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# Critical thinking in the AI era: An exploration of EFL students' perceptions, benefits, and limitations

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Additional information is available at the end of the article

**Abstract:** This study aimed to provide an in-depth understanding of English as a Foreign Language (EFL) students' perceptions concerning both the benefits and limitations of Artificial Intelligence (AI) in the context of critical thinking. Utilizing a qualitative research design that focuses on case studies and employs semi-structured interviews, seven master's degree students from two different Indonesian universities were purposively selected for the sample. The findings revealed a complex view of critical thinking that involves questioning norms, analyzing context, and evaluating evidence. Students acknowledged AI's utility in enriching various facets of critical thinking, such as academic research and theory scrutiny. However, concerns were also raised about AI's limitations, including lack of

Darwin

## ABOUT THE AUTHORS

Darwin, a doctoral student at Universitas Negeri Malang, Indonesia, is majoring in English Language Education. His research interests revolve around critical thinking, technology in education, and reading comprehension strategies.

Marzuki, serving as a faculty member in the English Language Education Study program at Universitas Madako Tolitoli, Indonesia, brings a diverse array of research interests and specializations to his role. His expertise lies in technology-enhanced language teaching, strategies for Teaching English as a Foreign Language (TEFL), and the nuances of academic writing. These interests underline his dedication to incorporating contemporary technological advancements into language education, investigating efficacious teaching methods, and enriching academic literature through his scholarly contributions.

Diyenti Rusdin is a faculty member of the English Language Education Study Program at Universitas Madako Tolitoli, Indonesia. Her research interests encompass Communicative Language Teaching, academic writing, and strategies in English as a Foreign Language (EFL).

## PUBLIC INTEREST STATEMENT

This research explores English as a Foreign Language (EFL) students' views on Artificial Intelligence's (AI) role in enhancing critical thinking. Interviews with seven master's students from Indonesian universities revealed that while AI is seen as beneficial for tasks like research and theory analysis, concerns about its limitations, such as lack of personalization and difficulty in nuanced understanding, also emerged. The findings suggest that AI can be a valuable tool in developing critical thinking skills, provided its use is balanced and its limitations are well-managed. This study is particularly relevant for educators and policymakers in language education, highlighting the need for a thoughtful integration of AI in teaching methodologies. It also opens up discussions for future research on optimizing AI's role in language learning.

personalization, potential for echo chambers, and difficulties in nuanced understanding. The study concludes that AI can be an asset in the development of critical thinking skills, but with caveats that require careful management. A balanced approach that capitalizes on AI's strengths while being aware of its limitations is necessary for cultivating robust critical thinking abilities among EFL students. Limitations of the study include its reliance on self-reported data, which may introduce biases, and the heterogeneity in the participants' backgrounds, affecting generalizability. Future research may consider more objective measures such as observations or psychometric tests, and investigate pedagogical methods for integrating critical thinking and AI applications effectively.

**Subjects: Artificial Intelligence; Computer Science (General); ICT; Instructional Communication; Higher Education; Information Technology; Education - Social Sciences**

**Keywords: critical thinking; AI era; EFL students; perceptions; benefits**

## 1. Introduction

In today's fast-paced, globalized world, the importance of critical thinking skills cannot be overstated. Critical thinking is indispensable for evaluating information, solving problems, and making informed decisions, both in academic and real-world scenarios (Quinn et al., 2020; Shanta & Wells, 2022). The evolution of Artificial Intelligence (henceforth AI) technologies has added a new dimension to this discussion. AI has the potential to revolutionize educational settings by personalizing learning experiences and providing real-time assessments, among other benefits (Alam, 2022; Kamalov et al., 2023). Specifically, AI can adapt educational content to suit the unique needs and learning styles of each student. This personalization means that students can learn at their own pace and in ways that are most effective for them, making education more engaging and efficient. Additionally, AI's capability to provide real-time assessments allows for immediate feedback on students' work. This instant feedback helps students quickly understand and correct their mistakes, leading to a more effective learning process. It also aids teachers in identifying areas where students may need extra help, allowing for more targeted and timely support. These advancements indicate a shift towards a more adaptable and responsive educational system, tailored to the needs of individual learners.

However, AI also poses challenges such as ethical concerns related to data privacy and the risk of widening educational inequalities (Marzuki et al., 2023; Nguyen et al., 2023). The use of AI in education often involves collecting and analyzing large amounts of student data. This raises significant concerns about data privacy, as there is a risk of sensitive student information being mishandled or exposed. Furthermore, not all students have equal access to the latest technology and AI resources. This disparity can lead to widening educational inequalities, where students with access to AI-enhanced learning have a significant advantage over those without. Additionally, there is a concern that reliance on AI in educational settings might lead to a one-size-fits-all approach, potentially overlooking the unique cultural, social, and emotional needs of individual students. This could inadvertently perpetuate existing biases and inequalities in education. These challenges highlight the need for careful consideration and balanced implementation of AI in educational contexts to ensure that its benefits are accessible to all students without compromising their privacy or exacerbating existing disparities. In parallel, the field of English as a Foreign Language (EFL) education is undergoing its own set of challenges and transformations. English's role as a global lingua franca places additional pressure on EFL students to attain linguistic proficiency and develop academic skills like critical thinking (Liu et al., 2023; Yuan, 2023). However, the EFL context brings in unique complexities such as linguistic limitations, cultural nuances, and varied educational backgrounds that influence students' ability to engage in critical thinking (Mafulah et al., 2023; Yuan, 2023, 2023).

