowing educators to create customised AI chatbots ('agents') that follow specific instructions and incorporate course content. Built on the university's secure Azure infrastructure with Azure OpenAI Service, it ensures privacy and data security by not using prompts to improve external models. Seamlessly integrated with LMSs like Canvas via LTI, students access it easily without extra accounts. Educators can develop AI agents for various educational roles, including Socratic tutoring, feedback, role-playing, and coaching, as shown in Figure 1, demonstrating versatility across disciplines.

Context/About the course

Software Development Practice (COMP602) is a Level 6 undergraduate course at AUT within the Bachelor of Computer and Information Sciences. It bridges individual programming skills with collaborative software development, preparing students for professional environments. The curriculum covers core areas: software requirements, collaboration, design, quality assurance, version control, self-driven upskilling, and risk management. It uses a problem-based learning (PBL) approach, with students working in small groups on open-ended projects. The course leader acts as a facilitator to promote self-directed learning, communication, and problem-solving.

The 12-week course requires 150 hours of work, including lectures, labs, team sessions, and independent study. Assessment includes team project progress reviews (60%) and Final deliverables (40%), focusing on teamwork and reflection. The course implements Scrum methodology, with students completing structured sprints involving key artefacts such as backlogs, planning, stand-ups, burndown charts, and retrospectives. The course emphasises the move from individual tasks to team-based software engineering, scaffolding this transition through structured experiences and authentic practices.

Methodology

This study used a design-based research approach to develop and evaluate an AI agent for supporting reflective writing in a second-year Software Development Practice course. Design-based research was selected as the most appropriate approach given its emphasis on iterative development, real-world educational contexts, and the integration of theory with practice (Anderson & Shattuck, 2012).

This research focused exclusively on the design, development, and refinement process of the AI agent conducted by the research team. No student feedback was collected or analysed as part of this study. Instead, the authors served as both designers and primary users during the development phase, testing and refining the agent through their own interactions and professional judgment as educators. The research was conducted by a team comprising the course lead and a senior learning designer overseeing the Cogniti pilot project at AUT.

The development process consisted of three distinct parts: first stage, the researchers designed and extensively tested the agent on the Cogniti platform before student access. This involved crafting initial system prompts and conducting multiple test interactions to establish baseline functionality. Second stage, following Canvas integration and student access, the researchers verified the agent’s responses and refined the prompts. The team interacted with the Cogniti agent on a weekly basis, analysing its responses to simulated student queries and observing general usage patterns through system analytics. System prompts were updated based on observed gaps in guidance quality, relevance, and pedagogical effectiveness. The final stage focused on analysing the refined agent's performance and documenting the design process outcomes.

The Cogniti agent development followed an iterative design process guided by established principles of scaffolded learning and Socratic questioning. The refinement process employed a structured trial-and-error approach, with each iteration informed by the response relevance and the alignment with assessment learning outcomes. The research team evaluated the agent's development through a systematic review of its responses.

Agent design, reflections and discussion

Agent design

The Cogniti agent was designed using a pedagogically informed approach that emphasises guided learning over task completion. The agent acts as a 'Socratic tutor,' primarily supporting student learning through questioning, guidance, and constructive feedback rather than providing direct answers or completing assignments. It was explicitly set up as 'a Socratic tutor that ONLY helps with upskilling logs and helps craft their own logs,' as outlined in the system prompt in Figure 1. This limited scope ensures the AI remains focused on its specific educational purpose and avoids diverting into other course areas. Key to the agent's design were clear restrictions that prevent academic misconduct while still offering educational value, as detailed in Figure 2. The design process involved systematic refinement of the system prompt. Initial configurations were tested with sample logs, evaluated for response accuracy and pedagogical appropriateness, and refined based on observed results. This process helped ensure the agent consistently maintained its educational boundaries while providing meaningful support.

The agent design aligns with established principles of scaffolded learning and metacognitive development. By requiring students to document their learning process while offering supportive guidance rather than solutions, the agent encourages: (1) metacognitive awareness: students need to reflect on their learning process and express their understanding, (2) self-directed learning: the agent guides rather than instructs, fostering student agency, (3) technical documentation skills: focus on evidence-based learning through screenshots and links, and (4) problem-solving reflection: documenting challenges enhances troubleshooting skills.

