Conceptual Framework for Responsible Artificial Intelligence Integration in Undergraduate Programming Education

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***Abstract*—The increasing popularity and development of AI in undergraduate studies are altering the way students undertake their studies and programming assignments. Various AI-based resources such as ChatGPT, Gemini, and programming assistants assist students in writing code efficiently and comprehending programming concepts easily. However, the increased usage of such AI tools raises concerns and risks relating to plagiarism, over-reliance, reduced problem-solving skills, and ethical problems. Therefore, this research proposes a theoretical model to promote responsible AI integration into undergraduate programming studies. A systematic literature review (SLR) approach was used to review and analyze available studies concerning AI in education, programming assistance, AI literacy, assessment, and responsible AI management. Results indicate that AI presents benefits in education but needs to be guided, ethically controlled, and assessed differently.**

***Index Terms*—Artificial Intelligence Literacy, Academic Integrity, Automated Coding Assistants, Ethical Use of Artificial Intelligence, Educational Technology, Responsible Use of Artificial Intelligence**

I. Introduction

A. Problem Background

Artificial Intelligence (AI) is being used more frequently in programming classwork and has significantly changed how students learn and complete programming tasks. Several AI-powered coding assistant tools such as ChatGPT, GitHub Copilot, and other intelligent programming assistants help students write programs faster, understand concepts more efficiently, debug code more effectively, and receive personalized learning support more easily [1], [2]. Consequently, the use of AI tools in programming education has increased rapidly in classrooms, assignments, and self-learning activities.

While technological advancement in education offers numerous educational advantages, it also introduces significant challenges. Many students may submit accurate and clean code developed with AI assistance; however, during oral presentations, viva sessions, or laboratory evaluations, a large number of students struggle to explain program logic, identify coding errors, or solve problems independently. This situation makes it difficult for instructors to evaluate students' actual knowledge, critical thinking abilities, and programming skills [4]–[6].

The major issues identified in the current educational environment include excessive dependence on AI assistance, reduced self-reliance in problem-solving, academic integrity concerns, lack of institutional policies for responsible AI usage, and challenges in conducting authentic student assessments.

B. Related Studies and Research Gap

Researchers have investigated AI integration in education from multiple perspectives. Several studies emphasize the importance of AI literacy, responsible AI usage, ethical governance, and AI competency development within educational environments [7], [8], [14], [15]. Other studies focus on the educational benefits and challenges associated with AI-powered coding assistants, generative AI tools, and AI-supported programming education [1], [2], [11], [12], [19]. These studies indicate that AI technologies can improve productivity, learning efficiency, programming support, and conceptual understanding within a relatively short period of time.

At the same time, several researchers warn that excessive reliance on AI tools may encourage superficial learning, reduce independent problem-solving abilities, and raise serious concerns regarding academic integrity and assessment validity [4]–[6], [16]–[18]. Previous studies also identified challenges related to transparency, ethical responsibility, fairness, assessment authenticity, and institutional preparedness for AI adoption within educational settings.

Although these studies provide valuable insights into AI integration in education, most of them focus only on individual

aspects of AI integration, such as AI ethics, governance, AI literacy, tool effectiveness, or assessment challenges. Only a limited number of studies have attempted to combine responsible AI usage, educational governance, and programming pedagogy within a single conceptual framework [13], [15]. Furthermore, there remains a lack of comprehensive frameworks that simultaneously integrate AI literacy, AI ethics, pedagogical strategies, assessment redesign, governance mechanisms, and responsible AI implementation specifically for undergraduate programming education [3], [20].

The literature also identifies broader institutional and social concerns regarding responsible AI adoption, including fair assessment of student capabilities, sustainability of long-term learning, student dependency on AI-generated solutions, and preparation for AI-enabled professional environments. Therefore, the primary research gap addressed by this study is the absence of a structured and simplified framework for the responsible and ethical integration of AI tools in undergraduate programming education.

C. Research Objectives and Questions

The primary objective of this study is to build a framework for the ethical and responsible adoption of Artificial Intelligence (AI) in undergraduate programming education. The study systematically investigates the current challenges, educational, ethical, and assessment-related, associated with AI-supported programming learning environments to reach this goal.