Although research has started to shed light on the interaction between AI and various educational contexts (e.g., Baidoo-Anu & Ansah, 2023; Grassini, 2023; Hwang & Chien, 2022), a specific focus on EFL education remains limited. Research by Kasneci et al. (2023) suggests that AI has the capacity to significantly affect language education, but the investigation into how EFL students themselves perceive the role of AI in their learning processes is less comprehensive. More critically, the dialogue on how AI could aid or inhibit the development of critical thinking skills, a key component of advanced language learning and academic success is even less established within the EFL context. The few existing studies, such as those by Mohamed (2023), provide preliminary insights but do not sufficiently delve into the nuanced perceptions EFL students have regarding the pros and cons of using AI to advance their critical thinking skills. Furthermore, EFL students may view the incorporation of AI into their learning ecosystem in a spectrum of ways, ranging from empowerment to skepticism (Alasadi & Baiz, 2023; DiGiacomo et al., 2023). While some (e.g., Gardner et al., 2021; Liu et al., 2021) may find AI tools like automated essay scoring or language learning apps to be beneficial for their problem-solving and analytical skills, others (e.g., Budhwar et al., 2023; Kooli, 2023) might raise valid concerns over AI algorithms reinforcing existing biases or hindering the development of independent thought. These varying perceptions could be influenced by numerous factors including but not limited to cultural background, prior exposure to technology, and the quality of AI tools available (Ray, 2023).

The situation in Indonesia presents a unique case for examining the impact of AI on critical thinking in EFL classrooms, as highlighted by the work of Hapsari and Wu (2022). Their research explored the use of AI chatbots in enhancing critical thinking among students, shedding light on the potential of AI in enriching academic pursuit within the Indonesian context. Here, academic pursuit encompasses not just the mastery of English as a foreign language, but also the nurturing of a critical and analytical mindset, which is crucial for higher education and professional success. AI tools like the chatbots studied by Hapsari and Wu (2022) can provide varied and complex linguistic content, simulate real-life scenarios for critical analysis, and offer personalized feedback, all key to fostering deep understanding and practical application of the language.

However, the utilization of AI in education must be approached carefully to ensure it bolsters rather than diminishes critical thinking skills. An over-reliance on AI for problem-solving or generating content could lead to a passive learning approach, counterproductive to the goal of developing active, critical learners. The design and implementation of AI tools are pivotal in this regard. They should be crafted to encourage not just rote learning or basic comprehension, but inquiry, debate, and critical evaluation. This aspect is particularly significant in Indonesia, where EFL students often have diverse educational backgrounds and varied access to technology. Thus, further research, building upon studies like Hapsari and Wu's (2022), is essential. Such research should evaluate the effectiveness of AI tools in improving language proficiency and shaping the development of critical thinking skills, a fundamental aspect of academic pursuit. This comprehensive understanding is vital to ensure that AI's integration into Indonesian EFL classrooms genuinely enhances learning experiences and equips students for the challenges of higher education and their future careers.

In response to the identified gap in the literature, this study explores the perceptions of EFL students about the role of critical thinking in their academics, with a focus on the impact of AI tools. Specifically, it aims to evaluate attitudes towards critical thinking, assess perceptions of AI's benefits in this area, and explore any limitations or drawbacks of using AI. The study will address these goals through the following research questions:

(1) What are EFL students' perceptions toward critical thinking in their academic pursuits?
(2) How do they perceive the benefits of AI in fostering critical thinking?
(3) What limitations and potential drawbacks do they identify in using AI for critical thinking?

By answering these questions, the study seeks to contribute to research in EFL education and educational technology. It aims to illuminate how AI can be effectively integrated or improved to support critical thinking development among EFL students.

## 2. Literature review

### *2.1. The conceptualization of critical thinking*

The conceptualization of critical thinking in academia is far from monolithic, reflecting the complex nature of this cognitive skill set. Several scholars (e.g., Abrami et al., 2015; Alsaleh, 2020; Bezanilla et al., 2019; Slavin et al., 2021) have undertaken the task of defining and dissecting the elements that constitute critical thinking, often yielding nuanced, multi-layered perspectives. Abrami et al. (2015) meta-analysis, for instance, posits that critical thinking is not a singular ability but rather a spectrum of skills ranging from analysis and evaluation to synthesis and problem-solving. This view aligns well with Bezanilla et al. (2019) study, which explores the development of critical thinking skills through diverse educational methods. Together, these works advocate for a broad understanding that encompasses multiple dimensions, such as analysis, context discernment, evidence evaluation, and reasoned conclusions. While the multifaceted nature of critical thinking is widely acknowledged, there is also a growing emphasis on the role of questioning and skepticism in academic contexts. Slavin et al. (2021) research offers an insightful angle by arguing that critical thinking fundamentally involves the questioning of established norms and accepted wisdom. This viewpoint is further corroborated by Alsaleh (2020), who explores pedagogical approaches to cultivate questioning skills in students. The act of challenging the status quo is not merely a by-product but an integral component of critical thinking. Both perspectives converge on the idea that skepticism, rigor, and proactive questioning are indispensable for the advancement of knowledge and understanding. This demonstrates that the academic discourse on critical thinking is shifting towards a more inclusive view that not just embraces analytical and methodological rigor but also recognizes the importance of questioning as a vital component.

### *2.2. The impact of artificial intelligence on critical thinking*

Artificial Intelligence (AI) is increasingly seen as a powerful tool to augment critical thinking skills, especially in educational settings. One of the primary areas of focus is its application in academic research, where AI technologies like Natural Language Processing (NLP) play a crucial role. NLP, which involves the use of algorithms to understand and manipulate human language, can perform extensive literature reviews by analyzing vast amounts of text data. It can identify key themes, trends, and gaps in existing research, thereby facilitating the formulation and refinement of research questions. NLP's ability to process and interpret complex language patterns accelerates the research process and enhances the accuracy and depth of literature analysis, making it a valuable tool in academic settings. Raharjana et al. (2021) highlight this utility by demonstrating how NLP can sift through voluminous academic literature efficiently. This is further underscored by Duman and Akdemir (2021), who argue that AI can dramatically amplify research capabilities by automating tasks that are both time-consuming and repetitive, such as literature reviews and issue identification. These efficiencies free up researchers to devote more cognitive resources to complex tasks like data interpretation and hypothesis formation, which are critical to nurturing higher-order cognitive skills. However, AI's influence on critical thinking is not confined to automation or efficiency gains; it also offers new avenues for scrutinizing existing theories and paradigms. According to Mathisen et al. (2019), the power of AI, particularly data analytics tools, lies in their capacity to empirically test existing frameworks, thereby reinforcing the importance of questioning as a cornerstone of critical thinking. Researchers like Halpern and Dunn (2021) and Spector and Ma (2019) echo these sentiments, suggesting that AI can be employed in a way that encourages skeptical inquiry and challenges accepted norms. For instance, machine learning technologies can aid in experimental design, especially in predicting outcomes to refine research questions, as noted by Lamb et al. (2020). This multifaceted role of AI, from automation to hypothesis testing, adds a new dimension to how critical thinking can be taught, learned, and applied, enabling a richer, more nuanced educational experience.

