



Impact of ChatGPT on Students' Learning Strategies and Critical Thinking Development

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Abstract: The rapid integration of artificial intelligence (AI) technologies, such as ChatGPT, into education has raised concerns about their potential to suppress students' critical thinking skills. This study aims to investigate whether ChatGPT facilitates or hinders the development of critical thinking through adaptive and individualized learning interactions. Using a qualitative approach, data were collected through in-depth interviews and direct observations of students and lecturers at Nurul Jadid University. The findings suggest that ChatGPT can enhance classroom discussions, encourage students to consider multiple perspectives, and refine their analytical skills. However, challenges such as over-reliance on AI, information bias, and decreased independent reasoning must be addressed to optimize the role of AI in education. This study concludes that ChatGPT offers significant benefits in fostering engagement and analytical reasoning. Its effective integration requires careful pedagogical strategies. The study contributes to educational research by providing insights into AI-assisted learning and proposing guidelines for maximizing AI's educational potential while mitigating its drawbacks.

Keywords: chatgpt; critical thinking; learning strategies

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INTRODUCTION

Artificial intelligence (AI), such as ChatGPT, is increasingly recognized within the education system as a tool to aid in the learning and teaching process (Fuchs & Aguilos, 2023; Malinka et al., 2023). This leads to improved efficiency in providing additional support to students and facilitating better access to academic information and scholarly resources (Bali et al., 2022). In expansion, a few higher education institutions are beginning to adopt AI as the platform of Chatbots and virtual assistants as tools to assist students with academic and administrative matters (Essel et al., 2022; Nguyen et al., 2023; Sidorkin, 2024; Villegas-Ch et al., 2020; Wang et al., 2023). This is supported by the need to provide precise and accurate assistance in the face of an expanding volume of student questions and assignments. The expanding use of AI in institutional education can provide more effective and individualized support to students.

Previous research has shown that AI, such as ChatGPT, has an important role to play in transforming the education system. The integration of AI in education may improve learning effectiveness by providing rapid feedback and personalizing learning materials (Chen et al., 2020; Murtaza et al., 2022). Other research has also found that higher education institutions in developed countries have adopted AI, mainly in the form of Chatbots and virtual assistants, to support administration and learning (Ragheb et al., 2022; Rahim et al., 2022). In addition, the use of AI can help address the decline in critical thinking skills by providing interactive tools that encourage deeper analysis and discussion (Aoun, 2017; Holmes et al., 2022; Luckin & Holmes, 2016; Pedro et al., 2019; Wu, 2024). However, some previous studies also identify challenges, such as the risk of biased information and excessive reliance on technology (Basha, 2024; Haque & Li, 2024; Zhai et al., 2024). Therefore, it is essential to overcome the challenges to maximise the benefits of AI. Although there have been many studies exploring the use of AI in academic support and improving administrative efficiency (Alshater, 2023; Rahim et al., 2022; Wang et al., 2023; Wu, 2024), this research further explores the influence of ChatGPT as feedback in the development of critical thinking skills through dynamic and personal interactions. The primary innovation of this study is the utilization of ChatGPT to model in-depth intellectual discussions and provide feedback to facilitate real-time analysis and evaluation of arguments.

This research paper aims to explore the integration of ChatGPT in education with a specific focus on the impact on students' critical thinking skills at Nurul Jadid University. The choice to study students at Nurul Jadid University is based on the institution's growing integration of AI tools in learning, particularly the recent adoption of ChatGPT as a digital assistant in classroom activities. Currently, several lectures at the University have started encouraging the use of ChatGPT as part of writing assignments, discussion forums, and problem-solving exercises. However, this increased usage has not been accompanied by structured guidelines or monitoring, raising concerns about students' growing dependence on AI and potential reduction in their analytical engagement. This makes the University an ideal case for examining the tension between technological

convenience and intellectual development. Furthermore, this study integrates data from various higher education institutions to provide a comparative foundation and reveals the perspectives of students and lecturers on how AI technologies, such as ChatGPT, can address the observed decline in critical thinking skills among Nurul Jadid University students. By identifying and exploring ChatGPT's role, the study enhances readers' understanding of both the potential and limitations of AI in supporting student learning while also bridging the gap between the problem and the proposed solution.

This research hypothesizes that integrating ChatGPT can transform students' approach to learning in the face of declining critical thinking skills. In addition, this study aims to investigate how students' interaction with ChatGPT can facilitate the development of their critical thinking skills through interactive discussions and feedback on information sources. Therefore, AI is expected to evaluate the impact of using ChatGPT on the effectiveness of learning methods and identify challenges and opportunities for integrating AI technology into the educational curriculum. Thus, this study aims to provide a comprehensive overview of the potential of ChatGPT in enhancing critical thinking skills and offer practical recommendations for educators and educational policymakers, especially at Nurul Jadid University.

The development of the Natural Language Processing (NLP) model can be traced historically back to the 1950s (Atallah et al., 2000). However, significant work in this direction began in the 2010s, driven by the integration of AI into deep learning techniques and the availability of large-scale datasets. However, the integration of AI into the classroom does not come without challenges and concerns. Among the overriding concerns is the possibility that AI systems would perpetuate discriminatory and biased practices within academic contexts. Aside from these, additional risks also exist, such as the misuse of the AI system to provide partial or biased results. A new artificial intelligence system, ChatGPT, was introduced at the end of 2022 (Caelen & Blete, 2024; Haleem et al., 2022). It is a type of language-based AI system that belongs to the transformer tool class.

