PREFACE

THEME: Creative Spaces for Learning – Redefining Classrooms with AI in the 21st Century

The rapid advancement of artificial intelligence (AI) is reshaping the educational landscape in profound and unprecedented ways. No longer confined to the realm of science fiction, AI has emerged as a powerful force within classrooms, enhancing learning, personalizing instruction, and enabling new forms of creativity and engagement. Recognizing the importance of this shift, this special issue of the *Journal of Creative Practices in Language Learning and Teaching (CPLT)* is dedicated to the theme *"Creative Spaces for Learning: Redefining Classrooms with AI in the 21st Century."*

This issue brings together a diverse collection of scholarly works that explore how AI technologies are being adopted, adapted, and critiqued across a variety of educational contexts. From programming classes and ESL classrooms to entrepreneurial initiatives and financial literacy efforts, these papers offer insight into how AI can be meaningfully integrated to create learning environments that are not only intelligent but also inclusive, ethical, and imaginative.

The contributions featured in this issue include:

1. **Examining Student Satisfaction with the BMC Touch Application: The Role of Perceived Usefulness, Perceived Ease of Use, Application Performance and Interface Quality**
2. **AI-Driven Pedagogies: Reimagining English Language Learning in Creative Classroom Spaces**
3. **Generative Artificial Intelligence in Computer Programming Classrooms: A 21st-Century Review**
4. **AI or I? Exploring Student Attitudes Toward AI-Assisted Article Analysis**
5. **Enhancing University Students' Financial Satisfaction Through AI-Driven Financial Tools**
6. **Reimagining ESP Classrooms in Higher Education: An Empirical Mapping of Creative Spaces Enhanced by Artificial Intelligence**
7. **Exploring The Influence and Effectiveness of Block-Based Visual Programming on Self-Efficacy towards Human Resource Students: A Systematic Review**
8. **TESL Students' Intention to Use AI in Academic Writing: A Research Protocol**
9. **Empowering Shariah-Compliant Knowledge Online Business among Student Entrepreneurs: Integrating Teaching and Learning using AI Technology Tools**

Each article in this special issue contributes to a larger conversation about the role of AI in education, not as a replacement for human connection, but as a partner in creating dynamic, responsive, and future-ready learning environments. We believe this issue will spark further research, dialogue, and innovation, and we are proud to support these scholarly efforts.

On behalf of the editorial team, I extend our sincere appreciation to the authors, reviewers, and contributing scholars whose commitment to excellence has made this issue possible.

Warm regards,

Associate Professor Dr. Azlyn Ahmad Zawawi
Guest Chief Editor
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Creative Spaces for Learning: Redefining Classrooms with AI in the 21st Century

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Responsible Generative AI Literacy (RAIL) and Academic Integrity in Computer Programming Language Classrooms: Evidence from Library and Information Management Students

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ABSTRACT

The integration of Generative Artificial Intelligence (GenAI) tools into higher education, particularly in computer programming courses, has transformed how students engage with code. However, it also introduces ethical challenges, especially among Library and Information Management (LIM) students with limited technical backgrounds. This study explores the influence of Responsible Generative AI Literacy (RAIL) on students' adherence to academic integrity within programming education. Utilizing a quantitative cross-sectional approach, data were collected from 68 diploma-level LIM students enrolled in C++ and Python-based courses. Partial Least Squares Structural Equation Modeling (PLS-SEM) validated the measurement model, confirming high reliability, validity, and a significant positive relationship between RAIL and academic intergrity ($\beta = 0.847$, $p < 0.001$). The findings highlight RAIL's role in fostering ethical awareness, responsible AI tool usage, and resistance to academic dishonesty. The study recommends embedding AI ethics into curricula, mandating AI usage declarations, and adopting scenario-based learning to enhance students' ethical and technical fluency. By promoting RAIL, this research underscores the necessity of discipline-specific AI literacy frameworks to ensure both academic honesty and effective academic integrity integration in programming education.

Keywords: Generative AI, Responsible AI Literacy, Academic Integrity, Programming Pedagogy, Library Science Students

INTRODUCTION

Large-scale implementation of Generative Artificial Intelligence (GenAI) in classrooms has revolutionized pedagogy and learning methodologies, particularly in programs with high-order thinking like computer programming. Tools for programming assistance like ChatGPT, Copilot, and others have provided learners with easy access to programming assistance, developing new and tailored learning environments. With the advantages come the same challenges, i.e., AI and correct use of Artificial IntelligenceI-generated content. In areas like Library and Information Management (LIM), where digital literacy itself is a minimum competence, introducing Artificial Intelligence literacy, more specifically, Responsible Generative AI Literacy (RAIL), is even more essential. With AI increasingly becoming a ubiquitous aid in students' learning process, it is imperative that its application holds ethical considerations and academic honesty (Hill & Hargis, 2024; Muthukrishnan et al., 2024).

In areas like LIM, where digital literacy is often a baseline skill, the concept of RAIL becomes vital. RAIL refers to students' ability to engage with GenAI tools in an ethical, informed, and critically reflective manner, emphasizing responsible use over dependency. Meanwhile, academic integrity is understood as a set of principles guiding students to complete their work without misrepresentation, particularly when using AI-generated code or content.