While the utility of AI in enhancing critical thinking skills is evident, there are also significant limitations that warrant attention. One of the primary concerns is the potential for AI systems to create "echo chambers," limiting the diversity of perspectives that one is exposed to. This issue has been discussed by Sasahara et al. (2019) and Kusters et al. (2020), who note that algorithmic biases can inadvertently narrow down the range of analytical outcomes, thereby limiting the scope for critical analysis. Another limitation lies in the lack of personalization in AI algorithms, which can restrict the well-rounded selection of information for academic research. Keyes et al. (2021) and Janssen et al. (2020) have warned that these algorithms often lack alignment with individual criteria for scholarly paper selection, and as such, could limit opportunities for in-depth critical analysis. Additionally, there are worries about how reliable and ethical these AI tools are, which adds to the complexity of the situation. As noted by Ryan (2020), there is a need for skepticism concerning the results generated by AI analytics tools, especially when considering that incorrect initial settings could lead to misleading or false outcomes. The findings of Heimerl et al. (2022) point out that AI's inherent limitations in understanding nuances like irony or emotional subtleties could lead to incomplete or flawed analyses. Participants in studies have also raised the issue of "cognitive offloading," arguing that heavy reliance on AI could diminish one's own critical thinking skills, a sentiment echoed by Marzuki et al. (2023). These limitations call for a balanced approach that incorporates human oversight to ensure both reliability and analytical objectivity, thus avoiding pitfalls that could undermine critical thinking.

### *2.3. Previous research on the impact of AI toward critical thinking*

A number research studies have collectively revealed an emerging trend that accentuates the critical role of Artificial Intelligence (AI) and technology in enhancing language education and critical thinking skills. Studies by Hapsari and Wu (2022) and Muthmainnah et al. (2022) suggest that AI tools like chatbots act as self-regulated learning platforms to improve speaking proficiency and work to alleviate emotional barriers such as anxiety. This dual function of AI—in both skill and emotional development—is also reiterated in the research by Xiao and Zhi (2023), which underscores the specific capabilities of ChatGPT as a personalized learning assistant. Moreover, the significance of AI in developing critical thinking skills is highlighted in multiple studies, confirming its role as a facilitator of higher-order cognitive skills in 21st-century education. In addition to technology, emotional and psychological aspects of learning are explored. Bahufite et al. (2023) emphasize that attributes like trust and self-confidence can be bolstered by AI-assisted learning, impacting not just language acquisition but also the cultivation of critical thinking abilities. These insights dovetail well with Liang's (2022) literature review, which provides a structured framework for leveraging technology to cultivate critical thinking, suggesting that the right application of technology can make a material difference in educational outcomes. Finally, different pedagogical approaches and their efficacy in nurturing skills vital in the era of AI are examined. Rampersad (2020) discusses Work Integrated Learning (WIL) as a transformative learning approach, while Suhirman et al. (2021) delve into the effects of problem-based learning methods. Both contribute to the larger discourse on how teaching methodologies, sometimes in conjunction with technology, can be designed to foster skills like critical thinking and innovation. Thus, these studies collectively provide a multidimensional view of how technology, emotional factors, and pedagogical strategies intersect to impact learning in a technologically advanced educational landscape.

While the existing literature has significantly contributed to our understanding of the relationship between AI and critical thinking, several areas remain underexplored and necessitate further research. The majority of studies focus primarily on the benefits of AI in enhancing critical thinking, often glossing over its potential drawbacks. As a result, there is a need for more empirical research that critically evaluates the limitations and ethical implications of using AI in educational settings. Therefore, the present study aims to fill these gaps in the existing literature by adopting a more holistic and critical approach to the evaluation of AI's impact on critical thinking in an EFL setting, particularly focusing on the Indonesian context. This study will not only assess the benefits but

also scrutinize the potential drawbacks, ethical considerations, and limitations of using AI tools for fostering critical thinking skills.

### *2.4. The theoretical framework*

Our framework, inspired by the foundational work of Abrami et al. (2015) and Bezanilla et al. (2019), conceptualizes critical thinking as a multi-dimensional skill set that integrates diverse cognitive abilities such as analysis, context discernment, and evidence evaluation. Aligning with modern educational theories, this perspective broadens the understanding of critical thinking beyond traditional confines. A central element of our framework is the emphasis on critical inquiry and skepticism, as highlighted by Slavin et al. (2021) and Alsaleh (2020). This approach underscores the importance of questioning established norms and empirically testing new ideas, fostering a culture of continuous intellectual curiosity and reflective learning. Additionally, our framework prioritizes methodological rigor in critical analysis, drawing insights from Shaw et al. (2020) and Mohseni et al. (2020). We advocate for structured, logical methodologies in problem-solving and data interpretation, enhancing the clarity and effectiveness of critical thinking processes. Incorporating the insights of Caena and Redecker (2019), our framework adopts an integrative synthesis approach. This holistic perspective merges various critical thinking skills into a unified discipline, focusing on the interconnectedness and complementarity of individual skills to form a comprehensive critical thinking pedagogy.