For instance, transformers are capable of processing and generating text datasets (Zhang et al., 2023). ChatGPT represents a class of chatbots that are trained on a large dataset of text drawn from the internet, with the goal of producing natural responses to a broad array of questions and commands (Algabri, 2024; Casheekar et al., 2024; Sridhar, 2024). It is becoming increasingly evident that NLP models have considerable potential for impact on higher education. They can facilitate individualized learning. Provide on-demand support and introduce a new teaching method. In the context of assisting students in higher education, NLP models are particularly beneficial. These models can be used to analyze and process information, including academic papers, textbooks, and other course materials. This empowers teachers to offer students personalized proposals, tailoring options to their specific needs and interests. Nothing escapes the extraordinary improvements in artificial intelligence and chatbots in recent years, not even academia, with the appearance of big data and the need for its speedy and efficient processing. AI systems and chatbots have become increasingly important for both researchers and academics. Recent studies have revealed a paucity of effort devoted to investigating the use of AI in the field of education (Bali et al., 2022; Zhang et al., 2023). In addition. Natural language processing models can be utilized to develop chatbots and virtual assistants that provide students with on-demand assistance and guidance. Two natural language processing (NLP) models with the potential to change higher education are ChatGPT by OpenAI and Bard (Fuchs, 2023).

These include, for example, ChatGPT and Google Bard, which provide responses that are grammatically correct, linguistically natural in content, and address questions, statements, and requests in an academic context. With the use of machine learning and natural language processing, it has become possible to program artificial conversational agents, known as chatbots, to mimic human speech patterns. Nevertheless, there is a growing trend of utilizing AI and chatbots in this domain, which raises numerous ethical concerns. The recent availability of ChatGPT and Google Bard, together with their growing popularity from as early as 2023 onwards, makes their utilisation crucial for enhancing student learning in a variety of situations, including dialect acquisition, composition, investigation, and educational requests in general (Hualpa et al., 2023). Furthermore, the authors discovered that chatbots can enhance students' interest and enthusiasm for academic pursuits. In a separate study the potential for integrating chatbots into institutional settings. The utilization of chatbots in the initial year of college has been demonstrated to enhance students' scholarly engagement and facilitate the transition to campus life for incoming students. The extensive literature indicates that interaction with chatbots enhances students' study propensities and social intelligence. Students report feeling more at ease in contacting their program leaders and receiving assistance as a result of the availability of Chatbots. Consequently, beyond the aforementioned example, NLP models are being employed in the higher education system and the development of novel applications aimed at facilitating students' academic pursuits (Sajja et al., 2023).

OpenAI's development of ChatGPT marks a pivotal point in the field of artificial intelligence, underscoring significant advancements in natural language processing, now more generally known as NLP, and machine learning, or ML. Fundamentally, ChatGPT works to respond in a manner similar to a person in conversation. This has the potential to revolutionize the way people interact with AI frameworks (Eisenring et al., 2024). This groundbreaking innovation represents the convergence of research and practical applications, illustrating the

potential for a transformative effect of AI in everyday life (Idoko et al., 2024). ChatGPT's remarkable capacity to comprehend and generate significant, contextually appropriate discourse serves as the foundation for its capabilities. This capacity is determined by its innovative algorithms, which not only facilitate the processing of fragmentary words but also recognize nuances and subtleties that distinguish meaningful interactions. A robust computing infrastructure supports these algorithms, ensuring that ChatGPT can easily accommodate users' computing needs in real-time (Rane et al., 2024).

ChatGPT's architectural foundation is built on the transformer neural network, a pioneering discovery within the field of deep learning. It illustrates exceptional capability in maintaining complex, long-term dependencies in textual data, which are fundamental for maintaining up-to-date and producing pertinent reactions across extended discourse (Haleem et al., 2022). One of the striking features of ChatGPT is its adaptability; it can effectively serve as a collaborative partner. It answers questions, explains complex notions, proposes solutions to exercises, and even discusses open issues of a particular type. The flexibility of ChatGPT makes it a potentially formidable tool for use in numerous applications, from improving customer service to auto-generating context, making instructions more personalized, and assisting writers who exist at both ends of the imaginative range. In truth, ChatGPT stands out especially in processing complex and challenging quick requests (Haleem et al., 2022; Javaid et al., 2023; Ray, 2023).

In addition, ChatGPT demonstrates particular proficiency in the efficient management of complex and demanding requests. ChatGPT utilizes comprehensive preparatory information to address complex problems and intricate issues, ensuring that users receive accurate and dependable data (Javaid et al., 2023). This highlight broadens the scope of pertinence to spaces where prescriptions and the profundity of data are of fundamental importance. A noteworthy aspect of ChatGPT's usefulness is its ability to learn and adapt continuously over time. In this respect, it employs a continuous learning methodology that enables ChatGPT to adapt to changing user needs, ensuring the tool remains relevant in a rapidly evolving technological landscape (Gill & Kaur, 2023). These limitations of ChatGPT mean it should be used cautiously. Like other AI systems, ChatGPT may inadvertently perpetuate biases in its training data and be sensitive to input dialect (Alawida et al., 2023; Ray, 2023). Users, designers, and organizations must exercise vigilant and ethical responsibility, particularly in applications where the AI choice result may have significant real-world repercussions (Tayan et al., 2024). ChatGPT is the fusion of state-of-the-art natural language processing algorithms, revolutionary neural network engineering, and a massive amount of training data. With the ability to generate responses similar to human nature, its adaptability, and constant refinement, it is poised to be one of the most revolutionary tools with wide-ranging implications. It is, however, imperative that wise and ethical methods be employed to realize the capabilities while fully mitigating potential ethical concerns. With OpenAI's relentless commitment to transparency, constant research, and user feedback, it means ChatGPT is only just beginning to develop its capabilities in creating value for a wide variety of applications and industries.

Students' engagement has been demonstrated to play a pivotal role in shaping effective learning environments. Active learning methodologies, known for fostering psychomotor, cognitive, and emotional development, are central to this engagement. However, the integration of artificial intelligence tools, such as ChatGPT, into active learning remains an under-explored field, particularly within the context of higher education. This study offers a novel contribution by investigating how ChatGPT can be leveraged to enhance student engagement and stimulate critical thinking. By focusing on real-world classroom interactions, this research bridges the gap between AI technology and pedagogical practice. The findings of this study contribute to the scientific field by providing empirical evidence on how AI-driven platforms can support active learning and encourage deeper student participation, which may lead to improved academic outcomes. However, even in a culturally and linguistically diverse setting such as Indonesia, reaching and maintaining high levels of student engagement remains an enormous challenge for teachers. Indeed, educators in Indonesia have adapted their pedagogical approaches to address this challenge. For instance, they contextualize instruction through activities that relate to students' experiences, local literature, and local knowledge (Robertson et al., 2018; Suprpto et al., 2021; Zidny & Eilks, 2018). Previous research has underscored the importance of leveraging technology to enhance student engagement in education (Almusaed et al., 2023; Early, 2011; Tay et al., 2021). The technology space offers a plenty of resources and platform that can support educational interactive experiences, promote dynamic engagement, and cater to diverse learning preferences, underscoring the transformative potential of technology in cultivating energetic learning situations, engaging students to collectively build information and meaningfully connected with academic materials (Ahmed & Opoku, 2022; Alam & Mohanty, 2023; Garlinska et al., 2023).