Moreover, the study investigates the existing literature on AI literacy, responsible AI use, academic integrity, governance mechanisms, and AI-supported programming education to identify the essential components for responsible AI integration in higher education.

Based on the findings of the systematic literature review, the study proposes a conceptual framework for ethical, effective, responsible, and sustainable use of AI technologies in undergraduate programming courses.

To achieve these objectives, the following research questions were formulated:

- **RQ1:** What are the key issues of implementing AI in undergraduate programming courses?
- **RQ2:** What are the key elements required for a conceptual framework for responsible AI integration in undergraduate programming education?

D. Research Contributions

This study contributes to the growing field of AI-integrated education by proposing a conceptual framework for responsible AI integration in undergraduate programming courses. The proposed framework aims to support students in using AI tools ethically and effectively while helping educators design improved teaching strategies and authentic assessment methods.

In addition, the framework may assist educational institutions in developing policies and governance strategies for responsible AI adoption. Therefore, this research contributes to ongoing discussions regarding ethical AI usage, academic integrity, sustainable learning practices, and responsible technology integration in higher education.

II. Methodology

A. Selection of Data Collection Method

This study used a Systematic Literature Review (SLR) as the main research methodology because it allows a structured, transparent, and complete investigation of existing research related to responsible AI integration in undergraduate programming education. SLR is well accepted as an effective method for identifying research trends, synthesizing evidence, analyzing existing findings, and discovering research gaps within emerging research domains [20], [21]. According to Kitchenham and Charters [21], SLR provides a rigorous and reproducible process for gathering, evaluating, and synthesizing evidence from previously published studies. Similarly, Snyder [22] highlighted that literature review methods are very appropriate for developing theoretical understanding, conceptual models, and future research directions in fast-moving interdisciplinary fields.

The SLR approach was selected as more appropriate for the current study than survey-based or interview-based research methods since the key aim of the research is to develop a conceptual framework based on existing scholarly knowledge rather than to collect subjective opinions or empirical responses from a limited group of participants. A qualitative thematic analysis approach was used to analyze the selected literature. Through this analysis, common themes, educational challenges, ethical concerns, assessment issues, and proposed solutions were identified to support the development of the proposed conceptual framework.

B. Description of the Data Collection Method

The systematic literature review was conducted following a PRISMA-inspired framework to ensure that the literature selection process remained systematic, transparent, and reproducible. The review process included four major stages: identification, screening, eligibility assessment, and final selection of studies.

Database and Publisher Sources. Relevant research papers were collected from multiple large academic databases and publishers, including Google Scholar, IEEE Xplore, SpringerLink, ScienceDirect, and the ACM Digital Library.

Search Engine. Google Scholar was used as the primary search engine because it provides broader access to academic publications, citations, conference proceedings, and related literature across multiple publishers and databases.

Search Keywords. The literature search was conducted using combinations of the following keywords: “Responsible AI in Education,” “AI in Programming Education,” “AI Coding Assistants,” “ChatGPT in Higher Education,” “AI Literacy,” and “Academic Integrity and AI.” Boolean operators such as AND and OR were applied to refine the search process and identify relevant studies.

Search Scope. The search scope included article titles, abstracts, keywords, and full-text contents to ensure comprehensive literature coverage.

Publication Duration. Most of the selected studies were published between 2019 and 2026 because this period reflects the rapid growth of generative AI technologies and their integration into educational environments.

Backward and Forward Search. Backward reference searching identified 8 additional relevant studies, while forward searching using the "Cited by" feature in Google Scholar identified 11 additional studies. Author citation searches identified a further 6 relevant studies.

Literature Selection Process. The initial literature search identified 56 studies. After removing duplicate papers and conducting title and abstract screening, 37 studies remained. Full-text reading and thematic relevance analysis were then conducted to finalize the literature selection. Finally, 20 highly relevant studies were selected for detailed qualitative analysis and framework development.

Inclusion and Exclusion Criteria. Inclusion criteria: studies published between 2019 and 2026; English-language publications; peer-reviewed journal articles or accepted conference papers; and studies related to AI in education, programming education, AI ethics, AI literacy, or responsible AI. Exclusion criteria: duplicate studies; non-English publications; blogs, opinion articles, and non-academic sources; studies unrelated to the research objectives; and papers with limited relevance to undergraduate programming education.

