

**INTERNATIONAL JOURNAL OF
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(IJMOE)**www.ijmoe.com**REDEFINING ASSESSMENT METHODS IN CHEMICAL
ENGINEERING EDUCATION THROUGH AI-DRIVEN
INNOVATIVE ASSESSMENT**Nurul Asyikin Md Zaki^{1,4*}, Syafiza Abd Hashib², Umami Kalthum Ibrahim^{3,4}¹ School of Chemical Engineering, College of Engineering, Universiti Teknologi MARA, Shah Alam, Malaysia
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This work is licensed under [CC BY 4.0](https://creativecommons.org/licenses/by/4.0/)**Abstract:**

This study investigates the integration of Artificial Intelligence (AI) tools in the assessment methods within chemical engineering education, specifically focusing on the Food Preservation Technology course at Universiti Teknologi MARA. Through a survey of 57 undergraduate students, this research explores the effectiveness of AI-assisted assessments in enhancing student engagement, understanding, and skill development. The results indicate that students find AI-assisted assessments significantly more engaging and effective than traditional methods, with high ratings for understanding complex concepts and developing critical thinking skills. However, concerns regarding academic integrity and ethical use of AI were also noted, suggesting a need for robust guidelines and continuous education to mitigate these risks. This study highlights the potential of AI tools to transform assessment practices in engineering education, promoting a balanced integration that maximizes benefits while addressing ethical considerations. The findings support the development of a comprehensive framework for the ethical and effective use of AI in educational assessments, ultimately aiming to produce well-rounded engineers equipped with both theoretical knowledge and practical expertise.

Keywords:

Innovative Assessment, Alternative Assessment, Authentic Assessment, Artificial Intelligence, Engineering Education

Introduction

In chemical engineering education, current and conventional assessment techniques frequently fail to capture the comprehensive skill set required for modern engineering tasks. Traditional exams and evaluations often overlook the practical and analytical skills essential for engineering practice, leading to a gap in the educational process. To address these limitations, this study investigates the potential of integrating Artificial Intelligence (AI) tools into assessment frameworks, aiming to provide a more robust evaluation of students' understanding and capabilities. By utilising AI technologies, educators can design assessments that not only test theoretical knowledge but also enhance practical skills and critical thinking abilities.

The aim of this study is to examine how AI-assisted assessments can transform the learning experience in Food Preservation Technology, an elective course in the Chemical Engineering undergraduate programme. AI tools, such as machine learning algorithms and intelligent tutoring systems, offer unique opportunities to create dynamic and interactive assessment environments. These tools can simulate real-world engineering problems, providing students with hands-on experiences that traditional methods cannot offer. This study aims to identify the ways in which AI-driven assessments can foster a deeper comprehension of chemical engineering principles and encourage students to use AI tools innovatively and responsibly.

Furthermore, this research seeks to develop a comprehensive framework for the effective and ethical integration of AI in educational assessments. The framework will address both the benefits and potential challenges of using AI in academic evaluations, such as ensuring academic integrity and preventing over-reliance on technology. By establishing guidelines for the responsible use of AI tools, this study aims to enhance the authenticity and reliability of assessment methods in chemical engineering education, ultimately contributing to the development of well-rounded engineers equipped with both theoretical knowledge and practical expertise.

Literature Review

Innovative Assessment Methods

Traditional assessment methods in engineering education primarily include written exams, quizzes, technical and laboratory reports. These methods have long been the foundation of evaluating students' theoretical knowledge and basic problem-solving skills. However, they often fail to assess higher-order cognitive skills such as critical thinking, creativity and the ability to apply knowledge in real-world scenarios. Traditional assessments are typically static and limited in scope, failing to capture the dynamic and complex nature of engineering tasks (Kozłowski et al., 2006). Consequently, there is a growing need to adopt innovative assessment methods that can more accurately reflect students' competencies and readiness for professional engineering challenges. Innovative assessment methods, on the other hand, leverage advancements in technology and pedagogical approaches to provide a more authentic and holistic evaluation of student performance. These methods include project-based assessments, e-portfolios, and simulations. They aim to create more engaging and interactive learning experiences, fostering deeper understanding and practical application of engineering principles. By incorporating real-world problems and collaborative tasks, innovative assessments help students develop essential skills such as teamwork, communication, and critical analysis.