METHODS

The research design employs qualitative methods to gain a detailed understanding of students' and lecturers' experiences with utilizing ChatGPT. Analysts utilize qualitative methods because of their ability to explore subjective perspectives and individual experiences (Hennik et al., 2020). Information was collected

through extensive interviews with students and lecturers, as well as direct observation of the use of ChatGPT during learning sessions. The interviews were conducted to obtain a more detailed insight into ChatGPT's impact on students' critical thinking skills and lecturers' perceptions of using this tool in the teaching process. Observations were conducted to capture the interaction and practical application of ChatGPT in a classroom environment. At that point, the collected data was analyzed to identify the main theme and emerging trends, providing a strong view of ChatGPT's role in transforming learning approaches at Nurul Jadid University.

The sources of data in this study consisted of both primary and secondary data. Primary data were obtained from in-depth interviews and direct observations involving three students (S1-S3) and four lecturers (L1-L4) from the English Language Department at Nurul Jadid University. These participants were selected through purposive sampling based on their use of ChatGPT in the learning process. The total number of students in the department during the study period was approximately 120, meaning that the interviewed students represented about 2,5% of the population. For this lecture, four out of nine permanent faculty members in the department were interviewed, representing approximately 44% of the total. This sample size is considered sufficient for qualitative research as it aims for depth of understanding rather than generalizability. Secondary data were collected through a review of previous literature to provide theoretical support and to compare this study's findings with existing research in the field.

Table 1. Interview And Observation Informant

Informant' Status	Informant Code
Student at Nurul Jadid University	S1
Student at Nurul Jadid University	S2
Student at Nurul Jadid University	S3
Lecturer at Nurul Jadid University	L1
Lecturer at Nurul Jadid University	L2
Lecturer at Nurul Jadid University	L3
Lecturer at Nurul Jadid University	L4

The data collection process was conducted through interviews and observations. First, in-depth interviews were conducted with students and faculty members to gather information about their experiences with ChatGPT. The interviews were used to explore the perceptions, challenges, and benefits experienced by participants. Secondly, the research utilized observations during learning sessions to examine the use of ChatGPT in an academic context. The researcher prioritized obtaining permission and consent from participants during the interview and observation sessions to ensure adherence to research ethics. Further analysis was conducted by systematically compiling the data that had been recorded and documented by these two methods. This process ensured that the data obtained was relevant and representative in response to the research question regarding the role of ChatGPT in learning.

This research used qualitative data analysis adopting the data approach developed by [Miles and Huberman](#) (1994). The approach describes the data analysis process as a continuous and iterative activity. The analysis process began with data collection through interviews and observations. Then the data were categorized and processed in several stages. The first stage is data reduction. In this stage, the researchers selected and filtered relevant data to reduce the volume of raw data into more focused and manageable information. The next stage is data display, organizing data that has been arranged and selected such as tables or matrices, to facilitate understanding and identification of emerging patterns. Finally, the inferences or verification stage concludes by displaying and verifying the data through an iterative process and compares the truth to existing data to ensure validation and consistency. The entire process of these stages is carried out with a reflective approach to ensure thorough and accurate interpretation and to connect the research findings with relevant literature and theories in the context of using ChatGPT to develop students' critical thinking skills.

RESULT AND DISCUSSION

The results demonstrate that ChatGPT serves as an effective facilitating tool for discussions in student learning. Questions posed by ChatGPT in discussions through facilitation in the discussion forums can stimulate different student perspectives on topics and enable students to consider other viewpoints, promoting critical thinking. This, in turn, improves the quality of discussions and understanding. In an interview with several lecturers and students from Nurul Jadid University, researchers found that the use of ChatGPT is highly effective in facilitating discussions. According to one of the informants, "We conduct a student discussion forum with the help of ChatGPT, where students ask questions to ChatGPT. It has helped our students stimulate their thoughts and think deeply about the subjects they are learning. During the forum, students seem to be more active and engaged in communicating with ChatGPT (W-L1-26/7)." One informant even shared the good experience of communicating with ChatGPT in the commentary, "while we are in a conversation with ChatGPT, we very often

encounter a question from ChatGPT, which causes us to think many times from different possible points of view. It helps us to look at the problem from different possible perspectives, making this conversation enjoyable (W-S3-26/7). In addition, in the classroom, the researcher observed that students became more active in the critical thinking process when ChatGPT participated in group discussions. For example, when a case study is mentioned, ChatGPT is asked an analytical question about it. Students are heard to express their views and provide other arguments. Observation also indicates that students were more courageous in expressing new ideas and challenging existing perceptions as a result of improvement in their critical thinking skills. In general, interviews and observations suggest that ChatGPT has played a significant role in facilitating thorough discussions and helping learners explore a wide range of topics. The results of this research demonstrate the validity of ChatGPT in engaging students in discussions. The use of ChatGPT in asking provocative questions enables students to participate actively. This was demonstrated by the increased engagement and assertiveness of students in the discussion, as well as their greater ability to articulate a viewpoint and challenge others' perspectives. ChatGPT appears to facilitate the creation of a learning environment that encourages students to contribute at a higher level.