Recent scholarly discourse has stressed Artificial Intelligence (AI) literacy programs that teach students how to use generative AI tools and promote ethical, responsible, and reflective use of these technologies (Cox, 2024; Lo, 2025; Karataş & Yüce, 2024; Muthukrishnan et al., 2024). Meanwhile, academic integrity issues have risen as students have ready access to AI-generated written content and code, which raises questions about authorship, plagiarism, and equity in assessment (Barrientos et al., 2024; Rasul et al., 2024).

In computer programming courses, using AI tools to generate code segments can lead to over-dependence and compromise students' understanding of solving problems unless presented by responsible pedagogical models (Smit & du Plessis, 2024). The literature has proposed several guidelines to embed ethics in AI usage via AI usage policies, learning-by-experience methods, and collaborative project work (Alghowinem et al., 2024; Narayan & Saharan, 2024; Rajabi, 2024). Nevertheless, a comprehensive and discipline-specific conceptual framework to guide the responsible and ethical use of AI in programming classrooms remains underdeveloped.

The core issue this paper addresses lies in the imbalance between the increasing accessibility of generative AI tools and students' preparedness to use them responsibly while maintaining academic integrity. Despite the availability of policies and isolated teaching strategies, students in library and information disciplines, who are future custodians of digital literacy, often lack structured training in responsible AI engagement. The absence of a clearly defined framework for nurturing RAIL (Cox, 2024; Lo, 2025) in programming education contributes to academic misconduct and cognitive dependency on AI. As such, this study seeks to investigate the relationship between RAIL and academic integrity among students and analyze students' views on RAIL and academic integrity in fundamental programming classrooms among LIM students.

This paper is structured into five sections: (1) Introduction, (2) Literature Review, (3) Methodology, (4) Result, and (5) Discussion and Conclusion.

LITERATURE REVIEW

Recent scholarship has increasingly focused on the intersection of generative AI and academic integrity, particularly within educational contexts that involve digital skill development (Muthukrishnan et al., 2024; Zhao et al., 2025). Cox (2024) advocated for algorithmic and RAIL in libraries and higher education, while Zhao et al. (2025) highlighted the specific needs of students in using generative AI, the pedagogical strategies to cultivate these literacies among non-computing students, such as those in LIM, remain underexplored. Furthermore, Muthukrishnan et al. (2024) emphasized the significance of ethical AI awareness and intrinsic motivation as foundational to responsible AI engagement, particularly among prospective students. Despite the emergence of frameworks on AI literacy (Cox, 2024), there is a paucity of studies that apply these specifically to programming education for LIM students. This gap becomes more significant in light of growing concerns over AI-induced plagiarism and academic dishonesty, as well as the ethical challenges posed by generative AI tools (Zhao et al., 2025). Therefore, this study builds on and extends these frameworks by proposing a discipline-specific lens, RAIL, to examine how such literacy influences ethical behavior in computer programming classrooms, addressing both the technical and ethical dimensions of AI use in education.

Responsible Generative AI Literacy (RAIL)

RAIL is one that has increasingly become more pertinent in LIM education (Cox, 2024; Lo, 2025), especially in coding units where AI tools are among the unavoidable topics to cover.

The objective of RAIL is to educate students on the ethical, practical, and reflective use of generative AI tools in academic settings, particularly in relation to programming tasks and academic integrity. Muthukrishnan et al. (2024) noted that ethical self-regulation and intrinsic motivation are at the core of students' responsible usage of AI. Ru and Tang (2025) further suggested the academic library's potential to facilitate AI literacy through high-quality curated resources and ongoing AI education models. For LIM students, this translates into acquiring the technical and moral AI expertise of applying generative tools in order to obtain learning outcomes without compromising academic values.

Computer Programming Language Classrooms in Library and Information Management

The integration of teaching computer programming languages into LIM studies is gaining relevance, especially with the shifting demands of the information society and AI settings (Thiruppathi, 2024). Though traditionally schooled in information retrieval and structuring, LIM students are now required to acquire fundamental programming skills to remain competitive and facilitate digital transformation within libraries. Programming classes help these students develop logical thinking, algorithmic reasoning, and technical fluency. However, due to their non-computing academic backgrounds, many LIM students face difficulties in mastering programming concepts. This often leads to increased reliance on digital aids and, more recently, generative AI tools. While helpful in learning syntax or debugging code, these tools also raise concerns about over-reliance and superficial learning if not monitored responsibly (Basu et al., 2024; Ru & Tang, 2025). Therefore, ensuring that students engage meaningfully with programming material while also understanding the ethical use of AI in programming assignments is a current priority in LIM education.

