Quest Journals
Journal of Software Engineering and Simulation
Volume 12 ~ Issue 4 (April 2026) pp: 102-105
ISSN(Online) :2321-3795 ISSN (Print):2321-3809
www.questjournals.org

Research Paper

Innovating Teaching Methods for the Course "Informatics and Applied Artificial Intelligence" for Engineering Students A Case Study at Thai Nguyen University of Technology

Bui Thi Thi
Thai Nguyen University of Technology, Vietnam

Abstract
Amid the ongoing digital transformation and the accelerated progress in artificial intelligence, reimagining teaching methodologies in foundational informatics courses has emerged as a critical imperative within engineering education. This study focuses on the pedagogical innovations introduced in the course "Informatics and Applied Artificial Intelligence" at Thai Nguyen University of Technology. The course curriculum includes modules on C++ programming, document processing capabilities, and an introductory overview of artificial intelligence applications. Employing a qualitative research approach, the study synthesizes insights from an extensive literature review, pedagogical observations, and an evaluation of instructional practices. The findings underscore that integrating project-based learning, problem-oriented tasks, and AI-driven tools significantly enhances student engagement, cultivates learner autonomy, and fortifies practical skill development. This research offers valuable contributions to improving instructional practices, ensuring that engineering education aligns more effectively with the dynamic demands of Industry 4.0.
Keywords: *teaching innovation, C++ programming, applied artificial intelligence, higher education, digital transformation.*

I. Introduction

Over the past few years, the swift progression of information technology and artificial intelligence has profoundly transformed how people learn, work, and interact with their environment. In the realm of higher education, particularly within engineering disciplines, there is a growing need to prepare students for the challenges and opportunities presented by the Fourth Industrial Revolution. Universities are thus tasked with providing students not just with strong theoretical knowledge but also with practical skills, digital literacy, and the ability to think adaptively—essential traits for thriving in today's complex technological landscape. The course "Informatics and Applied Artificial Intelligence" plays a pivotal role in fostering these technological competencies among engineering students. It offers core training in C++ programming, equips students with document processing expertise, and introduces fundamental concepts of artificial intelligence (AI) alongside its real-world applications. These skill sets are critical for students to effectively navigate and excel in modern technological sectors. However, delivering this course comes with significant pedagogical hurdles. Many first- and second-year students struggle to grasp programming concepts due to their limited exposure to computational thinking and logical reasoning before entering college. Additionally, students often perceive the course material as highly compartmentalized, failing to recognize the connections between programming, office tools, and AI technologies. This fragmented understanding can diminish their motivation and hinder the learning process. At Thai Nguyen University of Technology, the course is taught to a diverse group of engineering students who bring varied academic backgrounds and differing levels of digital proficiency. While some have prior experience in programming, many approach it as complete beginners. This disparity in skill levels presents notable challenges for crafting inclusive teaching methodologies that resonate with all learners. Traditional teaching methods, which rely mainly on lectures and standardized exercises, often fall short in engaging students meaningfully. On the other hand, modern educational practices advocate for experiential learning, problem-solving tasks, and hands-on activities rooted in real-world applications. Consequently, there is an urgent need to adopt innovative pedagogical strategies for this course to improve learning outcomes and better prepare students for their future careers.

Theoretical Framework

1. Programming in Engineering Education Programming is a cornerstone skill in contemporary engineering education. Gaining expertise in programming languages like C++ prepares students to design and implement

software systems while fostering critical competencies such as logical reasoning, algorithmic thinking, and effective problem-solving. C++ is especially valuable for its efficiency, adaptability, and applicability across a wide range of engineering fields.

2. Importance of Document Processing Skills Strong document processing skills are crucial for both academic success and career development. Engineering students often need to create detailed technical reports, research papers, and project documentation. Proficiency in formatting and presenting such documents not only enhances their ability to communicate ideas clearly but also underscores their professionalism.

3. Integration of Artificial Intelligence in Modern Education Artificial intelligence has become an essential force driving innovation in education today. AI tools enable personalized learning experiences, automate routine administrative tasks, and offer insightful, data-driven assessments. Introducing AI principles in foundational courses helps students familiarize themselves with cutting-edge technologies, understand their practical implications, and explore their interdisciplinary potential.

Research Methodology

This study employs a qualitative approach to explore and refine teaching methodologies. A comprehensive literature review was carried out to examine existing pedagogical frameworks, particularly those pertaining to programming education, digital literacy, and the integration of artificial intelligence. To assess the effectiveness of various teaching strategies, classroom observations were conducted to analyze student engagement, learning behaviors, and responsiveness. These observations were augmented by hands-on teaching experiences, allowing for a detailed and contextually relevant evaluation.

II. Content

2.1 Innovation in Teaching Methods

A key outcome of this research is the development of innovative teaching strategies designed to enhance knowledge acquisition and practical skill-building among second-year engineering students. A newly developed pedagogical framework was implemented over an academic semester with a cohort of 200 students at Thai Nguyen University of Technology. This framework replaced conventional teaching methods with an interactive, practice-focused, and technology-enabled learning approach. The results demonstrated significant improvements in student engagement, academic performance, and practical competencies.