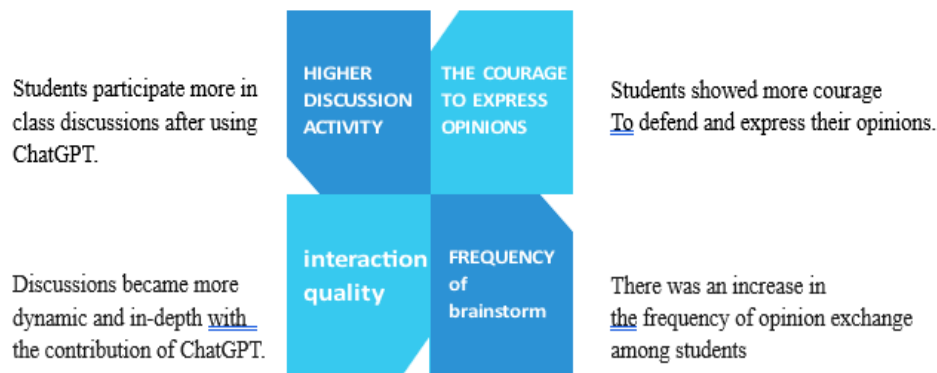


Figure 1. ChatGPT's role in class discussions

This study's discoveries build upon past investigations of active learning principles (Lin & Chang, 2023). Showing that students who utilize ChatGPT are more active participants in discussions. Active learning emphasizes students' active engagement in the learning process, as opposed to merely receiving information passively from teachers. ChatGPT functions as a catalyst that prompts participants to engage in active discourse by posing thought-provoking and challenging questions (Bonwell & Eison, 1991). Additionally, other studies have shown that enhancing students' assertiveness can be achieved through the application of self-efficacy theory (Liu et al., 2021). The theory, first presented by Bandura in 1997, posits that an individual's confidence influences their level of involvement in a particular activity (Bhati & Sethy, 2022; Hao & Fang, 2024; Li et al., 2023). This theory could be enhanced by the self-efficacy theory, as proposed by Bandura in 1977, which suggests that an individual's conviction in their capabilities contributes to the occurrence of the endogenous variable (Bandura, 1977).

Additionally, another study suggested that an increase in the frequency of opinion exchange among students may be correlated with the concept of collaborative learning, first introduced by Johnson and Johnson in 1999 (Yang, 2023). The concept of collaborative learning is based on the idea that learning occurs through social interaction and the exchange of ideas with others on the subject being learned (Barkley et al., 2014; Johnson & Johnson, 1999). The utilization of the ChatGPT platform will facilitate more productive dialogue among the students and enrich their learning experiences. Furthermore, the finding that the discussion became more dynamic and comprehensive is consistent with Chickering and Gamson's (2007) identification of seven principles for good practice in undergraduate education. One such principle is "encouraging contact between students and faculty." This can be expanded to encompass interaction with technologies such as ChatGPT, facilitating active and deep learning (Chickering & Gamson, 2007; Harper, 2018; Jun et al., 2021; Soliman, 2009).

The findings on which students engage most in ChatGPT are consistent with current higher education theory and practice as applied to existing research (Levine et al., 2024; Yu, 2023). ChatGPT facilitates more extensive and comprehensive discourse, encouraging students to engage in more assertive and thorough opinion exchange (Levine et al., 2024; Yu, 2023). The literature review provides evidence that active engagement, self-assurance, and collective learning are essential to improving the student learning experience.

These results suggest that ChatGPT is a valuable tool for presenting exercises and tasks designed to enhance students' critical thinking skills. One informant stated, "ChatGPT has facilitated structured and detailed argument analysis and evaluation of information sources, thereby supporting students in developing critical

thinking skills. The system provides a clear structure and supports students in developing their critical thinking skills" (W-L4-27/7). Another informant further claimed that exercises and assignments provided by ChatGPT empower students to practice based decision-making in a systematic manner, which was previously not a significant focus in our curriculum (W-L2-27/7).

The classroom observations revealed that students were actively engaged in exercises designed by ChatGPT. This engagement resulted in students demonstrating improved abilities in analyzing arguments, evaluating the validity of information sources, and making evidence-based decisions. One of the sources expressed, "the work given by ChatGPT proved invaluable in enabling me to develop a more critical approach to analysing arguments. The feedback I received enabled me to identify and correct insufficiencies in my argument" (W-S3-27-7). Another informant expressed "the feedback from ChatGPT reinforced my confidence in my decisions, which were based on both proof and my assessment of the quality of the information I used" (W-S1-27/7).

The discoveries demonstrate that ChatGPT effectively facilitates the development of critical thinking skills among students by creating well-designed exercises and tasks. These activities, including argument analysis, assessment of source information, and evidence-based decision-making, have been shown to challenge learners towards more sophisticated levels of thinking effectively. ChatGPT is an effective tool for developing course content that challenges students to think critically and analytically. This is further supported by the observation result, which demonstrated a positive response from active students to the exercises provided by ChatGPT. These students demonstrated an improved ability to conduct argument analysis and evaluate source quality. Therefore, it can be concluded that the exercises helped develop students' critical thinking skills.

Table 2. Research interview findings

Indicators	Descriptions	Objective source
Effective Exercise Design	The exercises and tasks designed by ChatGPT are effective in developing students' critical thinking skills.	WS, Observation
Application of Critical Thinking Skills	Exercise generated by ChatGPT enables students to apply critical thinking skills in a real-world context.	WL, Observation
Constructive Feedback	ChatGPT's feedback helps students refine and improve their specific critical thinking skills.	WL, Observation
Improved Analytical Ability	Students demonstrated improved skills in argument analysis and source evaluation following the exercise.	Observation
Confidence in Critical Thinking	Students felt more confident in using critical thinking skills thanks to the feedback from ChatGPT.	WS, Observation
Sustainable Use and Integration	The exercises generated by ChatGPT can be used sustainably and effectively to integrate critical thinking skills into the curriculum.	WL, Observation
Continued Utilization of Improved Decision-Making and Integration Skills	Exercise that involves evidence-based decision-making helps students make more solid and informed decisions.	WL, Observation

This further validates the findings of prior research, which indicate that exercises and questions generated by ChatGPT are an effective method for developing critical thinking skills in students (Guo & Lee, 2023). This is consistent with the principles of instructional design that emphasise the importance of challenging activities in facilitating active involvement in the learning process (Munna & Kalam, 2021). Another research study found that exercising with critical text using ChatGPT applies students' critical thinking skills in real-world and practical contexts (Wu, 2024). This provides empirical evidence to support the theoretical perspective that practical application is significant for creating critical thinking skills (Wu, 2024). The provided exercises help students understand the practical applications of critical thinking theory in real-life scenarios.