Literature Quality Assessment. The quality assessment process combined qualitative and quantitative evaluation criteria based on peer-review status, publisher reputation, database indexing, citation strength, and thematic relevance. Among the final 20 selected studies: 13 were indexed in SCOPUS, 11 were indexed in Web of Science, 18 were published in peer-reviewed journals or internationally recognized conference proceedings, all 20 had more than 60 citations according to Google Scholar, and 12 were published by major publishers such as ACM, IEEE, Springer, Elsevier, and Taylor & Francis.

C. Completeness of the Literature Review

The completeness and reliability of the systematic literature review were verified through multiple validation approaches. The selected studies were compared with previously published systematic literature reviews and meta-systematic reviews, particularly those conducted by Zawacki-Richter et al. [20] and Snyder [22], to ensure that the selected literature sufficiently covered the major research themes, emerging challenges, and ethical concerns associated with AI integration in education. Backward reference searching, forward citation searching, and author citation searches were applied to improve literature coverage and identify influential papers and emerging research trends.

D. Ethical Standards of Engineering Practice

This research is entirely based on secondary literature sources and does not involve collecting personal data from human participants. Therefore, the study does not present direct ethical risks related to human subjects. However, the research addresses several important ethical issues associated with Artificial Intelligence in undergraduate education, including fairness, transparency, accountability, academic integrity, algorithmic bias, and responsible AI usage. The proposed conceptual framework was designed to help mitigate these ethical challenges by promoting responsible, transparent, and pedagogically effective AI integration within undergraduate programming education.

III. Results and Analysis

A. Research Data and Literature Distribution

The systematic literature review process resulted in the final selection of 20 highly relevant studies related to Artificial Intelligence integration in undergraduate programming education. The selected studies were published between 2019 and 2026 and consisted of journal articles, conference papers, review studies, and conceptual research papers. Among the selected studies, 8 primarily focused on AI-assisted programming and coding tools, 5 examined AI ethics, governance, and responsible AI practices, 4 investigated AI literacy and educational readiness, and 3 focused on academic integrity and assessment challenges in AI-supported education. Regarding publication type, 13 studies were journal articles and 7 were conference proceedings. Most studies were published after 2022, reflecting the rapid growth of generative AI technologies such as ChatGPT, GitHub Copilot, and AI-powered programming assistants within educational environments.

B. Findings from the Systematic Literature Review

The systematic literature review identified that AI-based technologies such as ChatGPT and AI coding assistants can significantly support undergraduate programming education through automated code generation, debugging assistance, concept explanation, and personalized learning support. Several studies reported that AI tools improve learning accessibility, increase student productivity, reduce programming-related frustration, and support faster problem-solving processes [1], [2], [11], [12].

However, the review also identified major educational and ethical concerns associated with excessive AI usage in programming education. The most frequently discussed issues included overdependence on AI-generated solutions, superficial learning, reduced independent problem-solving abilities, plagiarism risks, and difficulties in evaluating authentic student understanding [5], [6], [13], [16], [17]. The selected studies consistently emphasized the importance of AI literacy, ethical awareness, transparency, governance policies, and assessment redesign for responsible AI integration within educational environments [7]–[10], [14], [15].

Table I summarizes the major themes identified from the selected literature.

TABLE I
MAJOR THEMES IDENTIFIED FROM THE LITERATURE REVIEW

Theme	Key Issues Identified
AI-Assisted Learning	Code generation, debugging, personalized learning support
Academic Integrity	Plagiarism, cheating, assessment validity concerns
Ethical Concerns	Transparency, fairness, accountability, responsible AI usage
AI Literacy	Critical evaluation, responsible usage, AI competency development
Assessment Challenges	Authenticity checks, oral evaluation, assessment redesign
Governance and Policy	Institutional guidelines, ethical governance, responsible AI policies

C. Discussion of Research Questions

RQ1: What are the key issues of implementing AI in undergraduate programming courses? The findings from the selected literature demonstrate that the challenges associated with AI integration are educational, ethical, and assessment-related in nature. Although AI tools provide substantial support for programming tasks, they may also encourage excessive reliance on AI-generated solutions and reduce students' independent critical thinking and problem-solving abilities. The most significant issues identified across the 20 reviewed studies include: excessive dependence on AI-generated solutions, reduced independent problem-solving ability, academic dishonesty and plagiarism risks, low levels of AI literacy, difficulties in conducting authentic assessments, and lack of institutional governance and responsible AI policies. These findings indicate that responsible AI integration requires not only technological adoption but also ethical governance, assessment redesign, pedagogical adaptation, and AI literacy development.