Academic Integrity

Academic integrity remains a cornerstone in higher education, particularly in technology-assisted learning environments such as programming courses. The emergence of generative AI tools has introduced new ethical dilemmas and challenges related to originality, plagiarism, and student accountability. With students now using applications like ChatGPT or GitHub Copilot for code writing, lecturers must reconsider what independent work is and where the role of such tools lies in the learning process. Barrientos et al. (2024) noted how computer and science students are constantly being presented with blurred lines between appropriate use and academic dishonesty. In addition, Basu et al. (2024) highlighted the fact that initial academic interventions such as academic integrity modules significantly increase students' awareness of ethical practice in coding exams. In the case of LIM students, where coding is an ancillary skill, the concern becomes more severe since coding inexperience may cause students to employ generative AI to plagiarize and complete assignments. Therefore, promoting academic integrity through awareness campaigns, honor codes, and guidelines for AI usage is necessary to ensure learning outcomes and institutional reputation.

Synthesis and Research Gap

While prior research highlights the significance of AI ethics and student awareness, most studies rely on either broad conceptual analysis (e.g., Cox, 2024) or non-programming contexts (e.g., Karataş & Yüce, 2024). Additionally, few studies integrate AI literacy with academic integrity as a measurable outcome in technical disciplines. Most lack a validated, multidimensional construct like RAIL to assess ethical AI usage. Thus, this study addresses these gaps by empirically examining the impact of RAIL on academic intergrity adoption, specifically among diploma-level students with minimal computing backgrounds.

Conceptual Framework and Hypothesis

This study offers a conceptual model that correlates RAIL with students' adherence to academic integrity, specifically in computer programming education. RAIL is a multidimensional construct that includes ethical knowledge (sensitivity to fairness, honesty, and transparency in using AI), practical competence (the proficiency to use AI tools like ChatGPT and GitHub Copilot), and reflective understanding (the critical capacity to assess the effects of AI on learning processes). The model builds on foundational AI ethics and digital literacy theory (Cox, 2024; Lo, 2025), academic integrity models (Barrientos et al., 2024; Rasul et al., 2024), and educational technology acceptance research with a concentration on ethical and responsible AI adoption (Muthukrishnan et al., 2024). It holds the assumption that more conscientious AI literacy levels among students will engage AI tools as auxiliary aids as opposed to shortcuts. This, in turn, eliminates academic misconduct and upholds core principles of honesty and transparency in their coding.

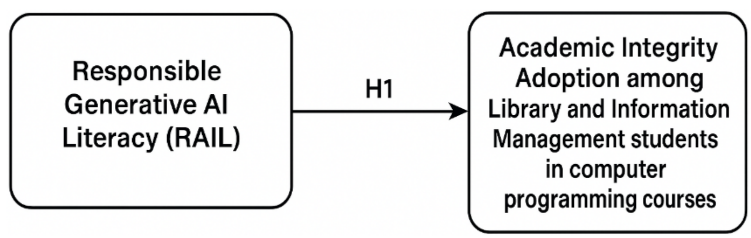

Figure 1. Illustrates the conceptual framework of the study

This conceptual framework in Figure 1 posits that RAIL plays a crucial role in promoting academic integrity adoption among LIM students in computer programming courses. By educating students on the responsible use of AI, lecturers can help mitigate ethical risks and ensure that students uphold academic integrity while leveraging the benefits of generative AI tools. The hypothesis (H1) suggests a positive relationship between RAIL and academic integrity, providing a foundation for further research and practical applications.

Thus, it is suggested that:

H1: RAIL positively influences Academic Integrity Adoption among LIM students in computer programming courses.

METHODOLOGY

Research Design

A quantitative cross-sectional survey research design was employed to collect data from diploma-level students enrolled in programming courses within LIM academic programs. This design was selected to allow for the systematic collection of students' views at a specific point in time and to evaluate the hypothesized relationship between AI literacy and integrity-based adoption in programming education. To examine students' perceptions and behavioral tendencies, the study used Partial Least Squares Structural Equation Modeling (PLS-SEM) as the analytical approach due to its suitability for theory testing, predictive modeling, and overseeing complex latent constructs with reflective indicators.

Measurement Instruments

Responsible Generative AI Literacy (RAIL)

The study operationalized RAIL through six validated subdimensions as summarized in Table 1: Ethical AI Awareness (addressing bias and fairness concerns), Ethical Knowledge (copyright and privacy understanding), Hands-on AI Interaction (practical application skills), Lifelong Learning Attitude (continuous skill development), Pragmatic Knowledge (tool selection and troubleshooting), and Reflective Knowledge (critical evaluation of AI impacts). These dimensions were measured using a 7-point Likert scale, with all indicators demonstrating strong reliability (loadings > 0.70). The multi-faceted assessment captures both technical competencies (HAI, PK) and ethical-cognitive dimensions (EAA, EK, RK, LLLA), providing a comprehensive evaluation framework for AI literacy in educational contexts. This approach enables educators to identify specific strengths (e.g., 82.4% proficiency in Hands-on Interaction) and gaps (40% struggling with technical distinctions) in students' AI readiness. Table 1 outlines seven key dimensions that collectively define RAIL. Each dimension represents a critical area of competence or awareness necessary for individuals to engage responsibly and effectively with generative AI technologies.