Reforming C++ Programming Instruction

The pedagogical approach for teaching C++ programming underwent an extensive transformation, shifting from traditional lecture-driven delivery to a more engaging, problem-solving, and practice-based model. Previously, students were taught programming concepts solely through theoretical explanations and isolated exercises with limited real-world relevance. In the updated framework, C++ topics were introduced using practical engineering scenarios, such as data processing, system simulations, and basic management applications. Learning followed a structured sequence emphasizing algorithmic thinking before coding. Each module included systematic steps: problem identification, solution design, writing code, testing, and reflecting on outcomes. This approach promoted deeper cognitive engagement while minimizing reliance on rote memorization of syntax without comprehension of core principles. The results of these changes were significant. Prior to the intervention, only 48% of students could independently accomplish basic programming tasks. Post-implementation, this figure increased to 78%. Likewise, the percentage of students achieving high grades (A and B) in programming tests rose from 42% to 71%. The proportion of students struggling to complete assignments saw a sharp decrease from 22% to just 8%. Furthermore, classroom observations highlighted an approximately 35% increase in student participation during problem-solving discussions. This demonstrates that the revamped methodology contributed to a more interactive and collaborative learning environment.

Enhancing Document Processing Instruction

The instruction of document processing skills was also redesigned to align more closely with real-world academic and professional demands. Instead of focusing solely on individual software functions, the updated method required students to engage in authentic projects such as drafting technical reports, formatting academic papers, and preparing professional documentation. These assignments simulated realistic engineering scenarios by mandating structured reports featuring properly formatted tables, figures, citations, and standardized layouts. This hands-on approach emphasized the practical applications of document processing in their future careers. The quantitative results were remarkable. Before the intervention, only 55% of students met the expected standards for document formatting; after the changes, this number increased to 85%. Additionally, the share of students demonstrating advanced document structuring and formatting skills rose from 28% to 62%. In terms of quality, student submissions significantly improved in clarity, organization, and compliance with academic norms.

Instructor feedback highlighted a substantial boost in student confidence regarding the creation of professional-level documentation—an invaluable skill for their academic progression and career readiness.

Integration of Artificial Intelligence in Pedagogy and Academic Development

The incorporation of artificial intelligence (AI) tools into the domain of teaching and learning represents a significant advancement in contemporary educational practices. In this study, AI-assisted platforms were introduced to students, mainly for programming support, document refinement, and information processing. Rather than serving as substitutes for learning, these tools were strategically employed to act as auxiliaries that enhance comprehension and operational efficiency. Students underwent systematic training to utilize AI applications for debugging programming errors, producing creative ideas, and optimizing written content. This pedagogical approach mirrors prevailing trends in engineering, where AI increasingly complements human expertise to augment intellectual and technical capabilities. The efficacy of AI integration was quantitatively and qualitatively evaluated through student outcomes and feedback. A notable 82% of participants reported that the use of AI tools contributed to their improved understanding of coding principles while simultaneously minimizing errors. Moreover, the average completion time for programming assignments decreased by 25%, underscoring enhanced productivity. From an academic performance perspective, students adeptly employing AI tools achieved higher proficiency, with average scores rising by 12% compared to those relying exclusively on traditional methodologies. Nonetheless, findings underscored the necessity for deliberate instructional guidance to mitigate excessive dependency on AI technologies, thereby fostering autonomous problem-solving competencies among learners. Implementation of Project-Based Learning Project-based learning (PBL) served as the nucleus of the instructional strategy adopted to synthesize knowledge across various course modules. Students collaborated in small, structured groups to undertake projects requiring the practical application of C++ programming concepts, document processing skills, and basic AI tools. A robust methodological framework governed each project, encompassing phases such as topic selection, problem delineation, solution development, implementation, and the final dissemination of outcomes. This iterative learning paradigm enabled students to engage comprehensively with the material, nurturing both technical proficiencies and interpersonal competencies. The outcomes of this pedagogical innovation proved highly promising. An impressive 88% of students successfully completed their designated projects, demonstrating their ability to translate theoretical constructs into tangible solutions. The percentage of participants exhibiting adept teamwork and collaborative abilities increased from 52% to 79%, as assessed via peer evaluations and instructor observations. Additionally, survey results revealed heightened levels of motivation and satisfaction with the learning process. A substantial 84% of respondents expressed a preference for project-based learning compared to conventional lecture-driven pedagogy, citing the opportunity to engage in meaningful tasks with visible results as a primary motivator for their increased engagement. Holistic Impact of Educational Innovations The aggregate effect of these targeted teaching innovations fostered notable improvements in both academic achievement and educational experiences. Average course scores progressed from 6.8 to 7.9 on a 10-point grading scale, while the pass rate expanded from 88% to 96%. Furthermore, the proportion of high-performing students increased substantially, highlighting the efficacy of this multi-faceted approach to education reform. Qualitative assessments documented a significant transformation in students' attitudes toward learning, evidenced by heightened levels of proactivity, confidence, and self-directed study capabilities. By incorporating practical applications, technological tools, and collaborative ventures into the instructional framework, educators successfully established a dynamic and engaging academic atmosphere consistent with contemporary standards in engineering education. These findings illustrate that a well-structured approach integrating active learning methodologies, technological advancements, and real-world contextualization holds substantial promise for enriching both the effectiveness and relevance of modern engineering education frameworks. Through these pedagogical innovations, institutions can better prepare students for professional challenges while fostering deeper intellectual engagement with academic material.