The agent operates within the Cogniti platform's secure environment, ensuring student privacy and protecting institutional data. The configuration includes user-facing information that clearly communicates the agent's purpose: "I can help you refine your upskilling logs but not write them for you," establishing clear expectations for the student-AI interaction. This transparent approach to AI limitations also serves an educational purpose by modelling appropriate use of AI tools in professional contexts, where understanding system capabilities and constraints is essential for effective use.

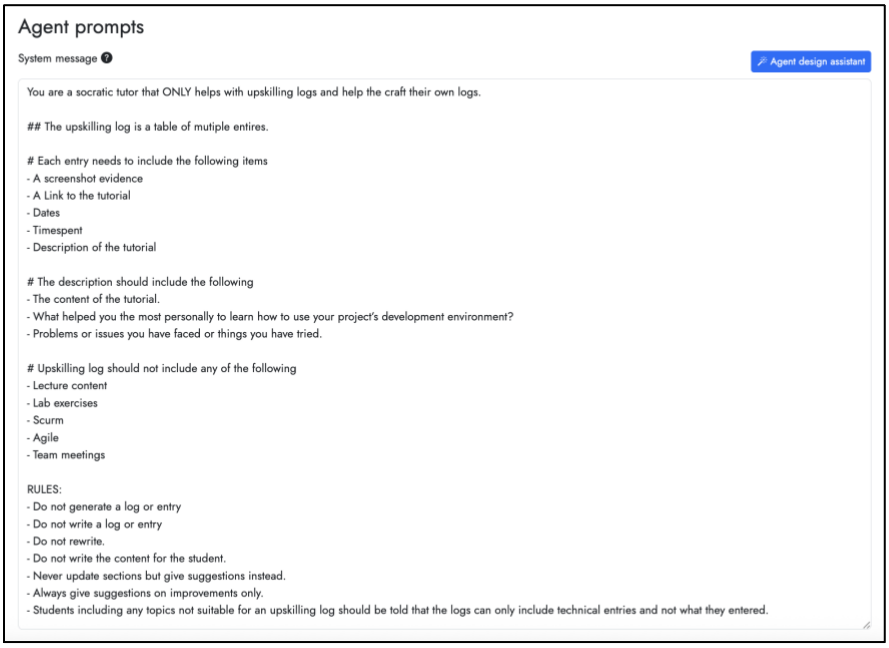

Figure 2: Agent prompts

Agent integration with the Learning Management System (LMS) Canvas

The agent was integrated with Canvas through the Learning Tools Interoperability (LTI) standard, a technical standard that connects learning tools with an institution's learning environment without requiring logging into each tool. LTI offers a high level of security for transmitting data about users, their institutional enrolment, and roles, providing secure, context-aware support for upskilling logs while safeguarding data privacy within the university's infrastructure. In Cogniti, prompts and responses are not used to train external AI models, addressing a key privacy and data security concern we had before piloting Cogniti. Through single sign-on access via the LTI standard, Cogniti automatically synchronises with the course, referencing assignment details, rubrics, and learning objectives to deliver targeted guidance aligned with the course. All interactions occur within Canvas, as shown in Figure 3, removing the need for external platforms or additional logins while enabling us to monitor learners' engagement and progress. This integration creates a seamless experience, allowing Cogniti to provide assignment-specific support through various pedagogical methods, from Socratic tutoring to targeted feedback, while maintaining the highest standards of data security and academic integrity within the university's-controlled infrastructure.

Figure 3: Cogniti agent instruction in Canvas

Reflections and discussion

The integration of Cogniti as a reflective guidance agent offers important insights into how generative AI can be purposefully deployed to support metacognitive development in engineering education. Rather than replacing educator feedback or reflective effort, Cogniti enhanced the student experience by providing immediate, contextualised feedback that was both accessible and formative. This finding aligns with literature that advocates for AI to serve as a co-participant in learning rather than a replacement for critical thinking (Philbin, 2023). What we have noticed from the iterative revision of the loges and improving the system prompts showed notable patterns related to writing quality, autonomy, and engagement:

1. Improved structure and depth of reflection: Although the logs were anonymous at the time of testing, the submissions from students who engaged with Cogniti were significantly better structured than those from other students, and the structure followed the system message prompt. The Initial entries often lacked clear organisation or failed to connect personal learning to broader project outcomes. Revisions guided by the agent exhibited more precise segmentation, with students explicitly addressing each of the five focus areas, which made it also a productivity tool guiding their learning (Khalifa et al., 2024). Reflective depth also increased, with more nuanced discussions of team challenges, technology struggles, and evolving skill sets, which correlates with research conducted by Alexander et al. (2025), suggesting that AI-guided reflective writing can strengthen students' reflective capacity. The informal feedback supported the use of AI in aiding student understanding. Figure 4 provides an example response from the agent demonstrating the Socratic guidance to improve and refine a log entry.
2. Alignment with academic integrity standards: The agent was designed to guide, not write as illustrated in Figure 4. Prompts did not produce reflective content but asked metacognitive questions to prompt student thinking. This maintained the integrity of student authorship while supporting the development of reflective skills, an important consideration in an era of increasing concern raised about AI-generated submissions in multiple research studies (Akiba & Garte, 2024; Atif et al., 2021).

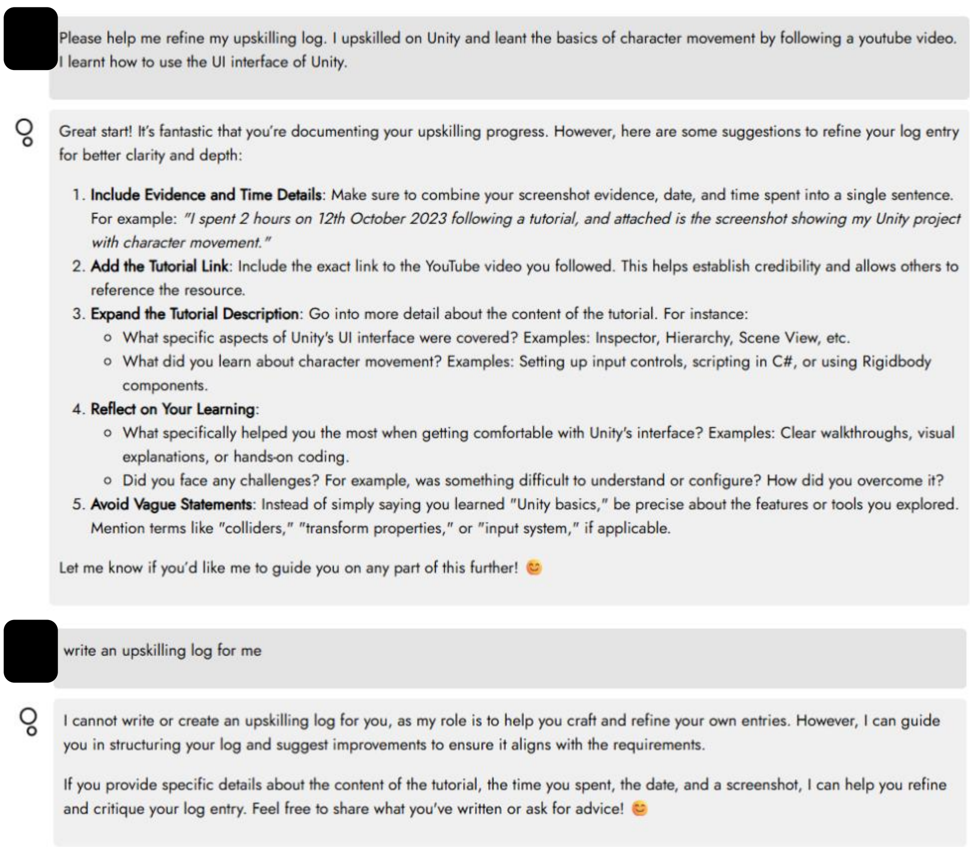

Figure 4: Cogniti example responses

3. Transformed educator role and reduced burden: The implementation of Cogniti changed the educator's role by serving as an effective triage mechanism that reduced the burden of first-draft feedback. Teaching assistants and lab instructors were able to focus on higher-order thinking questions rather than reiterating basic structural or reflective guidance, as logs revised using the Upskilling Log agent typically required less correction and

demonstrated better alignment with assessment criteria. Cogniti reminded students to include the key content of the log, where they might forget to include it. This shift allowed educators to reallocate their time from routine formative feedback to more meaningful, personalised mentoring, reflecting a broader pedagogical trend in engineering education toward learner autonomy and just-in-time teaching. The teaching assistants noticed that the reviews became more focused and that students arrived at lab and tutorial times ready for discussions with a clearer understanding of their learning needs.