Table 1. Responsible generative AI literacy dimensions and its acronym

Dimension	Acronym
Theoretical knowledge	TK
Ethical Knowledge	EK
Practical Knowledge	PK
Reflective Knowledge	RK
Equity and Access	EAA
Human-AI Collaboration	HAI
Lifelong Learning and Adaptation	LLLA

Academic Integrity Adoption

The Academic Integrity Adoption construct was measured through seven validated indicators assessing ethical technology use: Courage to Use AI (reporting misuse), Fairness, Honesty, Transparency (disclosing AI assistance), Trust, Responsibility, and Responsiveness (adapting to ethical guidelines). Each indicator demonstrated strong psychometric properties (loadings > 0.70 on a 7-point Likert scale), with particularly high scores for Honesty (78.9% ≥ 5/7) and Transparency (85.3% ≥ 5/7). This multidimensional operationalization captures both behavioral (COUR, RESPON) and normative (FAIR, HON, TRANS) aspects of integrity, providing a robust framework to evaluate how students reconcile AI adoption with scholarly ethics. The results reveal a tension between strong ethical principles (e.g., transparency) and practical challenges (e.g., responsibility for AI outputs), informing targeted interventions.

Table 2 presents eight fundamental dimensions that define the concept of **Academic Integrity**, along with their corresponding acronyms. These dimensions represent core values and principles that guide ethical behavior in academic environments and help foster a culture of honesty, responsibility, and fairness in learning and research.

Table 2. Academic integrity dimensions and its acronym

Dimension	Acronym
Courage	COUR
Trust	TRU
Fairness	FAIR
Honesty	HON
Respect	RESP
Responsibility	RESPON
Transparency	TRANS
Accountability	ACC

Data Analysis Techniques

Partial Least Squares Structural Equation Modeling (PLS-SEM)

This research utilized PLS-SEM with SmartPLS software for multiple methodological reasons. First, PLS-SEM is especially well-suited for theory development and exploratory research models based on prediction compared to theory confirmation (Hair et al., 2019). Second, the constructs of this research, RAIL and Academic Integrity Adoption, are theorized to be reflective and have multiple latent variables with various indicators, for which PLS-SEM is a suitable option to estimate complex relationships and hierarchical structures. Moreover, using the relatively small sample size (n = 68), PLS-SEM offers a dependable alternative to covariance-based SEM (CB-SEM), conventionally requiring larger samples and multivariate normality. Lastly, PLS-SEM's ability to analyze measurement and structural models simultaneously affords support for the aims of this present research to understand how RAIL influences academic honesty in a given learning environment.

Sample Size Consideration

While PLS-SEM is well-suited for exploratory models and small sample sizes due to its distribution-free nature and ability to oversee complex latent constructs (Hair et al., 2019), the sample size in this study (n = 68) is at the lower threshold of acceptability. Although the model met standard criteria for reliability and validity, a small sample may compromise the stability of parameter estimates and increase the likelihood of Type I or Type II errors. Therefore, the results should be interpreted cautiously, especially regarding generalizability to broader populations. This limitation may affect the robustness of the path coefficients and model predictiveness, and future studies should seek to replicate these findings using larger and more diverse samples to enhance external validity and statistical power.

Measurement Model Assessment

The scale confirmed good sound psychometric properties for both factors. All the indicator loadings had a reliability greater than 0.70. Internal consistency was captured via RAIL, which was highly reliable (Cronbach's $\alpha = 0.983$, CR = 0.984), and Academic Integrity Adoption (Cronbach's $\alpha = 0.978$, CR = 0.980). Convergent validity was established with Average Variance Extracted (AVE) values of 0.685 (RAIL) and 0.712 (Academic Integrity), which were all greater than 0.50. Discriminant validity was established by Heterotrait-Monotrait (HTMT) ratio (0.854 < 0.90), demonstrating unrelated yet dissimilar constructs. Close validation verifies that the measurement model is adequate for structural analysis.

Structural Model Testing

Structural model analysis revealed a statistically significant positive relationship between RAIL and Academic Integrity Adoption. A path coefficient of 0.847 ($p < 0.001$) and a large t-value of 30.842 reflect that RAIL has strong predictive power on student adoption of academic integrity practices to use AI tools while programming. These significant findings confirm our hypothesis that responsible AI skills development directly fosters students' ethical uses of generative AI tools in learning environments. The extremely high t-value and highly significant p-value ($p = 0.000$) demonstrate the robustness and dependence of this relationship, indicating that RAIL is a strong determinant of academic integrity in AI-facilitated programming education.

RESULTS

Participants

The survey gathered responses from 68 participants, primarily from a Diploma in Information Management (66.2%) and a Diploma in Library Informatics (33.8%). No respondents were recorded from the Bachelor (Hons) in Library Management program. In terms of programming course enrollment, a majority (63.2%) are taking the subject Computer Programming for Information Professionals using C++, while 36.8% are enrolled in the subject Computer Programming for Libraries using Python.