Recognizing the growing importance of technology in education, our framework includes the potential of AI and digital tools in enhancing critical thinking. Supported by the research of Raharjana et al. (2021) and Duman and Akdemir (2021), it explores AI's applications in literature review, experimental design, and data analysis, positing technology as a valuable asset in expanding critical thinking skills among EFL students. However, our framework also addresses the challenges of integrating AI in education. Echoing the concerns of Janssen et al. (2020) and Sasahara et al. (2019), it calls for a balanced approach to AI use, acknowledging risks such as algorithmic biases and the creation of echo chambers. We emphasize the need for human oversight and a skeptical approach to AI-generated results, ensuring that technology complements, rather than replaces, human judgment and analysis.

## 3. Research method

### *3.1. Research design*

To address the research questions, a qualitative research paradigm was applied, focusing on a case study framework. This method, often involving interviews and observations, permits the investigator to identify significant variables that surface in the course of its flexible design (Yin, 2009). By implementing this framework, we gained detailed insights into EFL students' attitudes towards critical thinking in academic contexts and the role that AI plays in fostering these skills. Importantly, the method also enabled us to ascertain their views on the potential limitations and drawbacks of AI in advancing critical thinking.

### *3.2. Research participants*

This study aimed to garner nuanced perspectives from EFL students pursuing their master's degrees at two distinct universities in Indonesia, focusing on their attitudes towards critical thinking in academic settings, their views on AI's utility in enhancing these skills, and their understanding of AI's limitations and potential disadvantages in this context. Participant selection was strategically based on their firsthand experience with AI tools in academic settings, their accessibility, and their willingness to engage in the study. Seven individuals were selected as participants, each identified by unique designations ranging from P1 to P7 in order to maintain strict confidentiality and anonymity. All of these participants possessed a minimum of one year's hands-on experience in actively engaging with a diverse array of AI tools, such as natural language processors, machine learning algorithms, and data analytics platforms. Furthermore, each participant demonstrated advanced proficiency in the English language, verified through their TOEFL ITP

**Table 1. Demography of participants**

| Participants | Experiences in Using AI tools (year) | English Proficiency Level | Gender | Age (year) |
|---|---|---|---|---|
| P1 | >1 | Advanced | Male | 24 |
| P2 | >1 | Advanced | Male | 23 |
| P3 | >1 | Advanced | Female | 25 |
| P4 | >1 | Advanced | Female | 24 |
| P5 | >1 | Advanced | Female | 25 |
| P6 | >1 | Advanced | Female | 25 |
| P7 | >1 | Advanced | Male | 23 |

scores obtained prior to their enrollment in the university. The use of this specific test score as a criterion ensured that all participants had a standardized measure of language ability. This was crucial for confirming that they possessed the requisite level of English proficiency to articulate nuanced perspectives about their interactions with AI. By relying on these pre-existing TOEFL ITP scores, we aimed to add depth and rigor to the study's findings, while also enhancing the transparency and validity of our participant selection process. The focus on these scores, reflecting a high standard of linguistic capability, was deliberately chosen to ensure the participants were well-equipped to engage in detailed discussions and contribute meaningful insights into the study.

The recruitment phase commenced by reaching out to potential participants via email. This correspondence outlined the objectives of the study, the roles expected of participants, the methods of data collection, and the ethical considerations involved, including their right to withdraw at any stage without repercussions. To ensure adherence to ethical research protocols, we provided each prospective participant with an informed consent form to read, understand, and sign should they agree to participate. This meticulous recruitment strategy upheld the highest ethical standards while also capturing a wide range of pertinent experiences and viewpoints. Demographic details of the participants are disclosed in Table 1.

### *3.3. Instrument*

We employed semi-structured interviews as our primary research instrument to collect nuanced information. Informed by an array of authoritative scholarly literature—including works by Muthmainnah et al. (2022), Nguyen et al. (2023), Ray (2023), Spector and Ma (2019)—the interviews were meticulously crafted to feature a set of open-ended questions. These questions were strategically designed to elicit substantive, comprehensive responses, thereby allowing for an exploration of nuanced perspectives on the topic at hand. Prior to the main interviews, we conducted a pilot test with a select group of participants to ensure the effectiveness of our questions and the interview format. Feedback from this pilot phase was instrumental in refining the questions, thereby enhancing their clarity, neutrality, and focus. This process was crucial for validating our instruments, ensuring they accurately captured the intended concepts, and assessing their reliability to produce consistent responses across various participants. This step was essential for maintaining the internal consistency of our research.

The semi-structured format also allowed room for follow-up questions based on participants' initial answers, enabling us to explore issues in greater detail. Before the interviews, participants were provided with a brief outline of the study's objectives, and informed consent was obtained to ensure ethical compliance. The use of semi-structured interviews was particularly well-suited for our qualitative approach, as it enabled us to gather rich, layered data from EFL students enrolled in master's programs at two distinct universities in Indonesia. Specifically, the interviews focused on several key areas: understanding of critical thinking, perceived benefits of AI, and limitations and

drawbacks of using AI. This comprehensive approach ensured a well-rounded understanding of the participants' attitudes and beliefs, meeting the study's objectives for gathering qualitative data.

### *3.4. Data collection procedure*

Upon meticulously crafting an interview protocol centered around three focal points—the students' conceptual understanding of critical thinking, their perceptions of the benefits conferred by AI, and their awareness of AI's limitations and potential drawbacks—we coordinated individual interview sessions with each participant. These sessions were thoughtfully scheduled to accommodate the participants' availability and convenience. Prior to commencing each interview, we provided participants with a comprehensive briefing that outlined the study's objectives, clarified the interview procedures, and emphasized our stringent measures for data confidentiality and protection. With complete transparency, we secured their informed consent, assuring them of their ethical rights, including the prerogative to withdraw from the study at any stage without repercussions. The interview itself was structured in a manner that sequentially addressed each research question, fostering a relaxed and conducive atmosphere for candid discussions.