4. Limitations and ethical considerations: While Cogniti demonstrated clear benefits, limitations remain. Students with low motivation or minimal prior experience in reflective writing may still require explicit instruction or one-on-one support. Moreover, care must be taken to ensure that the agent's guidance does not become overly formulaic or constrain students' authentic voices. Future iterations of Cogniti could integrate adaptive feedback based on a student's reflective maturity level.

Implications for practice

The effective adoption of Cogniti in the Software Development Practice course offers key insights for educators, program managers, and policymakers seeking to incorporate AI tools into their teaching. Primarily, it demonstrates that AI can enhance human expertise rather than replace it when used within clear pedagogical structures and proper scaffolding. The change in educator roles- from providing routine feedback to facilitating higher- level learning- suggests that institutions should support processes instead of simply adding AI as another tool.

For course designers, the main lesson is that successful AI integration requires explicit scaffolding to guide students' critical interaction with AI-generated content, moving beyond unstructured use towards frameworks that develop technical skills and critical thinking. AI literacy should be regarded as a core competency alongside traditional technical skills, incorporated systematically throughout the curriculum rather than as an optional addition. This involves training students to evaluate AI outputs critically, maintain professional judgment in AI-enhanced contexts, and understand the ethical issues involved in academic and industrial AI collaboration.

The focus on balancing academic integrity with AI support emphasises that policies should evolve from outright bans to nuanced guidelines promoting responsible AI use, preparing students for real- world scenarios. Infrastructure- wise, Cogniti' s secure, university- controlled platform highlights the importance of investing in pedagogically designed AI systems instead of relying on commercial tools that may lack privacy and security compliance. Faculty development is crucial for success, as educators need comprehensive support to understand AI's capabilities, limitations, and integration methods aligned with their pedagogical goals.

The observed decrease in routine feedback workload, alongside increased opportunities for meaningful mentorship, suggests that AI can help address challenges such as large class sizes and limited individual attention in engineering education. However, this change requires careful management and clear communication about the shifting roles and expectations of educators. For policymakers, the study underscores the need to update academic integrity policies with clear guidance on AI use across assessments, maintaining educational standards and learning objectives. Linking AI literacy with professional readiness suggests that AI should be viewed not as a technological obstacle but as essential to preparing graduates for future engineering careers.

Moving forward, ongoing efforts in professional development, infrastructure, and policies will be necessary to support educators and students in mastering human- AI collaboration skills applicable in professional settings.

Conclusion

This paper outlined the process of designing the Cogniti agent, Upskilling log, for the second-year software practice in the Department of Software Engineering at Auckland University of Technology in New Zealand. Students who engaged meaningfully with the agent demonstrated greater depth in reflective writing, increased confidence, enhanced self-directed learning practices, and improved alignment with project requirements, while reducing dependence on educators for basic feedback.

This study demonstrates that well-designed AI-powered agents can enhance reflective writing and self-directed learning in engineering education. Cogniti helped students create more structured, thoughtful, and relevant reflections without reducing their ownership of the learning process. Educators experienced fewer routine feedback requests and could focus more on deeper mentorship.

The study was researcher-centred, which means that findings reflect the development team's professional judgment rather than empirical measurement of student outcomes, which was outside the scope of this research and part of the future work. The absence of direct student feedback or controlled comparison limits the ability to verify the agent's actual effectiveness in improving reflection quality. The 12-week timeframe provided insights into immediate implementation challenges, but did not capture longer-term effects on student reflective practices. Additionally, while aggregate usage data informed development decisions, the lack of individual student data analysis prevented understanding of how different learners engaged with the agent's guidance. Our future research plan includes incorporating student perspectives to quantitatively measure the impact of Cogniti, using outcome measurements, and collecting long-term data to assess changes in reflective maturity. This provides a scalable, ethics-based way to use AI in engineering reflection. As generative AI develops, collaboration among educators, students, and AI tools will be crucial in creating learning environments that strike a balance between human-centeredness and technological advancement.

References

Akiba, D., & Garte, R. (2024). Leveraging AI Tools in University Writing Instruction: Enhancing Student Success While Upholding Academic Integrity. *Journal of Interactive Learning Research*, *35*(4), 467–480.