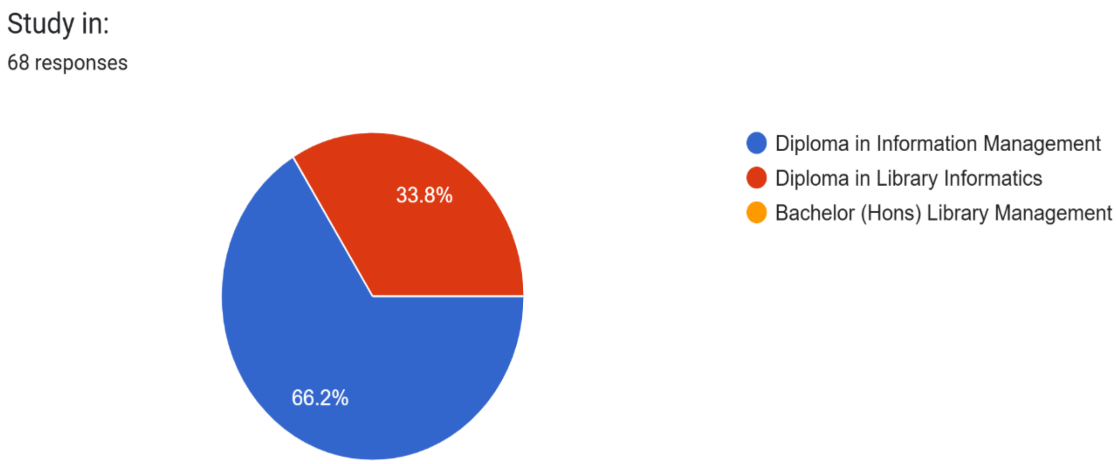

Figure 1: Study program

The higher representation of diplomas in information management students suggests that findings may be more reflective of this group, warranting a comparative analysis to explore differences in AI literacy across programs. Additionally, the greater enrollment in C++ programming could indicate a perceived relevance of this language in their academic and professional development. However, considering Python's strong association with AI applications, it would be valuable to examine whether students enrolled in Python programming demonstrate higher AI literacy and adoption rates. Understanding these variations can provide insights into how responsible AI adoption differs based on programming exposure. Tailoring AI literacy initiatives to suit both C++ and Python learners may be necessary to optimize their understanding and ethical use of AI tools in academic and professional settings.

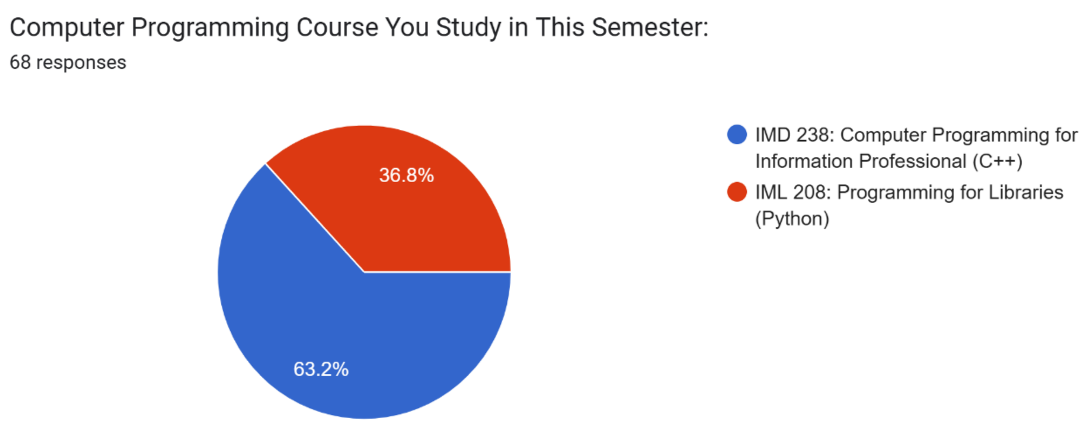

Figure 2: Computer programming courses

The third pie chart in Figure 3 presents the gender distribution, indicating that the majority of respondents, **76.5%**, are female, while **23.5%** are male. These findings suggest that female students dominate the surveyed academic environment. Additionally, the significant representation from multiple groups indicates diverse perspectives on AI adoption and programming literacy.

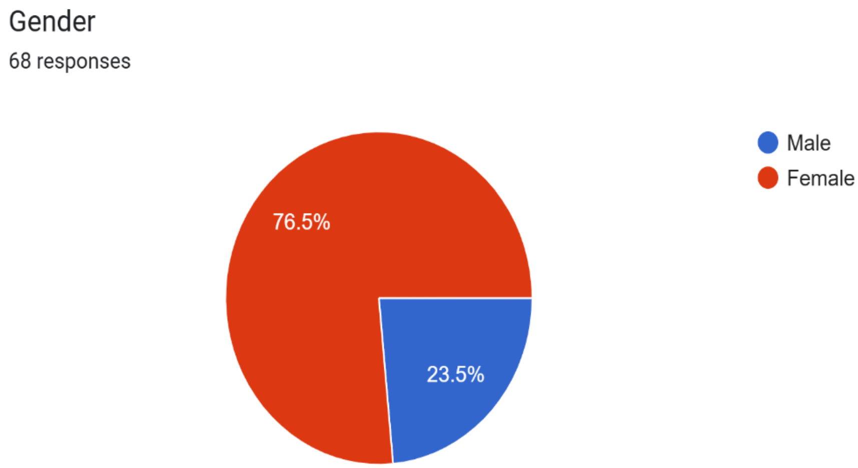

Figure 3: Gender of respondents

Measurement Model Evaluation (Outer Model)