We began with a set of open-ended questions focusing on EFL students' perceptions of critical thinking, carefully avoiding any mention of AI. This approach was crucial for capturing their uninfluenced perspectives and personal definitions of critical thinking in their academic journey. As the interviews progressed, we smoothly transitioned into the second stage by introducing the concept of AI. Here, we probed their thoughts on how AI might benefit or enhance their critical thinking skills, aiming to understand their expectations and experiences with AI in academic settings. This segment provided rich insights into the perceived utility and potential of AI as an educational tool. Finally, we delved into the potential limitations and drawbacks of using AI for critical thinking. This final stage was designed to elicit candid responses about the challenges and downsides of integrating AI into critical thinking exercises, including discussions on possible limitations, dependency issues, and the inadequacies of AI in fully catering to the nuanced needs of critical thinking in an academic setting. This part of the interview was pivotal for understanding the broader implications, both technological and pedagogical, of relying on AI for critical thinking development.

To mitigate the risk of social-desirability bias, we explicitly conveyed to participants that the study sought authentic viewpoints rather than any ostensibly "correct" answers. Every interview was audio-recorded with the participants' consent for accuracy, and note-taking was employed to capture key moments and immediate observations. After each interview, we meticulously transcribed the conversations, ensuring accuracy for reliable data analysis. All materials were securely stored, maintaining the privacy of our participants and enabling efficient data management for subsequent stages of analysis and reporting.

### *3.5. Data analysis*

In our study, we adopted a thematic case study approach for the analysis of qualitative data, as outlined by Braun and Clarke (2006). This method involved a rigorous five-phase process aimed at uncovering recurring patterns and linkages among emerging themes from the qualitative data, thus addressing our research objectives. Initially, we immersed ourselves in the data through multiple readings of the interview transcripts, gaining a deep familiarity with the participants' responses. This was followed by the generation of initial codes, where we clustered related terms and phrases consistent with our research aims. After thorough scrutiny, these initial codes were organized into distinct categories, allowing us to discern relationships and recurring patterns among them.

For Research Question 1, focusing on EFL students' perceptions of critical thinking, our thematic analysis started with initial coding of the interview transcripts. Here, we concentrated on how students defined and understood critical thinking. This process led to the identification of key themes such as "Definition of Critical Thinking," "Importance in Academics," and "Challenges in Application." We meticulously reviewed and refined each theme to accurately reflect the depth of

students' perceptions, their valuation, application, and the challenges they faced with critical thinking in their educational context.

Moving to Research Question 2, which dealt with the benefits of AI in enhancing critical thinking, we followed a similar coding process but focused on the positive perceptions and expectations of AI. This stage of the analysis brought forth themes like "Enhancement of Critical Thinking Skills," "AI as a Learning Aid," and "Innovative Approaches to Problem-Solving." These themes were critically analyzed within the broader context of AI in education, ensuring a distinct thematic delineation from the limitations and drawbacks explored in Research Question 3.

For the final research question, concerning the limitations and potential drawbacks of using AI for critical thinking, our coding targeted the negative perceptions, concerns, and challenges associated with AI. This led to the identification of themes such as "Technological Limitations," "Pedagogical Shortcomings," and "Dependency Issues." This part of the analysis was pivotal in understanding the broader technological and pedagogical implications of integrating AI into critical thinking exercises. Throughout the thematic analysis process for each research question, we maintained a disciplined and rigorous approach, ensuring that the themes related to each question were distinctly and comprehensively analyzed, thus providing a holistic understanding of the participants' nuanced perspectives.

## 4. Findings

The research findings are organized into three main sets: first, the perceptions of EFL students regarding the concept of critical thinking in their academic endeavors; second, the perceived benefits of AI in enhancing their critical thinking skills; and lastly, the perceived limitations and drawbacks of AI's impact on their critical thinking skills.

### *4.1. EFL students' views on critical thinking*

**RQ 1:** *What are EFL students' perceptions toward critical thinking in their academic pursuits?*

In accordance with the initial set of findings, we discovered that participants revealed various perceptions concerning critical thinking. P1 and P5, for instance, both emphasize the multifaceted nature of critical thinking. P1 defines it as a broad skill set of analysis, context discernment, evidence evaluation, and reasoned conclusions, employing these skills to tackle contrasting academic claims about syntactic structures. In a parallel vein, P5 views critical thinking as making well-informed decisions amidst ambiguity and conflicting opinions, revealing the power of nuanced thinking when navigating complex issues like the role of culture in language acquisition. Below is the excerpt of their responses:

P1: " … Well, I think critical thinking is the ability to analyze information, discern the context, evaluate evidence, and arrive at a reasoned conclusion. [… .] I employed critical thinking to weigh the evidence and methodologies used, eventually opting for a more nuanced viewpoint in my own research."

P5: " […] critical thinking is the ability to navigate through ambiguity and uncertainty to make well-informed decisions. [… .] when studying the effects of culture on language acquisition, I found conflicting research. […] I had to sift through these divergent viewpoints critically to form my own hypothesis."

Striking a different chord, P2 and P3 both stand on the platform of challenging established norms and ideas. P2 seeks to question and overturn accepted theories, as seen in the skepticism towards Noam Chomsky's Universal Grammar. Similarly, P3 adopts rigorous skepticism as the cornerstone of her approach, applying this principle through methodical design of controlled experiments in

Second Language Acquisition. Together, they elevate the critical role of skepticism and questioning in academia. Following is a snippet of their feedback:

P2: ” To me, critical thinking is about questioning the status quo and not accepting information at face value. [...] when the instructor presented Noam Chomsky’s Universal Grammar as an established fact. I had to critically think and delve into other theories like Cognitive Grammar and Construction Grammar to present an alternative view in class.

P3: ”[...] critical thinking is the practice of applying rigorous skepticism to dissect complex problems and issues. [...] In Second Language Acquisition course, we were taught various techniques to teach vocabulary. Instead of blindly accepting them, I designed an experiment using a control group to test the efficacy of these methods, thereby employing critical thinking [...]”