Another research study presents a similar observation, claiming that exercise and feedback from ChatGPT enhanced students' confidence in using critical thinking skills (Guo & Lee, 2023). This concept aligns with Bandura's (1977) self-efficacy theory, which posits that self-efficacy is a key determinant of actual participation and engagement in an activity. Therefore, confidence is a primary factor in determining whether students will engage in critical thinking activities. Previous studies have demonstrated that training provided by ChatGPT can be sustained over time, and the improvement of critical thinking skills can be integrated into existing educational curricula (Shanto et al., 2024; Wu, 2024; Yu, 2023). These discoveries bolster the

significance of integration and continuity in learning (Biggs & Tang, 2011). The results of interviews with several informants indicate that ChatGPT possesses remarkable analytical capabilities, particularly in evaluating student responses and providing tailored feedback. One of the informants stated, "ChatGPT provides comprehensive and precise feedback that's invaluable in identifying the strengths and weaknesses of the students' thought processes." This enables us to offer more focused direction on how to upgrade the quality of the feedback we provide" (W-L4-27/7). Moreover, another informant noted, "The real-time investigation capability of this ChatGPT ensures that students receive feedback promptly "(W-L3-27/7). The respondents also indicated that the feedback from ChatGPT prompted students to engage in further reflection. "The feedback from ChatGPT encourages me to reconsider my approach and pursue avenues for improvement. It facilitates my academic development "(W-S1-27/7). Subsequently, the students were directly observed during learning sessions. The observations indicated that the students received feedback well from ChatGPT. The utilization of ChatGPT in providing feedback was perceived to be effective, and students were observed to apply the feedback to improve the quality of their assignments. It was evident that students demonstrated a greater interest in and a more proactive attitude towards upgrading their work after receiving feedback from ChatGPT.

The observation session provided evidence that students who had received feedback from ChatGPT exhibited improved abilities in task reflection and improvement. The findings suggest that the use of ChatGPT in the feedback process may have positively impacted the students' reflection and improvement skills. Initiated concrete changes and rectified previous errors, demonstrating a notable shift in reflection. This evidence demonstrates the significant role of feedback based on data provided by ChatGPT in facilitating student learning and advancing critical thinking. The students demonstrated that the feedback provided by ChatGPT was important in helping identify the qualities and limitations of their thought processes. Additionally, the students indicated that the feedback was remarkably detailed and data-driven, prompting them to engage in more profound reflection and identify areas for improvement. This suggests that ChatGPT not only provides constructive feedback but also underpins the process of meaningful reflection on the enhancement of critical thinking skills. The students were attempting to rectify the work of their peers and refine their approach to problem-solving, which is an encouraging indication that ChatGPT was effectively facilitating their learning journey.

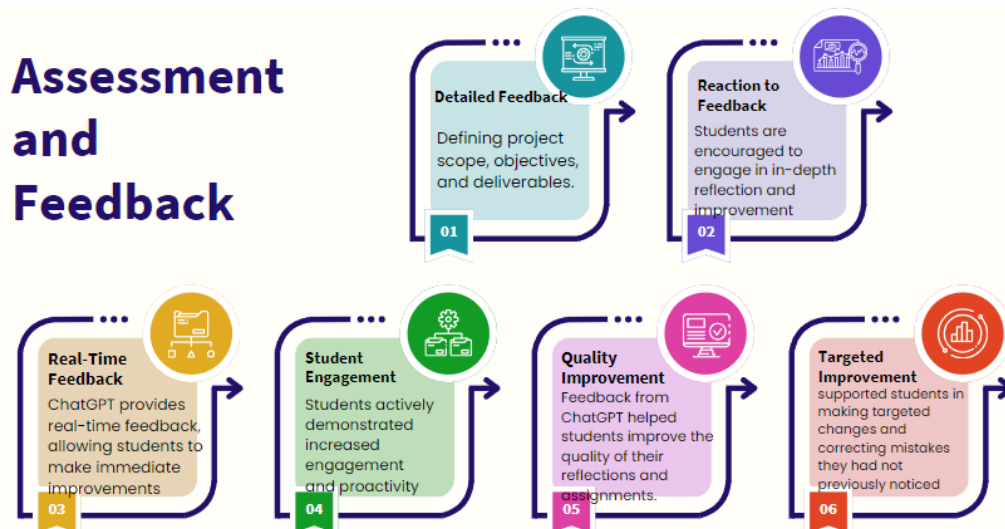


Figure 2. ChatGPT Assessment and Feedback

The results of interviews and observations already indicate that ChatGPT has the potential to significantly enhance students' learning process through the provision of highly specific, detailed, and real-time quality feedback. It is not only the substance of feedback, but also the process of deep reflection, that is of extraordinary significance for the academic development of students. ChatGPT's real-time analysis and feedback capability is adept at analyzing student responses in real-time, providing clear and specific feedback that enables students to identify strengths and weaknesses in their approach to thinking. Additionally, ChatGPT offers real-time correction capabilities, allowing students to receive immediate feedback and make necessary adjustments. Prior research has demonstrated the exceptional value of prompt and precise feedback not only for learning but also for the learning process itself (Hattie & Timperley, 2007). However, this study provides a novel contribution by demonstrating how AI-driven feedback, specifically from ChatGPT, fosters not only accuracy in students' responses but also metacognitive awareness and independent analytical thinking aspects that have been underexplored in previous research. Unlike traditional feedback methods, ChatGPT enables dynamic and iterative student interactions, encouraging them to refine their reasoning continuously.