A measurement model was used to assess and validate the reliability of constructs used in this study, i.e., RAIL and Academic Integrity Adoption, both of which were measured through multiple reflective indicators. The reliability of indicators was tested by validating through outer loadings, which were derived from SmartPLS outputs. All the loadings of the indicators were higher than the commonly used cut-off value of 0.70, presented excellent individual item reliability, and confirmed that the observed indicators are good indicators of their respective latent constructs. For the Academic Integrity Adoption factor, the indicative salient measures such as COUR1–COUR3 (Courage to Adopt AI), FAIR1–FAIR3 (Fairness), HON1–HON3 (Honesty), TRANS1–TRANS3 (Transparency), TRU1–TRU3 (Trust), RESP1–RESP3 (Responsibility), and RESPON1–RESPON3 (Responsiveness) obtained high factor loadings between 0.718 and 0.931, and hence revealed high convergent validity. Similarly, the RAIL construct was measured through Ethical AI Awareness (EAA), Ethical Knowledge (EK), Hands-on AI Interaction (HAI), Lifelong Learning Attitude (LLLA), Pragmatic Knowledge (PK), and Reflective Knowledge (RK). All items yielded high outer loadings (0.731 and 0.912), confirming the strength of the measurement model.

These results confirm the measurement model's strength and provide a sound basis for structural model estimation. Extremely high construct reliability and validity enable safe interpretation of correlations between RAIL and Academic Integrity adoption in computer programming education.

Structural Model Testing

The structural model was evaluated to investigate the reliability, validity, and discriminant validity of the constructs using internal consistency estimates and the HTMT ratio.

Construct Validity and Reliability

Internal consistency reliability was tested for both constructs, RAIL and Academic Integrity Adoption, using Cronbach's alpha, rho_A, and Composite Reliability (CR). All were above the suggested value of 0.70, which indicates excellent reliability. Moreover, AVE values were higher than 0.50 for both constructs (Academic Integrity = 0.712; RAIL = 0.685), indicating high convergent validity, thereby establishing that the constructs explain more than half the variance of their respective indicators.

Table 3. Construct validity and reliability

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Academic Integrity	0.978	0.980	0.980	0.712
RAIL	0.983	0.984	0.984	0.685

Discriminant Validity

Discriminant validity was also established using the HTMT ratio of correlations. The HTMT between RAIL and Academic Integrity constructs was 0.854, which falls short of the strictest value of 0.90, reflecting that the constructs are empirically unique and quantify conceptually disparate phenomena. The results validate both constructs to fulfill the reliability and validity criteria, presenting a strong foundation for future interpretation of causal relations in the model.

Path Coefficients Bootstrapping (for Significance Testing)

The path analysis outcome indicates a strong and significant positive relationship between RAIL and Academic Integrity Adoption. The original sample (O) is 0.847, and the sample mean (M) is 0.852, which suggests that the estimation is highly reliable and robust.

The standard deviation (STDEV) is 0.027, which is very low, indicating minimal variation among the bootstrapped samples. The T-statistic, absolute value of O divided by STDEV, is 30.842, astronomically higher than the previous cut-off of 1.96, and this is evidence that the relationship is statistically significant. Furthermore, the p-value of 0.000 is well below the threshold of 0.05 for significance. This conclusively confirms the hypothesis that RAIL significantly affects students' adoption of academic integrity.

Last but not least, the analysis confirms that better RAIL would make students adopt Academic Integrity tools ethically and efficiently in computer programming.

Table 4. Impact of RAIL on academic integrity

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
RAIL -> Academic Integrity	0.847	0.852	0.027	30.842	0.000

DISCUSSIONS AND CONCLUSION

The use of generative AI in computer programming education, especially among LIM students, is both promising and complex. This section addresses the impact of RAIL on academic integrity in computer programming education, grounded in empirical evidence and recent research.

Ethical Implications of RAIL in Programming Education

RAIL is a foundation of ethical programming practice. The advent of AI technologies like ChatGPT and GitHub Copilot is raising plagiarism, dependence, and impersonation of student work issues. Students acknowledge the benefits of AI in learning support but emphasize the need for clearly articulated institutional policy and ethics training to prevent abuse (Barus et al., 2025; Nguyen, 2025).

The strong, positive correlation between RAIL and academic integrity adoption ($\beta = 0.847$, $p < 0.001$) indicates that ethically grounded AI literacy significantly predicts responsible student behavior in programming contexts. This supports Muthukrishnan et al. (2024), who emphasized the role of AI literacy in the responsible use of AI. These findings also extend both Cox's (2024) and Lo’s (2025) conceptual work on RAIL by operationalizing RAIL into measurable subdimensions (theoretical knowledge, ethical knowledge, pragmatic knowledge, and reflective knowledge). Our results demonstrate that these dimensions predict academic integrity behavior, thus adding empirical weight to Cox's and Lo’s theoretical framing.