Pivoting in a distinct direction, P4 and P6 focus on the application of methodical frameworks to dissect and understand information. P4 sees critical thinking as a toolbox for analyzing arguments and data, employing this approach to sift through various statistical methods. In a similar investigative spirit, P6 compares the process to a detective’s methodology, incorporating observation, clue gathering, and logical reasoning to decipher a complex literary work. Their approaches spotlight the value of systematic methodology and logical scrutiny. The following extract showcasing their comments:

P4: ” I view critical thinking as the mental toolbox that enables one to dissect arguments [...]. In a research methods course, I scrutinized different statistical methods to determine which would be most effective for the research question I was investigating.”

P6: ” To me, critical thinking is like being a detective. It involves observing, gathering clues, and making logical deductions to solve a problem or answer a question. I used critical thinking when interpreting a difficult text for a Literature course.”

Culminating this exploration, P7 serves as the epitome of disciplined critical thinking, unifying the various themes by defining it as the art of employing the most effective reasoning possible in any situation. In a high-stakes sociolinguistics debate, P7 showcased this disciplined mastery by dissecting, challenging, and evaluating a range of arguments before arriving at a final, reasoned stance. Below is the excerpt of his responses:

P7: ” I view critical thinking as the disciplined art of ensuring that you use the best possible thinking you are capable of in any situation. During a debate in a sociolinguistics class, I was presented with arguments both for and against linguistic relativity.”

### *4.2. AI benefits in critical thinking*

**RQ2:** *How do they perceive the benefits of AI in fostering critical thinking?*

The second layer of our findings focuses on the perceived benefit of AI, particularly NLP, in the development of critical thinking. Both participants P1 and P5 emphasize the broad range of applications that AI can offer in academic research. P1 views AI as a tool for expediting the sifting of extensive academic literature, thereby facilitating a nuanced approach to critical evaluation. Similarly, P5 discusses AI’s ability to scour the vast academic landscape to identify research gaps or conflicting viewpoints, aiding in critical thinking. The excerpt below represents their responses:

P1: ” [...] for EFL learners like me, AI-based translation and summarization tools can be game-changers. They make complex English texts more accessible, which aids my critical thinking process. [...] by using Natural Language Processing algorithms, I can conduct a more

comprehensive review of scholarly papers, which helps me evaluate multiple viewpoints efficiently."

P5: "AI can sift through large volumes of information to identify research gaps or conflicting viewpoints, enabling me to think more critically about complex issues like the role of culture in language acquisition."

P2 centers on the ability of AI to scrutinize and question established theories. Utilizing data analytics tools, AI can empirically test existing paradigms, aligning with P2's focus on the importance of questioning as a cornerstone of critical thinking. Through data analytics tools, AI can provide the empirical backbone to subject established theories to rigorous scrutiny. Below is the excerpt of her responses:

P2: "AI-driven data analytics tools allow me to scrutinize large datasets, helping me challenge established theories with empirical evidence."

Furthermore, P3 and P4 both delve into the specific applications of AI in research methodologies. P3 highlights the role of machine learning in experimental design, particularly in predicting outcomes to refine research questions. P4, on the other hand, discusses AI's role in performing complex statistical analyses, thus freeing up mental bandwidth for data interpretation—a critical component of thinking critically. The following passage encapsulates the participants' feedback:

P3: " AI assists me in designing better research experiments. [...] machine learning algorithms can predict outcomes based on different variables, enabling me to fine-tune my research questions and methodologies."

P4: " AI helps me in my statistical analyses. [...] Automated tools can quickly perform complex calculations, allowing me to focus more on interpreting the data critically rather than getting bogged down with computations."

Additionally, P6 and P7 focus on the role of AI in literary and sociolinguistic analysis. P6 likens AI to a literary analyst, capable of dissecting complex texts to identify themes and motifs, thereby aiding critical engagement. P7 extends this discussion to the realm of sociolinguistics, emphasizing AI's capability to simplify academic jargon and facilitate more accessible critical engagement with the material. The subsequent text embodies the responses garnered from participants:

P6: "AI can help analyze literary texts by identifying recurring themes, motifs, or rhetorical devices, thus aiding my ability to interpret these texts critically. [...] Natural Language Processing tools can summarize or paraphrase challenging passages, making them easier to understand and allowing me to engage with them critically."

P7: "In my sociolinguistics class, I used AI to analyze social media data for patterns in language use across different communities. This not only saved time but also provided new perspectives for critical discussion. [...] AI's capacity for semantic understanding can break down complicated academic jargon into simpler terms, making it easier for me to grasp and critically analyze material."

### *4.3. Limitation and drawbacks of AI in critical thinking development*

**RQ3:** *What limitations and potential drawbacks do they identify in using AI for critical thinking?*

The third stratum of our research focuses on the perceived limitations concerning the influence of Artificial Intelligence on participants' critical thinking skills. A comprehensive analysis is presented in the sections that follow. First, both P1 and P5, for instance, delve into the limitations of AI in offering a diversified, well-rounded selection of information for analysis. P1 specifically addresses how AI's algorithms may fail to align with the user's personal criteria for selecting scholarly papers, thereby limiting the scope for critical analysis. Similarly, P5 points out the potential for AI to create "echo chambers" that restrict exposure to a variety of perspectives.

P1: "While AI can help me sift through scholarly papers, it sometimes filters out articles based on metrics that I don't necessarily agree with. [...] sometimes, the AI's summary of a complex paper can oversimplify the nuances, affecting my ability to think critically about the topic."

P5: "AI algorithms can sometimes produce echo chambers by recommending articles similar to those I've already read, which narrows the breadth of perspectives I'm exposed to. [...] being fed information that aligns with my existing beliefs can discourage me from questioning or thinking critically about alternative viewpoints."