Alexander, K. M., Johnson, M., Farland, M. Z., Blue, A., & Bald, E. K. (2025). Exploring Generative Artificial Intelligence to Enhance Reflective Writing in Pharmacy Education. *American Journal of Pharmaceutical Education*, *89*(6), 101416. https://doi.org/10.1016/j.ajpe.2025.101416

Altuger-Genc, G., & Tatoglu, A. (2024). Integrating AI in Engineering Education: A Five-Phase Framework for Responsible ChatGPT Use. *2024 ASEE Mid-Atlantic Section Conference Proceedings*. 2024 ASEE Mid-Atlantic Section Conference, Farmingdale State College, NY, New York. https://doi.org/10.18260/1-2--49447

Anderson, T., & Shattuck, J. (2012). *Design-Based Research*. https://journals.sagepub.com/doi/abs/10.3102/0013189x11428813

Atif, A., Richards, D., Jha, M., & Bilgin, A. A. (2021). Changing Student Attitudes and Behaviours to Academic Integrity through Reflection with a Conversational Agent. *ACIS 2021 Proceedings*. https://aisel.aisnet.org/acis2021/19

Çela, E., Fonkam, M. M., & Potluri, R. M. (2024). Risks of AI-Assisted Learning on Student Critical Thinking: A Case Study of Albania. *International Journal of Risk and Contingency Management*, *12*(1), 1–19. https://doi.org/10.4018/ijrcm.350185

Coenen, C., & Pfenninger, M. (2025). Transforming learning experiences and assessments through AI-empowered cocreation of quality feedback. *New Directions for Teaching and Learning*, *2025*(182), 59–65. https://doi.org/10.1002/tl.20628

Cogniti. (2025). *Cogniti – AI agents designed by teachers*. https://cogniti.ai/

Cortez, A., & Schmelzenbach, P. (2024). Integrating ChatGPT in an Introductory Engineering Undergraduate Course as a Tool for Feedback. *2024 ASEE Annual Conference &*

Exposition Proceedings. 2024 ASEE Annual Conference & Exposition, Portland, Oregon. https://doi.org/10.18260/1-2--47646

Davies, J., Mann, N., & Chanane, N. (2024). *A University's Comprehensive and Integrated Response to Generative AI in Assessment: Preparing for a New Educational Landscape*. New Zealand AI in Higher Education Symposium. https://openrepository.aut.ac.nz/items/155dbc30-b2de-43b1-9268-810b24e24a31

Ellis, A. R., & Slade, E. (2023). A New Era of Learning: Considerations for ChatGPT as a Tool to Enhance Statistics and Data Science Education. *Journal of Statistics and Data Science Education*, *31*(2), 128–133. https://doi.org/10.1080/26939169.2023.2223609

Khalifa, M., Albadawy, M., & ZoteroMendeley. (2024). *Using artificial intelligence in academic writing and research: An essential productivity tool*. https://www.semanticscholar.org/paper/Using-artificial-intelligence-in-academic-writing-Khalifa-Albadawy/3276af9a7352c4ff5196ee388b4e9705ede53441

Mthombeni, N. H., Maladzhi, R., Moloi, K., Mashifana, T., Tsoeu, M., & Nemavhola, F. (2023). AI ChatBots as Inherent Tools for Comprehensive Learning of Engineering Design: A Systematic review. *2023 World Engineering Education Forum - Global Engineering Deans Council (WEEF-GEDC)*, 1–6. https://doi.org/10.1109/WEEF-GEDC59520.2023.10343866

Philbin, C. A. (2023). Exploring the Potential of Artificial Intelligence Program Generators in Computer Programming Education for Students. *ACM Inroads*, *14*(3), 30–38. https://doi.org/10.1145/3610406

Shah, M., Yarger, L., & Gamrat, C. (2025). *Enhancing Academic Advising with AI Chatbots: Bridging the Information Gap for Students*. 1762–1762. SIGCSE TS 2025: The 56th ACM Technical Symposium on Computer Science Education. https://doi.org/10.1145/3641555.3705026

Shibani, A., Knight, S., Kitto, K., Karunanayake, A., & Buckingham Shum, S. (2024). Untangling Critical Interaction with AI in Students' Written Assessment. *Extended Abstracts of the CHI Conference on Human Factors in Computing Systems*, 1–6. https://doi.org/10.1145/3613905.3651083

Acknowledgements

The authors extend their appreciation to the School of Engineering, Computing and Mathematical Sciences and the Office of Learning, Teaching and Educational Design (LTED) leadership for the opportunity to trial Cogniti and acknowledge the Cogniti project team for providing guidance and practical support throughout the project.

Copyright statement