Furthermore, Basu et al. (2024) focused on student perspectives on generative AI governance in higher education to ensure responsible and ethical AI integration. Conversely, our results suggest that RAIL, when embedded into programming learning, can independently foster ethical behavior, particularly in disciplines where programming is not a core strength, such as in LIM.

Moreover, Wu et al. (2024) argued that higher education institutions must provide governance principles to neutralize the misuse of generative AI, for example, open policies and the inclusion of AI-based academic integrity problems within the study curriculum. The absence of systematic ethical principles enables the utilization of AI in computer programming to reduce conventional scholarly standards and ethics (Gruenhagen et al., 2024).

Enhancing Students' Understanding of AI Ethics

A strong positive correlation between the AI literacy level of students and the way they use AI tools responsibly in learning settings has been established through research. Awareness and internal motivation have been discovered to strongly predict writing and programming activity ethical behavior with AI, as noted by Muthukrishnan et al. (2024). In programming settings, AI-literate students will differentiate between using AI as a learning tool and misusing it for cheating on tests.

In addition, the students support the incorporation of generative AI in curricula but with more emphasis on ethics-driven education with data privacy, anti-plagiarism, and algorithmic fairness as the focus areas (Barus et al., 2025). This indicates a sensible student-driven demand for ethical boundaries and responsible use of AI in educational settings.

Challenges in Integrating RAIL into Programming Classrooms

Introducing RAIL in computer programming teaching poses a variety of structural and pedagogical challenges. Chinedu et al. (2024) identified technical limitations, the issue of cost, and the need for proper faculty training as among the challenges. Ethical issues involving privacy of information, impartiality in the content created by AI, and fear of the replacement of teachers with AI are also involved.

Universities are still grappling with the rapid growth of AI technology, where they are challenged to have tangible policy implementation that finds a middle ground between academic integrity and innovation (Gruenhagen et al., 2024). Inconsistencies in AI policies create confusion among students, which makes it challenging to distinguish between correct and incorrect AI applications in programming tasks.

Benefits of RAIL in Promoting Academic Integrity

Despite the challenges, accountable AI literacy has some academic and moral advantages. With RAIL provided to the students, they will harness the use of AI tools to augment and not substitute their education. For instance, AI can help students debug, brainstorm algorithms, and test various code methods without losing creativity (Muthukrishnan et al., 2024).

Barus et al. (2025) clarified that students would prefer generative AI to be integrated into learning provided that there are policy arrangements in place, such as monitoring plagiarism and open disclosure of employing AI, that ensure academic integrity. Educators can leverage their willingness by providing assignments that promote reflective learning and critical consideration of the output from AI.

Potential Consequences of Inadequate Generative AI Literacy

Generative AI illiteracy can devastate academic integrity in computer programming education to a great degree. People with inadequate knowledge of AI ethical use can plagiarize without realizing it by presenting code developed by the utilization of AI (Leoste et al., 2025; Smit & du Plessis, 2024). In other words, illiteracy leads to academic dishonesty and lowers the creativity of work conducted by students. In addition, excessive reliance on these tools will discourage learning fundamental programming skills, including problem-solving and critical thinking skills, resulting in students' poverty in learning (Lyons et al., 2024). There are also ethical issues where unequal access and differential use of AI tools yield unequal learning gains and further exacerbate prevailing education inequalities (Dhruv et al., 2024; Farrelly & Baker, 2023). AI content detection is an education issue and makes cheating undetectable or creates false positives (Milinković et al., 2024; Rajabi, 2024). These problems highlight the imperative necessity of incorporating ethics training and AI skills in learning to enable the student to practice AI ethically and maintain academic integrity (Chui et al., 2024; Lodge et al., 2024). Without these learning interventions, institutions are likely to disassemble trust in academic testing and fail to prepare students for ethical practice in professional computing settings.

Implications for Policy and Pedagogy

The findings have several policy and pedagogical implications for policymakers and lecturers who wish to uphold academic integrity in the age of generative AI. Firstly, the principles of RAIL must be integrated into the first programming modules to ensure that students acquire ethical awareness right from the start. Secondly, requesting students submit AI use statements and coding tasks can guarantee transparency and encourage responsible practice. AI plagiarism-checking tools are also required to remove any potential dishonesty and maintain academic integrity. Second, workshops regarding the responsible use of AI must be conducted between the students and the lecturers to ensure that there is a level playing field on what is responsible practice. Finally, integrating scenario-based discussion within the curriculum can help students think critically about real-world ethical dilemmas in AI-facilitated programming. Collectively, these pedagogical strategies increase students' technical skills and offer a strong ethical foundation, preparing them for both academic and ethical professional work in AI-enabling environments.

CONCLUSION

Despite the study's strong psychometric results, the limited sample size remains a notable constraint. Replicating the model with a larger and more diverse student cohort would strengthen the validation of RAIL as a determinant of academic integrity and help refine the proposed framework. Ethically grounded generative AI literacy has significantly enhanced students' ability to uphold academic integrity in programming courses by deepening their understanding of ethical norms. It also promotes transparency in AI use and mitigates risks such as academic fraud and overreliance on AI tools. However, for successful implementation, institutions must address underlying systemic, technological, and ethical challenges. A well-structured and ethically anchored approach to AI literacy can thus serve as a vital mechanism for preserving academic integrity in the era of intelligent systems.