Furthermore, P2 and P3 focus on the potential for misleading results due to AI's limitations in analytics and predictive modeling. P2 cautions against the false leads that incorrect initial settings in AI analytics tools can generate. P3, meanwhile, explores how AI's predictive models could introduce bias, undermining the objectivity of analyses. The following passage encapsulates the participants' feedback:

P2: "AI analytics tools can sometimes produce results that are misleading if the initial parameters aren't set correctly. [...] this has occasionally led me to question credible theories erroneously."

P3: "AI's predictive models can create a bias in how I design my research experiments. If not carefully managed, this can compromise the objectivity of my research. [...] the automated nature of AI analyses can sometimes make me lazy in questioning the data's validity or the methodology behind it."

Additionally, both P4 and P7 address the issue of an overabundance of data generated by AI. P4 introduces the term "cognitive offloading," which implies that over-reliance on AI can lead to a reduction in critical thinking skills. P7 notes that AI's capacity to produce a deluge of data, especially in social media analytics for sociolinguistics, can be overwhelming, hampering the extraction of meaningful insights and making critical analysis more challenging. The excerpt below represents their responses:

P4: "While AI can perform complex calculations quickly, it can't provide the 'why' behind the data, which is crucial for critical evaluation. [...] relying too much on AI for statistical analyses can lead to a form of cognitive offloading, where I might neglect the critical thinking process that should accompany data interpretation."

P7: "Using AI to analyze social media data in my sociolinguistics class gave me a large volume of data, but it couldn't capture the subtleties of human interaction and language use. [...] making it challenging to distill meaningful insights or think critically about the implications."

Lastly, P6 extends this argument to the realm of literary analysis, citing AI's inability to grasp elements such as irony and emotional nuance. Both respondents suggest that over-reliance on AI

can result in superficial or technically accurate yet emotionally and contextually hollow interpretations. The subsequent text embodies her responses.

P6: "AI literary analysis tools may highlight certain themes or motifs but might miss out on the human elements like irony, humor, or emotional nuance. [. . .] such tools can sometimes lead me to form interpretations that are technically accurate but lack depth or human understanding"

## 5. Discussions

The objectives of this study are to gauge opinions on critical thinking, examine views on the advantages of AI in this context, and investigate any potential downsides or limitations of employing AI. The findings of our research are organized into three main layers: first, the perceptions of EFL students regarding the concept of critical thinking in their academic endeavors; second, the perceived benefits of AI in enhancing their critical thinking skills; and lastly, the perceived drawbacks of AI's impact on their critical thinking abilities.

In alignment with the first layer of findings, participants (P1 & P5) emphasized the multifaceted nature of critical thinking. They advocate for a broad skill set involving analysis, context discernment, evidence evaluation, and reasoned conclusions. This concept aligns well with Abrami et al. (2015) meta-analysis, which provides empirical support for the multi-dimensionality of critical thinking skills, and Bezanilla et al. (2019) study that focuses on the development of these skills through diverse educational methods. Some participants like P2 and P3 underscored the importance of questioning and challenging established norms. They advocated for skepticism and rigorous experimental design as proactive efforts to advance understanding, aligning with the viewpoints expressed by both Slavin et al. (2021) and Alsaleh (2020). Slavin et al. (2021) study discusses how critical thinking involves the questioning of accepted norms and wisdom, while Alsaleh (2020) explores the pedagogical approaches to enhancing questioning skills in students. Others (P4 & P6) emphasized the role of methodical frameworks for dissecting information, including the need for systematic methodology and logical scrutiny in both statistical and literary analysis (Mohseni et al., 2020; Shaw et al., 2020). Shaw et al. (2020) research on critical thinking in higher education supports the need for structured methods in approaching problems, and Mohseni et al. (2020) findings point out the importance of these skills in interpreting statistical data effectively. The concluding view of P7 integrated these diverse perspectives, defining critical thinking as the evolving discipline of employing the most effective reasoning possible in any situation. This is in line with Caena and Redecker's (2019) work offers a synthesis approach that integrates various aspects of critical thinking into a single framework.

The second layer of our findings resonates with recent research suggesting the utility of AI in enhancing critical thinking among EFL students. Participants (P1 & P5) emphasized the broad applications of AI in academic research, a point also noted by Raharjana et al. (2021), who highlighted how Natural Language Processing (NLP) can sift through extensive academic literature. This aligns with a broader academic discourse on the role of technology in amplifying research capabilities (Duman & Akdemir, 2021), which our participants also echoed by underscoring the efficiency gains in automating tasks like literature review and issue identification. Another segment of participant (P2) specifically focused on AI's role in scrutinizing and questioning established theories. Her views find support in Mathisen et al. (2019), who emphasize the power of data analytics tools in empirically testing existing paradigms. This angle on the utility of AI reinforces the idea that questioning is a cornerstone of critical thinking (Daniswara & Cahyono, 2023; Halpern & Dunn, 2021; Spector & Ma, 2019). Furthermore, P3 and P4 engaged with the nitty-gritty applications of AI in research methodologies. According to them, machine learning has a vital role in experimental design—consistent with Lamb et al. (2020)—especially in predicting outcomes to refine research questions. Additionally, they advocated for the use of AI in conducting complex statistical analyses to free up cognitive resources for data interpretation. This discussion aligns well with the ongoing scholarly debates around the ethics and practicalities of machine

involvement in scientific research (Anggraini et al., 2022; Hafifah et al., 2021; Segun, 2020; Silaigwana & Wassenaar, 2019). Lastly, participants (P6 & P7) explored AI's role in literary and sociolinguistic analysis. They likened AI to a literary analyst, mirroring Kreps et al. (2020) viewpoint, emphasizing the capacity to dissect complex texts to identify themes and motifs. Their views also extended to sociolinguistics, where they highlighted AI's capability to simplify academic jargon, making academic discourse more accessible. This aligns with current debates on the democratization of knowledge and the significance of interdisciplinary research, as underscored by Christensen et al. (2021) and Miller et al. (2019).