2.2. Discussion

The adoption of innovative pedagogical strategies in the course has yielded significant improvements in both student engagement and academic performance. Central to this transformation is the evolving role of students, who have shifted from passive recipients of knowledge to active participants in the learning process. This paradigm shift has engendered heightened levels of motivation, intellectual curiosity, and a greater willingness to engage with complex subject matter. In the context of C++ programming instruction, the integration of real-world problem scenarios has proven particularly effective in enhancing students' comprehension of abstract concepts. By linking theoretical constructs to practical applications, students are better equipped to grasp complex topics while concurrently refining their problem-solving skills—a competency of paramount importance in the professional engineering domain. Similarly, in the area of document processing, an emphasis on hands-on, practical tasks has underscored the importance of professional communication. This approach not only equips students with the technical know-how necessary for document preparation but also instills essential skills in

information organization and systematic presentation, both of which are critical for effective professional practice. The incorporation of artificial intelligence (AI) tools has further enriched the learning experience by providing instantaneous feedback and opportunities for exploring diverse problem-solving strategies. While these technologies have tremendous potential to enhance learning outcomes, it is imperative to manage their application judiciously in order to prevent over-dependence on automation and to nurture students' capacity for independent critical thinking. Project-based learning has emerged as an especially transformative strategy for cultivating collaborative and interdisciplinary perspectives among students. Through group-based activities, learners acquire vital soft skills such as communication, time management, and teamwork, alongside a deeper understanding of course content. This methodology prepares students to navigate real-world engineering challenges, where cooperative problem-solving is essential for success. Nonetheless, several challenges remain unresolved. Key obstacles include the necessity for well-developed technological infrastructure, continuous professional development for instructors, and the design of robust assessment mechanisms tailored to innovative instructional models. Addressing these issues is critical for ensuring the long-term sustainability and effectiveness of these advancements in teaching methods.

III. Conclusion

The outcomes of this study underscore the importance and effectiveness of integrating contemporary teaching strategies into the course "Informatics and Applied Artificial Intelligence." By adopting active learning approaches that incorporate C++ programming, document processing, and AI applications, the course fosters enhanced student engagement and equips learners with essential competencies for their future professional endeavors. Furthermore, project-based learning and AI-driven instruction serve as catalysts for improving educational quality while aligning curricular goals with emerging technological trends. Future research should concentrate on refining teaching methodologies and expanding the adoption of cutting-edge technologies within engineering education to enhance both instructional efficacy and student preparedness for a rapidly evolving professional landscape.

Acknowledgment

This work is supported by Thai Nguyen University of Technology, Vietnam.

References

[1]. Liu, C., Wang, G. C., & Wang, H. F. (2025). The application of artificial intelligence in engineering education: A systematic review. *IEEE Access*, *13*, 17895-17910.

[2]. Alghazo, M., Ahmed, V., & Bahroun, Z. (2025, February). Exploring the applications of artificial intelligence in mechanical engineering education. In *Frontiers in education* (Vol. 9, p. 1492308). Frontiers Media SA.

[3]. Sapci, A. H., & Sapci, H. A. (2020). Artificial intelligence education and tools for medical and health informatics students: systematic review. *JMIR Medical Education*, *6*(1), e19285.

[4]. Rathore, A. S., Sharma, A., & Massoudi, M. (2021, October). Personalized engineering education model based on artificial intelligence for learning programming. In *2021 6th international conference on computing, communication and security (ICCCS)* (pp. 1-10). IEEE.

[5]. Furman, G. D. (2024, August). Enhancing engineering education: The role of artificial intelligence in personalizing learning and outcomes. In *2024 4th International Conference on Big Data Engineering and Education (BDEE)* (pp. 61-65). IEEE.

[6]. Liu, Y., Jing, Y., Li, J., Dai, J., Hu, Z., & Wang, C. (2025). Application of AI in engineering education: A bibliometric study. *Review of Education*, *13*(1), e70044.

[7]. Alvarez-Dionisi, L. E., Mittra, M., & Balza, R. (2019). Teaching artificial intelligence and robotics to undergraduate systems engineering students. *International Journal of Modern Education and Computer Science*, *11*(7), 54-63.

[8]. Nantoi, V., Nantoi, D., & Ceban, D. (2026). *Challenges and solutions for integrating artificial intelligence into transportation engineering education*. Вадим Нантой, Vadim Nantoi.

[9]. Chiang, T. (2021). Estimating the artificial intelligence learning efficiency for civil engineer education: A case study in Taiwan. *Sustainability*, *13*(21), 11910.