The AI-generated feedback encouraged students to engage in deep reflection, a practice that is integral to the development of critical thinking skills and academic competitiveness (W-S1-27/7). Observations revealed that students become more proactive in seeking improvements and critically evaluating their reasoning, leading to increased engagement and intellectual autonomy. This finding aligns with previous studies on formative assessment (Black & Wiliam, 1998) but extends their insight by demonstrating how AI-driven feedback can support continuous self-directed learning in a digital context. The impact of ChatGPT on the quality of learning can be described as both beneficial and conducive to a reflective learning process. Students have reported that they found improvement in understanding the strengths and flaws in their thinking approach. Then, they can target for improvement. This can be considered an effective intervention (Nicol & MacFarlane-Dick, 2006). This study contributes to educational research by highlighting the potential of AI-assisted feedback as an effective pedagogical intervention to promote self-regulated learning and the development of critical thinking. Furthermore, it provides a framework for integrating AI-driven tools into higher education curricula to optimize digital learning experiences and foster cognitive skills that are crucial in the 21st century.

CONCLUSION

This research demonstrates that AI, particularly language models such as ChatGPT, plays a significant role in developing students' critical thinking skills. The integration of AI-driven exercises structured instructional engagement and cognitive growth among students. The utilization of AI-supported learning in this manner not only enhances students' academic abilities and self-confidence but also broadens their capacity for independent and reflective thinking. Beyond individual learning, the findings of this study have broader implications for educational practice. The potential of AI to supplement traditional academic methods for educational practice. The potential of AI to supplement traditional academic approaches suggests a transformative shift in pedagogical strategies where AI-driven tools can serve as personalized learning assistants. Educators can leverage AI to provide more targeted feedback, encourage critical thinking discussions, and foster adaptive learning environments that cater to diverse student needs. Moreover, this study makes a significant contribution to the field of educational research by providing a comprehensive analysis of how AI can be integrated to enhance critical thinking skills. The practical application of these findings underscores the need for institutions to develop structured AI-based learning frameworks that align with existing curricula. Policymakers and educators should consider incorporating AI-driven methodologies to optimize learning outcomes, ensuring that students are equipped with the essential cognitive skills required in an increasingly technology-driven world. The complete integration of AI into the higher education curriculum, with the implementation of appropriate exercise design and the provision of targeted feedback to support critical thinking, is essential to ensure the optimal realization of both the benefits and the potential of AI in this context. The efficiency of AI, such as ChatGPT, may also depend very much on the manner in which it is implemented and structured, and thus requires further adaptation across disciplines. Further studies are required to adopt a broader longitudinal approach to explore the long-term impact of AI, variability, and to provide recommendations for its integration in different learning contexts.

REFERENCES

- Ahmed, V., & Opoku, A. (2022). Technology Supported Learning and Pedagogy in Times of Crisis: The Case of COVID-19 Pandemic. *Education and Information Technologies*, 27(1), 101–123.
- Alam, A., & Mohanty, A. (2023). Educational Technology: Exploring the Convergence of Technology and Pedagogy Through Mobility, Interactivity, AI, and Learning Tools. *Cogent Engineering*, 10(2).
- Alawida, M., Mejri, S., Mehmood, A., Chikhaoui, B., & Isaac Abiodun, O. (2023). A Comprehensive Study of ChatGPT: Advancements, Limitations, and Ethical Considerations in Natural Language Processing and Cybersecurity. *Information (Switzerland)*, 14(8).
- Algabri, H. K. M. (2024). *Artificial Intelligence and ChatGPT*. Academic Guru Publishing House.
- Almusaed, A., Almssad, A., Yitmen, I., & Homod, R. Z. (2023). Enhancing Student Engagement: Harnessing "AIED"'s Power in Hybrid Education—A Review Analysis. *Education Sciences*, 13(7).
- Alshater, M. (2023). Exploring the Role of Artificial Intelligence in Enhancing Academic Performance: A Case Study of ChatGPT. *SSRN Electronic Journal*.
- Aoun, J. E. (2017). *Robot-Proof: Higher Education in the Age of Artificial Intelligence*. MIT Press.
- Atallah, M. J., McDonough, C. J., Raskin, V., & Nirenburg, S. (2000). Natural Language Processing for Information Assurance and Security: An Overview and Implementations. *Proceedings of the New Security Paradigm Workshop*, 51–65.