Artificial Intelligence (AI) is at the forefront of transforming assessment practices in engineering education. AI technologies, such as machine learning algorithms, natural language processing, and intelligent tutoring systems, offer new ways to design and implement assessments that are more adaptive, personalized, and comprehensive. AI can analyse large volumes of data to provide real-time feedback, identify learning patterns, and tailor assessments to meet individual student needs (Seo et al., 2021; Cao et al., 2020; Yi et al., 2018). This level of personalization ensures that assessments are not only more effective but also more inclusive, accommodating diverse learning styles and abilities.

AI-driven assessments can simulate complex engineering problems, allowing students to engage in authentic, hands-on problem-solving activities. For example, virtual labs and AI-based simulations can recreate real-world engineering scenarios, providing students with the opportunity to apply theoretical knowledge in a controlled, risk-free environment. This approach not only enhances learning outcomes but also prepares students for the practical challenges they will face in their professional careers. Furthermore, AI can automate administrative tasks associated with assessments, such as grading and feedback generation, freeing up educators to focus on more meaningful interactions with students.

The integration of AI into assessment practices offers several advantages over traditional methods. AI-assisted assessments can provide continuous, formative feedback, helping students to identify and address their weaknesses in real-time. This ongoing feedback loop fosters a growth mindset and encourages self-directed learning. In contrast, traditional assessments often provide feedback only after the completion of a task, which can delay the learning process and limit opportunities for improvement. Moreover, AI-assisted assessments can enhance the objectivity and reliability of evaluations. AI algorithms can analyse student responses without the biases that might influence human graders, ensuring a fair and consistent assessment process (Owan et al., 2023). Additionally, AI can handle a broader range of data inputs, including textual, visual, and behavioural data, to provide a more comprehensive evaluation of student performance.

However, the adoption of AI-assisted assessments has many challenges and raises concerns regarding the transparency and accountability of AI algorithm and the potential for over-reliance on technology. It is crucial to strike a balance between leveraging AI's capabilities and maintaining the human element in education, ensuring that assessments remain meaningful and aligned with educational goals.

Ethical Considerations and Academic Integrity

The integration of Artificial Intelligence (AI) into educational assessments should be carefully addressed with ethical considerations to ensure fair and responsible use. AI are only as unbiased as the data they are trained on, and if the training data contains biases, these can be perpetuated or even amplified in the assessment process. This can lead to unfair treatment of certain groups of students, reinforcing existing inequalities in education. Ensuring that AI are transparent and subject to rigorous ethical standards is essential to mitigate these risks. Moreover, there is the issue of data privacy and security. AI-driven assessments often require the collection and analysis of large amounts of student data, including personal information and performance metrics. Protecting this data from unauthorized access and ensuring it is used ethically is crucial. Institutions must implement robust data governance policies and educate both students and educators on the importance of data privacy.

While AI tools have the potential to enhance learning and assessment, they also pose risks related to academic dishonesty. The ease of access to AI-powered solutions, such as automated writing and problem-solving tools, can tempt students to use these technologies to complete assignments without genuine understanding or effort. This undermines the integrity of the assessment process and devalues the educational experience. It is essential for educators to design assessments that minimize opportunities for cheating and to use AI tools in ways that promote learning rather than shortcuts. Another concern is the potential for AI tools to be misused by students to generate answers or complete tasks, bypassing the critical thinking and problem-solving processes that are integral to learning. This can result in students becoming overly reliant on AI, diminishing their ability to perform independently. To combat this, educational institutions should emphasize the responsible use of AI, providing clear guidelines and fostering a culture of academic integrity. This includes educating students on the ethical implications of using AI and implementing measures to detect and prevent academic dishonesty.