RQ2: What are the key elements required for a conceptual framework for responsible AI integration in undergraduate programming education? The systematic literature review identified several core elements necessary for responsible AI integration, including AI literacy, ethical awareness, governance policies, instructor supervision, assessment redesign, responsible AI usage guidelines, and continuous monitoring of learning outcomes. Based on these findings, this study proposes a conceptual framework consisting of five major phases: (1) Educational Inputs, (2) AI-Supported Learning Processes, (3) Ethical and Governance Controls, (4) Pedagogical and Assessment Mediators, and (5) Learning Outcomes and Risk Evaluation. The proposed framework also incorporates a continuous feedback mechanism that supports ongoing improvement of educational policies, assessment strategies, and teaching practices. The analysis further revealed that no single previous study comprehensively integrated AI literacy, AI ethics, governance mechanisms, pedagogical mediation, assessment redesign, and continuous institutional feedback within one unified framework specifically designed for undergraduate programming education. Therefore, the proposed framework addresses an important research gap identified during the systematic literature review process.

D. Solution Validation

The proposed framework was validated conceptually rather than through direct classroom implementation. First, the framework was compared with existing literature related to AI literacy, AI ethics, governance, responsible AI usage, and assessment redesign, demonstrating consistency with major themes and recommendations identified in previous studies. Second, logical consistency validation was performed by mapping each component of the framework to the educational and ethical challenges identified during the systematic literature review, confirming that each phase addresses specific problems related to AI integration in programming education. Third, the framework was conceptually applied to undergraduate programming education scenarios where students initially solve problems independently, then use AI support in a guided manner, and are finally evaluated using understanding-based assessment methods such as oral explanations, reflection, and code verification. These findings suggest that the proposed framework is coherent, evidence-based, and educationally applicable. However, the practical effectiveness of the framework should be evaluated through future empirical research involving classroom implementation, surveys, or experimental studies.

IV. CONCLUSION

A. Concluding Remarks

This study examined the growing use of Artificial Intelligence (AI) in undergraduate programming education and proposed a conceptual framework for responsible AI integration. The findings from the systematic literature review indicate that AI-powered tools such as ChatGPT and coding assistants can significantly improve programming education by supporting code generation, concept explanation, debugging, personalized learning, and learning accessibility.

However, the study also identified several important challenges associated with AI integration, including excessive dependence on AI-generated solutions, academic integrity concerns, low levels of AI literacy, superficial learning, and difficulties in assessing authentic student understanding. These findings suggest that uncontrolled or poorly supervised AI usage may negatively affect students' independent problem-solving abilities and critical thinking skills.

To address these issues, this research proposed a five-phase conceptual framework (Fig. 1) that integrates educational inputs, AI-supported learning processes, ethical governance, pedagogical mediators, and assessment strategies within a unified model. The framework emphasizes responsible AI usage, understanding-based evaluation, ethical awareness, and continuous institutional improvement.

Overall, the study concludes that Artificial Intelligence should not be completely restricted in programming education; instead, it should be integrated in a controlled, ethical, and pedagogically guided manner that supports authentic learning and responsible technology usage.