- Bali, M. M. E. I., Kumalasani, M. P., & Yunilasari, D. (2022). Artificial Intelligence in Higher Education: Perspicacity Relation Between Educators and Students. *Journal of Innovation in Educational and Cultural Research*, 3(2), 146–152.
- Bandura, A. (1977). Self-Efficacy: Toward a Unifying Theory of Behavioral Change. *Psychological Review*, 84(2), 191.
- Barkley, E. F., Major, C. H., & Cross, K. P. (2014). *Collaborative Learning Techniques: A Handbook for College Faculty*. John Wiley & Sons.
- Basha, J. Y. (2024). The Negative Impacts of AI Tools on Students in Academic and Real-Life Performance. *International Journal of Modern Developments in Engineering and Science*, 1(3), 1–16.
- Bhati, K., & Sethy, T. P. (2022). Self-Efficacy: Theory to Educational Practice. *The International Journal of Indian Psychology*, 10(1), 1123–1128.
- Black, P., & Wiliam, D. (1998). Assessment and Classroom Learning. *Assessment in Education: Principles, Policy & Practice*, 5(1), 7–74.
- Bonwell, C. C., & Eison, J. A. (1991). *Active Learning: Creating Excitement in the Classroom*. ASHE-ERIC Higher Education Report.
- Caelen, O., & Blete, M. A. (2024). *Developing Apps with GPT-4 and ChatGPT: Build Intelligent Chatbots, Content Generators, and More*. O'Reilly Media, Inc.
- Casheekar, A., Lahiri, A., Rath, K., Prabhakar, K. S., & Srinivasan, K. (2024). A Contemporary Review on Chatbots, AI-Powered Virtual Conversational Agents, ChatGPT: Applications, Open Challenges and Future Research Directions. *Computer Science Review*, 52, 100632.
- Chen, L., Chen, P., & Lin, Z. (2020). Artificial Intelligence in Education: A Review. *IEEE Access*, 8, 75264–75278.
- Chickering, A. W., & Gamson, Z. F. (2007). Seven Principles for Good Practice in Undergraduate Education. *AAHE Bulletin*, 39(7), 3–7.
- Early, S. L. (2011). Book Review: Student Engagement Techniques: A Handbook for College Faculty. *Journal of the Scholarship of Teaching and Learning*, 11(1), 155–157.
- Eisenring, M. A. A., Jamiluddin, J., Hairul, M. A., & Putri, D. (2024). The Use of Chatbots in the English Language Teaching to Promote Modern Language Learning: A Literature Review. *International Journal of Indonesian Education and Teaching*, 8(1), 127–139.
- Essel, H. B., Vlachopoulos, D., Tachie-Menson, A., Johnson, E. E., & Baah, P. K. (2022). The Impact of a Virtual Teaching Assistant (Chatbot) on Students' Learning in Ghanaian Higher Education. *International Journal of Educational Technology in Higher Education*, 19(1).
- Fuchs, K. (2023). Exploring the Opportunities and Challenges of NLP Models in Higher Education: Is ChatGPT a Blessing or a Curse? *Frontiers in Education*, 8.
- Fuchs, K., & Aguilos, V. (2023). Integrating Artificial Intelligence in Higher Education: Empirical Insights from Students About Using ChatGPT. *International Journal of Information and Education Technology*, 13(9), 1365–1371.
- Garlinska, M., Osial, M., Proniewska, K., & Pregowska, A. (2023). The Influence of Emerging Technologies on Distance Education. *Electronics (Switzerland)*, 12(7).
- Gill, S. S., & Kaur, R. (2023). ChatGPT: Vision and Challenges. *Internet of Things and Cyber-Physical Systems*, 3, 262–271.
- Guo, Y., & Lee, D. (2023). Leveraging ChatGPT for Enhancing Critical Thinking Skills. *Journal of Chemical Education*, 100(12), 4876–4883.
- Haleem, A., Javaid, M., & Singh, R. P. (2022). An Era of ChatGPT as a Significant Futuristic Support Tool: A Study on Features, Abilities, and Challenges. *BenchCouncil Transactions on Benchmarks, Standards and Evaluations*, 2(4), 100089.
- Hao, X., & Fang, F. (2024). Learners' Speaking Self-Efficacy, Self-Efficacy Sources and Their Relations in the Traditional and Flipped Instructional Modes. *Asia Pacific Journal of Education*, 1–16.
- Haque, M. A., & Li, S. (2024). Exploring ChatGPT and Its Impact on Society. *AI and Ethics*, 5(2), 791–803.
- Harper, B. (2018). Technology and Teacher–Student Interactions: A Review of Empirical Research. *Journal of Research on Technology in Education*, 50(3), 214–225.

- Hattie, J., & Timperley, H. (2007). The Power of Feedback. *Review of Educational Research*, 77(1), 81–112.
- Hennik, M., Hutter, I., & Bailey, A. (2020). *Qualitative Research Methods*. Sage Publications.
- Holmes, W., Persson, J., Chounta, I. A., Wasson, B., & Dimitrova, V. (2022). *Artificial Intelligence and Education: A Critical View Through the Lens of Human Rights, Democracy and the Rule of Law*. Council of Europe.
- Huallpa, J. J., Flores Arocutipa, J. P., Panduro, W. D., Huete, L. C., Flores Limo, F. A., Herrera, E. E., Alba Callacna, R. A., Ariza Flores, V. A., Medina Romero, M. Á., Quispe, I. M., & Hernández, F. A. (2023). Exploring the Ethical Considerations of Using ChatGPT in University Education. *Periodicals of Engineering and Natural Sciences*, 11(4), 105–115.
- Idoko, I. P., Enyejo, L., & Ebiega, G. I. (2024). Integrating Superhumans and Synthetic Humans into the Internet of Things (IoT) and Ubiquitous Computing: Emerging AI Applications and Their Relevance in the U.S. Context. *Global Journal of Engineering and Technology Advances*, 19(1), 6–36.
- Javaid, M., Haleem, A., Singh, R. P., Khan, S., & Khan, I. H. (2023). Unlocking the Opportunities Through ChatGPT Tool Towards Ameliorating the Education System. *BenchCouncil Transactions on Benchmarks, Standards and Evaluations*, 3(2), 100115.
- Johnson, D. W., & Johnson, R. T. (1999). Making Cooperative Learning Work. *Theory into Practice*, 38(2), 67–73.
- Jun, J. S., Kremer, K. P., Marseline, D., Lockett, L., & Kurtz, D. L. (2021). Effective Social Work Online Education in Response to COVID-19. *Journal of Teaching in Social Work*, 41(5), 520–534.
- Levine, S., Beck, S. W., Mah, C., Phalen, L., & Pittman, J. (2024). How Do Students Use ChatGPT as a Writing Support? *The Michigan Daily*, 1–13.
- Li, J., Wang, C., Zhao, Y., & Li, Y. (2023). Boosting Learners' Confidence in Learning English: Can Self-Efficacy-Based Intervention Make a Difference? *TESOL Quarterly*, 58(4), 1518–1547.
- Lin, M. P. C., & Chang, D. (2023). CHAT-ACTS: A Pedagogical Framework for Personalized Chatbot to Enhance Active Learning and Self-Regulated Learning. *Computers and Education: Artificial Intelligence*, 5, 100167.
- Liu, T., Yu, X., Liu, M., Wang, M., Zhu, X., & Yang, X. (2021). A Mixed Method Evaluation of an Integrated Course in Improving Critical Thinking and Creative Self-Efficacy Among Nursing Students. *Nurse Education Today*, 106, 105072.
- Luckin, R., & Holmes, W. (2016). *Intelligence Unleashed: An Argument for AI in Education*. UCL Knowledge Lab.
- Malinka, K., Peresíni, M., Firc, A., Hujnák, O., & Janus, F. (2023). On the Educational Impact of ChatGPT: Is Artificial Intelligence Ready to Obtain a University Degree? *Annual Conference on Innovation and Technology in Computer Science Education, ITiCSE*, 1, 47–53.
- Miles, M. B., & Huberman, A. M. (1994). *Qualitative Data Analysis: An Expanded Sourcebook*. Sage Publications.
- Munna, A. S., & Kalam, M. A. (2021). Impact of Active Learning Strategy on the Student Engagement. *GNOSI: An Interdisciplinary Journal of Human Theory and Praxis*, 4(2), 96–114.
- Murtaza, M., Ahmed, Y., Shamsi, J. A., Sherwani, F., & Usman, M. (2022). AI-Based Personalized E-Learning Systems: Issues, Challenges, and Solutions. *IEEE Access*, 10, 81323–81342.
- Nguyen, T. T., Tran, H. T., & Nguyen, M. T. (2023). Empowering Education: Exploring the Potential of Artificial Intelligence. In *Advanced Technologies and AI-Equipped Applications* (pp. 140–161).
- Nicol, D., & MacFarlane-Dick, D. (2006). Formative Assessment and Self-Regulated Learning: A Model and Seven Principles of Good Feedback Practice. *Studies in Higher Education*, 31(2), 199–218.
- Pedro, F., Subosa, M., Rivas, A., & Valverde, P. (2019). *Artificial Intelligence in Education: Challenges and Opportunities for Sustainable Development*. UNESCO.
- Ragheb, M. A., Tantawi, P., Farouk, N., & Hatata, A. (2022). Investigating the Acceptance of Applying Chatbot (Artificial Intelligence) Technology Among Higher Education Students in Egypt. *International Journal of Higher Education Management*, 8(2), 1–13.