To ensure the ethical use of AI in educational assessments, institutions must adopt comprehensive strategies that address both the potential benefits and risks associated with these technologies. One effective approach is the development of clear ethical guidelines and policies that govern the use of AI in education. These guidelines should cover issues such as data privacy, algorithmic transparency, and the responsible use of AI tools by both students and educators. Regular audits and reviews of AI systems can help ensure compliance with these guidelines and identify areas for improvement. Educators also play a critical role in maintaining academic integrity. They should be trained in the ethical implications of AI and equipped with the knowledge and tools to design assessments that leverage AI effectively while safeguarding against misuse. This includes creating assessment tasks that require higher order thinking and cannot be easily completed by AI tools, as well as using AI to monitor and detect potential instances of academic dishonesty. Furthermore, fostering a culture of integrity within educational institutions is essential. This can be achieved through continuous dialogue about the ethical use of AI, involving students in discussions about academic honesty, and promoting the value of genuine learning and effort. By embedding these principles into the educational environment, institutions can help students understand the importance of integrity and the responsible use of technology.

Frameworks and Models for AI Integration

The integration of AI into educational systems has led to the development of various frameworks and models aimed at optimizing its application and ensuring effective implementation. One prominent model is the SAMR (Substitution, Augmentation, Modification, Redefinition) framework, which guides educators in integrating technology into teaching and learning processes. This model can be adapted to AI integration, where AI tools can initially substitute traditional methods, augment educational practices by enhancing functionality, modify existing processes to create significant task redesign, and ultimately redefine assessment methods in ways that were previously inconceivable.

Another notable framework is the Technological Pedagogical Content Knowledge (TPACK) model, which emphasizes the interplay between technology, pedagogy, and content knowledge. This model helps educators understand how AI tools can be seamlessly integrated into their teaching strategies to enhance learning outcomes. By leveraging TPACK, educators

can design AI-driven assessments that are pedagogically sound and content-specific, ensuring that the use of AI aligns with educational goals and standards.

Additionally, the AI in Education (AIED) framework focuses specifically on the unique aspects of AI technologies in educational contexts. It provides a comprehensive approach to integrating AI, considering factors such as data analytics, adaptive learning, and personalized feedback. The AIED framework emphasizes the need for continuous evaluation and iteration, ensuring that AI applications are effectively meeting educational objectives and adapting to the evolving needs of students and educators.

| Table 1: Comparison of Existing Frameworks for AI Integration in Education | | | |
|--|--|--|--|
| Framework Focus Areas | | Strengths | Limitations |
| SAMR | Technology integration levels | Guides progressive integration of technology; easy to understand and apply | May oversimplify the complexities of technology integration |
| | (Substitution, Augmentation, Modification, Redefinition) | | |
| TPACK | Interaction between Technology, Pedagogy, and Content Knowledge | Holistic view of technology integration; emphasizes balance between pedagogy and content | Requires deep understanding of all three components; may be challenging for novice educators |
| AIED | Comprehensive approach to AI in education including data analytics, adaptive learning, and personalized feedback | Addresses unique aspects of AI; focuses on continuous evaluation and adaptation | Can be complex to implement; requires ongoing adjustment and monitoring |

Source: Author’s own analysis

The integration of AI into educational assessments is supported by various frameworks and models that guide its effective implementation. By adhering to best practices and learning from successful case studies, educational institutions can harness the potential of AI to enhance assessment processes, improve learning outcomes, and better prepare students for the demands of the modern workforce.

Methodology

Phase 1: Implementation of AI-Assisted Assessment Interventions

Specific AI tools, such as ChatGPT, Notion, Gamma, Gemini, and Copilot were selected based on their relevance and their ability to provide personalized feedback. The chosen AI tools were integrated into Food Preservation Technology course for one specific assessment. The intervention ensures transparency, ethical use, and a balance between AI assistance and human oversight. Students were briefed on using the AI tools effectively. Instructional materials were provided, and continuous support was available throughout the semester to address any technical issues and ensure smooth integration. Figure 1 shows the detailed assessment description provided to the students.