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Conflict of Interest

The authors have no conflicts of interest to declare.

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APPENDICES

Appendix A: Measurement of Variable RAIL and Academic Integrity

	Academic Integrity	RAIL	Measurement
COUR1	0.867		I am willing to report unethical programming practices, such as code plagiarism, if I encounter them.
COUR2	0.931		I adhere to ethical coding practices, even under pressure to compromise.
COUR3	0.915		I hold myself accountable for following ethical guidelines in my programming projects.
EAA1		0.816	I believe AI literacy opportunities should be accessible to individuals from diverse backgrounds and skill levels.
EAA2		0.845	I think educational institutions and libraries have a responsibility to provide equitable access to AI learning resources.
EAA3		0.829	I feel that my access to AI technologies and training is inclusive and adequate for my needs.
EAA4		0.810	I support initiatives that aim to reduce disparities in access to AI tools and education.
EAA5		0.867	I am aware of the barriers that certain groups face in engaging meaningfully with AI technologies and advocating for solutions.
EK1		0.787	I understand the ethical issues related to bias in generative AI outputs.
EK2		0.768	I am aware of the privacy risks associated with the use of generative AI tools.
EK3		0.878	I critically evaluate the legal and ethical implications of using copyrighted material for training generative AI.
EK4		0.778	I consider the environmental impact of generative AI technologies when deciding to use them.
EK5		0.812	I reflect on how generative AI impacts social equity and access to technology.
FAIR1	0.851		I feel that all students are given equal access to programming tools and resources.
FAIR2	0.915		I believe the evaluation criteria for programming assignments are applied fairly.
FAIR3	0.887		I think my programming work is assessed based on objective and transparent standards.
HAI1		0.817	I see AI as a tool that enhances my decision-making process rather than replacing my judgment.
HAI2		0.891	I feel confident using AI technologies to support my creativity and problem-solving tasks.

HAI3		0.847	I collaborate effectively with AI tools to achieve better outcomes in my work or studies.
HAI4		0.803	I believe AI and humans can complement each other's strengths to perform tasks more efficiently.
HAI5		0.842	I view AI as a supportive partner in tasks that require critical thinking and innovation.
HON1	0.718		I ensure all external code or libraries I use are properly cited in my programming assignments.
HON3	0.816		I am transparent about the sources and tools I use in my programming projects.
LLLA1		0.849	I actively seek opportunities to learn about new AI tools and technologies as they emerge.
LLLA2		0.912	I adapt my skills and knowledge to keep up with the rapid advancements in AI.
LLLA3		0.905	I am committed to understanding the ethical implications of AI throughout my personal and professional life.
LLLA4		0.870	I recognize the importance of continuous learning to stay competent in using AI technologies.
LLLA5		0.866	I am open to exploring how AI can shape and influence societal and cultural changes over time.
PK2		0.791	I am confident in my ability to effectively use generative AI tools to achieve desired outcomes.
PK3		0.808	I stay updated on the latest advancements and functionality of generative AI applications.
PK4		0.731	I can troubleshoot issues that arise while using generative AI tools.
PK5		0.813	I understand how to tailor generative AI outputs to meet specific contextual needs.
RESP1	0.878		I respect the intellectual property of others by not using code without permission or proper acknowledgment.
RESP2	0.820		I acknowledge the contributions of my peers in collaborative programming projects.
RESP3	0.810		I avoid tampering with or misusing others' code in shared repositories.
RESPON1	0.895		I take full responsibility for the quality and originality of my programming assignments.
RESPON2	0.778		I adhere to deadlines and project requirements in my coding tasks.
RESPON3	0.849		I am accountable for identifying and fixing bugs or errors in my code.
RK1		0.855	I regularly reflect on how my use of generative AI influences my personal learning or problem-solving processes.
RK2		0.761	I am aware of how generative AI might affect my dependency on technology.

RK3		0.766	I consider the potential impact of generative AI on my critical thinking and creativity.
RK4		0.813	I reflect on how generative AI may alter my interpersonal interactions and social connections.
RK5		0.841	I evaluate the potential long-term effects of generative AI use on my professional or personal skills.
TRANS1	0.853		I ensure my programming work is transparent by providing detailed comments and documentation.
TRANS2	0.863		I make my coding process clear and easy for others to understand.
TRANS3	0.874		I am open about the sources and tools I use in my programming tasks.
TRU1	0.767		I trust my peers to contribute original and ethical work in collaborative programming projects.
TRU2	0.762		I believe my instructors evaluate my programming assignments fairly and transparently.
TRU3	0.786		I feel confident that group projects are assessed equitably based on individual contributions.

Appendix B: Heterotrait of Variable RAIL and Academic Integrity

Heterotrait-Monotrait Ratio (HTMT)

	Academic Integrity
Academic Integrity	
RAIL	0.854