- Rahim, N. I. M., Iahad, N. A., Yusof, A. F., & Al-Sharaf, M. A. (2022). AI-Based Chatbots Adoption Model for Higher-Education Institutions: A Hybrid PLS-SEM-Neural Network Modelling Approach. *Sustainability (Switzerland)*, 14(19).
- Rane, N., Choudhary, S., & Rane, J. (2024). Gemini Versus ChatGPT: Applications, Performance, Architecture, Capabilities, and Implementation. *Journal of Applied Artificial Intelligence*, 5(1), 69–93.
- Ray, P. P. (2023). ChatGPT: A Comprehensive Review on Background, Applications, Key Challenges, Bias, Ethics, Limitations and Future Scope. *Internet of Things and Cyber-Physical Systems*, 3, 121–154.
- Robertson, A., Curtis, P. M., & Dann, C. (2018). Outcomes of a Collaborative Contextualised Learning Approach to Teacher Professional Development in Papua, Indonesia. *International Education Journal*, 17(2), 88–101.
- Sajja, R., Sermet, Y., Cikmaz, M., Cwiertny, D., & Demir, I. (2023). *Artificial Intelligence-Enabled Intelligent Assistant for Personalized and Adaptive Learning in Higher Education*.
- Shanto, S. S., Ahmed, Z., & Jony, A. I. (2024). Enriching Learning Process with Generative AI: A Proposed Framework to Cultivate Critical Thinking in Higher Education Using ChatGPT. *Journal of Propulsion Technology*, 45(1), 3019–3029.
- Sidorkin, A. M. (2024). *Embracing Chatbots in Higher Education: The Use of Artificial Intelligence in Teaching, Administration, and Scholarship*. Taylor & Francis.
- Soliman, N. (2009). *Blended Teaching Pedagogies and Facilitating Online Interaction*.
- Sridhar, V. (2024). *ChatGPT and Artificial Intelligence*. Academic Guru Publishing House.
- Suprpto, N., Prahani, B. K., & Cheng, T. H. (2021). Indonesian Curriculum Reform in Policy and Local Wisdom: Perspectives from Science Education. *Jurnal Pendidikan IPA Indonesia*, 10(1), 69–80.
- Tay, L. Y., Lee, S. S., & Ramachandran, K. (2021). Implementation of Online Home-Based Learning and Students' Engagement During the COVID-19 Pandemic: A Case Study of Singapore Mathematics Teachers. *Asia-Pacific Education Researcher*, 30(3), 299–310.
- Tayan, O., Hassan, A., Khankan, K., & Askool, S. (2024). Considerations for Adapting Higher Education Technology Courses for AI Large Language Models: A Critical Review of the Impact of ChatGPT. *Machine Learning with Applications*, 15, 100513.
- Villegas-Ch, W., Arias-Navarrete, A., & Palacios-Pacheco, X. (2020). Proposal of an Architecture for the Integration of a Chatbot with Artificial Intelligence in a Smart Campus for the Improvement of Learning. *Sustainability (Switzerland)*, 12(4).
- Wang, T., Lund, B. D., Marengo, A., Pagano, A., Mannuru, N. R., Teel, Z. A., & Pange, J. (2023). Exploring the Potential Impact of Artificial Intelligence (AI) on International Students in Higher Education: Generative AI, Chatbots, Analytics, and International Student Success. *Applied Sciences (Switzerland)*, 13(11).
- Wu, Y. (2024). Critical Thinking Pedagogics Design in an Era of ChatGPT and Other AI Tools — Shifting from Teaching "What" to Teaching "Why" and "How." *Journal of Education and Development*, 8(1), 1.
- Yang, X. (2023). A Historical Review of Collaborative Learning and Cooperative Learning. *TechTrends*, 67(4), 718–728.
- Yu, H. (2023). Reflection on Whether ChatGPT Should Be Banned by Academia from the Perspective of Education and Teaching. *Frontiers in Psychology*, 14.
- Zhai, C., Wibowo, S., & Li, L. D. (2024). The Effects of Over-Reliance on AI Dialogue Systems on Students' Cognitive Abilities: A Systematic Review. *Smart Learning Environments*, 11(1).
- Zhang, H., Song, H., Li, S., Zhou, M., & Song, D. (2023). A Survey of Controllable Text Generation Using Transformer-Based Pre-Trained Language Models. *ACM Computing Surveys*, 56(3).
- Zidny, R., & Eilks, I. (2018). Indigenous Knowledge as a Socio-Cultural Context of Science to Promote Transformative Education for Sustainable Development: Insights into a Case Study on the Baduy Community (Indonesia). *Building Bridges Across Disciplines for Transformative Education and a Sustainable Future*, 249–256.