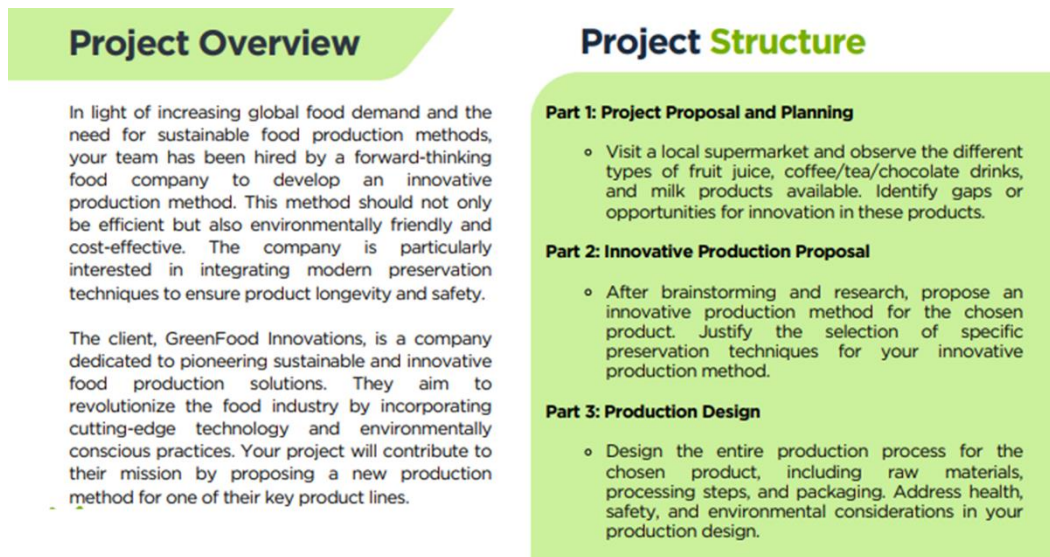


Figure 1: AI-Assisted Assessment Description for the Food Preservation Technology

Phase 2: Post-Intervention Analysis

Data was collected through surveys and analysis of assessment results. A post-intervention survey measured the students' perceptions and experiences. Focus group discussions will provide deeper insights into the experiences with AI-assisted assessments. Quantitative data from surveys will be analysed statistically to compare pre- and post-intervention results, focusing on metrics such as student engagement, performance, and satisfaction. Qualitative data from focus group discussions will be analysed thematically to identify common patterns and insights.

Results and Discussion

The survey conducted among 57 undergraduate students enrolled in the Food Preservation Technology course at Universiti Teknologi MARA Shah Alam revealed insightful perceptions and experiences regarding AI-assisted assessments. Figure 2 shows the evaluation of various aspects of AI in education as perceived by the students.