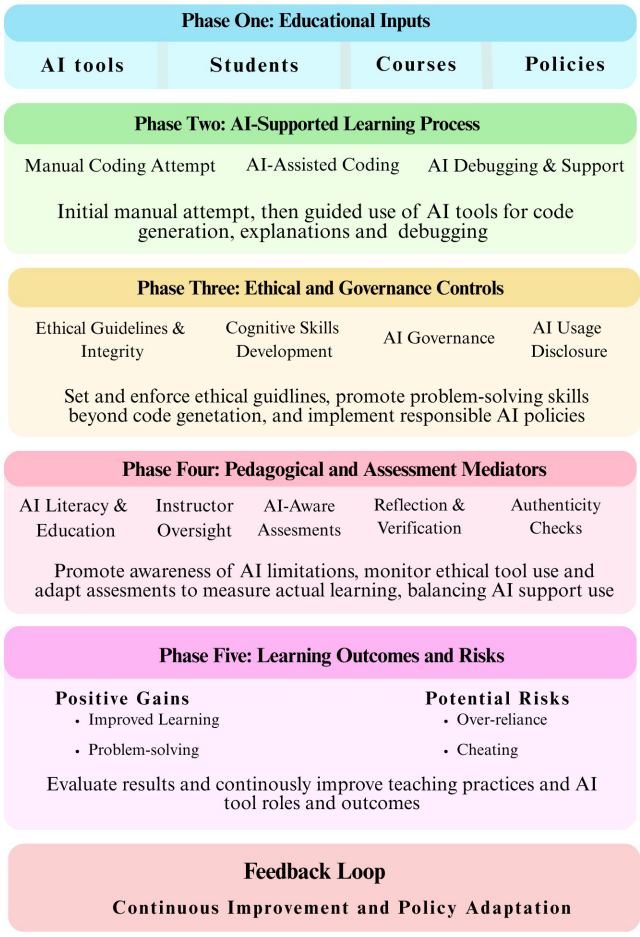


Fig. 1. Proposed conceptual framework for responsible AI integration in undergraduate programming education.

B. Limitations of the Study

This study is primarily based on a systematic literature review and theoretical analysis. The proposed framework has not yet been implemented or tested in real undergraduate programming classrooms. Furthermore, the study does not include survey responses, interviews, classroom observations, or experimental data collected from students or instructors. As a result, the practical effectiveness, usability, and educational impact of the proposed framework remain to be validated through empirical research and real-world implementation.

C. Future Research Scope

Future researchers may extend this study in several important directions. First, the proposed framework can be implemented and evaluated in real undergraduate programming courses to examine its practical effectiveness in improving responsible AI usage and authentic learning outcomes. Second, future studies may incorporate surveys, interviews, classroom observations, and experimental research involving both students and instructors to obtain deeper insights into AI-supported learning experiences and assessment challenges. Third, comparative studies may investigate how students with different academic backgrounds, skill levels, or learning styles respond to AI-assisted programming education, as AI technologies may support some learners effectively while negatively affecting others through increased dependency or reduced critical thinking. Finally, future research should also investigate the long-term educational effects of AI integration, including its influence on problem-solving ability, programming competence, ethical awareness, and professional readiness in AI-enabled workplaces.

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REFERENCES

[1] S. Barke, M. B. James, and N. Polikarpova, "Grounded Copilot: How Programmers Interact with Code-Generating Models," *Proc. ACM Program. Lang.*, vol. 7, no. OOPSLA1, p. 78, 2023.

[2] B. A. Becker, P. Denny, J. Finnie-Ansley, E. A. Santos, J. Prather, and A. Luxton-Reilly, "Programming is Hard—or at Least It Used to Be: Educational Opportunities and Challenges of AI Code Generation," in *Proc. 54th ACM Tech. Symp. Comput. Sci. Educ.*, Denver, CO, USA, 2023.

[3] M. Bond, H. Khosravi, M. de Laat, N. Bergdahl, V. Negrea, E. Oxley, P. Pham, S. W. Chong, and G. Siemens, "A Meta-Systematic Review of Artificial Intelligence in Higher Education: A Call for Increased Ethics, Collaboration, and Rigour," *Int. J. Educ. Technol. High. Educ.*, vol. 21, no. 1, p. 4, 2024.

[4] J. Borenstein and A. Howard, "Emerging Challenges in AI and the Need for AI Ethics Education," *AI Ethics*, vol. 1, no. 1, pp. 61–65, 2021.

[5] T. K. F. Chiu, "AI Literacy and Competency: Definitions, Frameworks, Development and Future Research Directions," *Interact. Learn. Environ.*, vol. 33, no. 5, pp. 3225–3229, 2025.

[6] D. R. E. Cotton, P. A. Cotton, and J. R. Shipway, "Chatting and Cheating: Ensuring Academic Integrity in the Era of ChatGPT," *Innov. Educ. Teach. Int.*, vol. 61, no. 2, pp. 228–239, 2024.

[7] European Commission, *Ethics of Artificial Intelligence: Issues and Initiatives*, Publications Office of the European Union, Tech. Rep., 2019.

[8] J. Finnie-Ansley, P. Denny, B. A. Becker, A. Luxton-Reilly, and J. Prather, "The Robots Are Coming: Exploring the Implications of OpenAI Codex on Introductory Programming," in *Proc. 24th Australasian Comput. Educ. Conf.*, ACM, 2022.

[9] L. Floridi and J. Cowls, "A Unified Framework of Five Principles for AI in Society," *Harvard Data Sci. Rev.*, vol. 1, no. 1, 2019.

[10] Y. Fu and Z. Weng, "Navigating the Ethical Terrain of AI in Education," *Comput. Educ. Artif. Intell.*, vol. 7, p. 100306, 2024.

[11] E. Kasneci, K. Sessler, S. Küchemann, et al., "ChatGPT for Good? On Opportunities and Challenges of Large Language Models for Education," *Learn. Individ. Differ.*, vol. 103, p. 102274, 2023.

[12] M. Kazemitabaar, J. Chow, C. K. To Ma, B. J. Ericson, D. Weintrop, and T. Grossman, "Studying the Effect of AI Code Generators on Supporting Novice Learners in Introductory Programming," in *Proc. 2023 CHI Conf. Human Factors Comput. Syst.*, ACM, Hamburg, Germany, 2023.

[13] A. Lagman, R. Que, K. C. Piad, and A. R. Caballero, "A Pedagogical Framework for Responsible Use of ChatGPT in Programming Education," *J. Cultural Anal. Soc. Change*, vol. 11, no. 1, pp. 2693–2697, 2026.

[14] D. T. K. Ng, J. K. L. Leung, S. K. W. Chu, and M. S. Qiao, "AI Literacy: Definition, Teaching, Evaluation and Ethical Issues," *Comput. Educ. Artif. Intell.*, vol. 2, p. 100041, 2021.
[15] E. Papagiannidis, P. Mikalef, and K. Conboy, "Responsible Artificial Intelligence Governance: A Review and Research Framework," *J. Strateg. Inf. Syst.*, vol. 34, no. 2, p. 101885, 2025.
[16] J. Rudolph, S. Tan, and S. Tan, "ChatGPT: Bullshit Spewer or the End of Traditional Assessments in Higher Education," *J. Appl. Learn. Teach.*, vol. 6, no. 1, pp. 342–363, 2023.
[17] Z. Swiecki, H. Khosravi, G. Chen, et al., "Assessment in the Age of Artificial Intelligence," *Comput. Educ. Artif. Intell.*, vol. 3, p. 100075, 2022.
[18] A. Tlili, B. Shehata, M. A. Adarkwah, et al., "What if the Devil Is My Guardian Angel: ChatGPT as a Case Study of Using Chatbots in Education," *Smart Learn. Environ.*, vol. 10, no. 1, p. 15, 2023.
[19] P. Vaithilingam, T. Zhang, and E. L. Glassman, "Expectation vs. Experience: Evaluating the Usability of Code Generation Tools Powered by Large Language Models," in *Proc. 2022 CHI Conf. Human Factors Comput. Syst.*, ACM, New Orleans, LA, USA, 2022.
[20] O. Zawacki-Richter, V. I. Marín, M. Bond, and F. Gouverneur, "Systematic Review of Research on Artificial Intelligence Applications in Higher Education," *Int. J. Educ. Technol. High. Educ.*, vol. 16, no. 1, p. 39, 2019.
[21] B. Kitchenham and S. Charters, *Guidelines for Performing Systematic Literature Reviews in Software Engineering*, Keele Univ. and Durham Univ., Tech. Rep., 2007.
[22] H. Snyder, "Literature Review as a Research Methodology: An Overview and Guidelines," *J. Bus. Res.*, vol. 104, pp. 333–339, 2019.