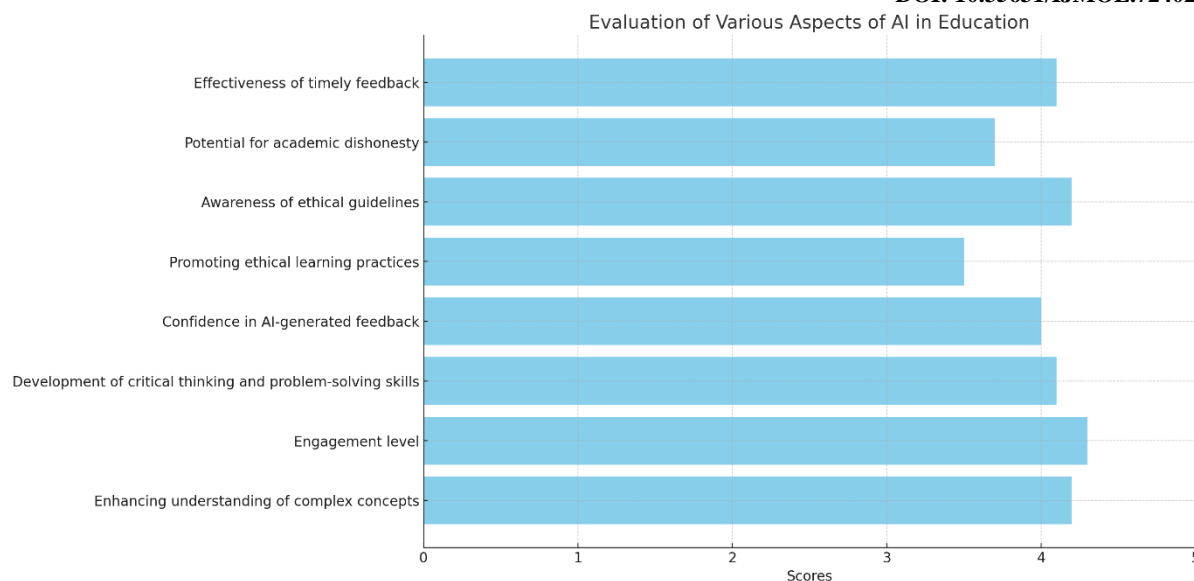


Figure 2: Evaluation of AI Integration in Education

Enhancing Understanding and Skills

The data strongly indicates that students find AI-assisted assessments significantly more engaging and effective than traditional methods. AI tools evidently play a crucial role in facilitating deeper comprehension of chemical engineering subjects with a mean rating of 4.2 for enhancing understanding of complex concepts. The engagement level rated at 4.3 further supports the notion that AI tools not only make learning more interactive but also motivate students to participate actively in their educational journey. These findings align with existing literature that emphasises AI's potential to create dynamic learning environments and improve educational outcomes (Darwin et al., 2023), (Qureshi, 2023).

Developing Problem-Solving and Critical Thinking Skills

High rating for the development of critical thinking and problem-solving skills (mean rating of 4.1) shows the effectiveness of AI tools in fostering essential cognitive abilities among students. The frequent use of AI tools with a mean rating of 3.8 indicates that students regularly incorporate these technologies into their studies, enhancing their ability to tackle complex engineering problems. The confidence in AI-generated feedback (mean rating of 4.0) reflects students' trust in the accuracy and reliability of AI assessments, which is crucial for fostering a learning environment where students feel supported and guided (Nguyen et al., 2017), (Crompton & Burke, 2023).

Ethical Considerations and Academic Integrity

While the benefits of AI-assisted assessments are evident, the survey also highlights concerns related to academic integrity. The moderate rating for AI tools promoting ethical learning practices (mean rating of 3.5) and the higher awareness of ethical guidelines (mean rating of 4.2) suggest that students are conscious of the ethical implications but may need more robust guidance and support. The potential for academic dishonesty, rated at 3.7, indicates a significant concern that must be addressed to ensure the responsible use of AI in assessments. Clear ethical guidelines and continuous education on the proper use of AI tools are essential to mitigate these risks and promote integrity (Lee et al., 2024), (Tahiru, 2021).

Overall Satisfaction and Feedback

The high overall satisfaction with AI-assisted assessments (78% rating 4 or 5) reflects a positive reception among students. The effectiveness of timely feedback (mean rating of 4.1) is particularly noteworthy, as it highlights one of the key advantages of AI, the ability to provide instant, personalized feedback that can guide and improve student performance in real-time. This immediate feedback loop is a critical factor in enhancing learning outcomes and ensuring students can promptly address their weaknesses (Labadze et al., 2023), (Chan & Hu, 2023).

The qualitative data from open-ended responses as shown in Figure 3 further enriches our understanding of students' experiences. Students appreciated the enhanced engagement, personalized feedback, and improved understanding facilitated by AI tools. These benefits align with the quantitative findings and reinforce the value of AI in modern educational contexts. However, concerns about over-reliance on AI and the potential for academic dishonesty underscore the need for balanced integration and ethical oversight. Clear training and guidelines on the ethical use of AI are imperative to address these concerns and ensure AI tools are leveraged to their full potential without compromising academic integrity (Casal-Otero et al., 2023), (Hwang & Chen, 2023).

Briefly describe what you learn or experience while completing the innovation pitching project assessment.

Teamwork

There are variety of idea generated with the help of AI, it would be beneficial for future use

I have learn that there are more innovations can be done to surpass the current food problem in the market through extensive research.

Completing the project assessment helped deepen the understanding of various preservation methods and fosters creativity in addressing related challenges. It enhances skills in market research, business planning, and effective pitching, while encouraging collaboration and incorporating constructive feedback to refine innovative ideas.

Its quite difficult at first to brainstorm for innovation. However, using the right prompt at the right platform quite be useful in generating idea using the ChatGPT

Learning new things and innovations relating to the food industries and sustainability that required to make our planet green

Figure 3: Students' Responses and Feedback on the AI-Assisted Assessment for Food Preservation Technology

Conclusion

AI-driven innovative assessment methods represent a promising advancement in chemical engineering education. They provide a more holistic evaluation of student performance, foster deeper understanding and enhance critical thinking and problem-solving skills. Moving forward, it will be important to address the ethical challenges associated with AI to ensure its responsible and effective use. With the right strategies and frameworks in place, AI has the potential to significantly transform educational assessments and contribute to the development of well-rounded, capable engineers.

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