The third layer of our findings sheds light on the potential drawbacks of AI in the context of enhancing EFL students' critical thinking. One of participants (P1) echoes Keyes et al. (2021) concern that AI might restrict a well-rounded selection of information. Specifically, participants reveal that AI's algorithms often fail to align with their individual criteria for selecting scholarly papers. This lack of personalization limits the scope for critical analysis, much like Janssen et al. (2020) warned. Another portion of the participants (P5) reflects on the risk of AI creating "echo chambers"—a limitation already suggested by Sasahara et al. (2019). This participant is particularly vocal about how AI's algorithms can limit the diversity of perspectives, further narrowing down analytical outcomes. Kusters et al. (2020) has similarly argued that such algorithmic biases can lead to a restrictive information landscape. A different set of participants (P2 & P3) take this skepticism a step further by questioning the reliability of AI's analytics and predictive modeling. They caution against the misleading avenues that incorrect initial settings in AI analytics tools can create. This concerns in line with the findings of that Ryan (2020) who stress the importance of being skeptical of AI-generated results and the necessity for human oversight to ensure both reliability and analytical objectivity. Further P4 focus on the incapacity of AI to provide nuanced explanations, resonating with the sentiments expressed by Heimerl et al. (2022). Extending this notion to literary analysis, some participants identify AI's limitations in understanding elements such as irony and emotional nuances—observations also highlighted by Berberich et al. (2020) and Mieczkowski et al. (2021). Furthermore, P4 also argue for a more cautious approach to AI, warning against over-reliance that could result in emotionally and contextually hollow interpretations. Finally, the issue of data overload is a significant concern among participants. They introduce the term "cognitive offloading," which implicates that heavy reliance on AI may reduce critical thinking skills. This concern has been raised by Marzuki et al. (2023) who argue that AI has the potential to diminish one's capacity for critical thinking. A participant (P7) further draw attention to the overwhelming amount of data that AI can generate, especially in the field of social media analytics for sociolinguistics. This concern aligns with Gao's (2020) caution that such a data deluge can make extracting meaningful insights increasingly challenging, thus complicating critical analysis.

In summary, our research presents a comprehensive view of critical thinking among EFL students and its relationship with AI. Participants highlighted the multifaceted nature of critical thinking, emphasizing the importance of questioning norms, methodical frameworks, and effective reasoning. The utility of AI in enhancing critical thinking was acknowledged, particularly in literature review, theory scrutiny, experimental design, and data analysis. However, concerns were raised about AI's potential drawbacks, including limited personalization, the risk of creating echo chambers, reliability issues, and its inability to grasp nuanced aspects. Participants also cautioned against over-reliance on AI and the challenges of handling data overload. This research underscores the need for a balanced approach, harnessing AI's benefits while mitigating its limitations in promoting robust critical thinking skills among EFL students.

A significant limitation of our study, however, pertains to the reliance on self-reported data and the limited number of participants involved. Due to the focused and in-depth nature of our qualitative approach, we engaged with a smaller, more specialized group of participants. While this allowed for a detailed exploration of individual experiences and perspectives, it also means that our findings may not be generalizable to a wider population. The limited sample size can affect the breadth of the data and might not fully represent the diversity of experiences and

opinions that exist in a larger population. Additionally, while self-report measures are commonly used in research, they introduce the potential for bias and inaccuracies. Participants' responses are influenced by various factors, including social desirability, recall bias, and individual biases, which can skew the data. Moreover, self-reported data may not fully capture the complexity of participants' experiences and attitudes, and there is a risk of heterogeneity in responses due to diverse backgrounds. To address these limitations, future research in this field should consider incorporating objective measures and observation methods alongside self-reporting, and expanding the participant base to include a more diverse and larger sample, to obtain a more comprehensive and reliable understanding of the subject matter.

## 6. Conclusions

The central aim of this study was to offer an in-depth understanding of EFL students' perceptions concerning critical thinking and the role of Artificial Intelligence (AI) in this context. Our research revealed that EFL students regard critical thinking as a multifaceted discipline, involving elements like questioning norms, analyzing context, and evaluating evidence. They acknowledge the utility of AI in enhancing various facets of critical thinking, such as academic research, theory scrutiny, and experimental design. Despite this, they also expressed concerns about the limitations of AI. These include issues like lack of personalization, risk of echo chambers, and challenges in nuanced understanding. The study implies that while AI can be a powerful tool for enhancing critical thinking skills, it is not without drawbacks that need to be carefully managed. There is a compelling need for a balanced approach that utilizes AI's capabilities while being cautious of its limitations to cultivate robust critical thinking skills among EFL students. One major limitation of this study is its reliance on self-reported data, which introduces the potential for biases and inaccuracies, possibly affecting the validity of the findings. The heterogeneity in participants' backgrounds may also introduce variations in responses, thus limiting the generalizability of the results. Future research could employ more objective measures, such as observations or psychometric tests, to complement self-reported data for a more reliable and comprehensive understanding. Additionally, investigating the pedagogical methods that can effectively blend critical thinking skills with AI applications might provide valuable insights. As such, this study underscores the importance of a nuanced, balanced view in leveraging AI for enhancing critical thinking skills among EFL students, while also highlighting areas where caution and further research are warranted.

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**Correction**
This article has been corrected with minor changes. These changes do not impact the academic content of the article.

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**References**

Abrami, P. C., Bernard, R. M., Borokhovski, E., Waddington, D. I., Wade, C. A., & Persson, T. (2015). Strategies for teaching students to think critically: A meta-analysis. *Review of Educational Research*, *85*(2), 275–314. https://doi.org/10.3102/0034654314551063

Alam, A. (2022). Employing adaptive learning and intelligent tutoring robots for virtual classrooms and smart campuses: Reforming education in the age of artificial intelligence. *Advanced Computing and Intelligent*

*Technologies: Proceedings of ICACIT 2022* (pp. 395–406). Singapore: Springer Nature. https://doi.org/10.1007/978-981-19-2980-9_32

Alasadi, E. A., & Baiz, C. R. (2023). Generative AI in education and research: Opportunities, concerns, and solutions. *Journal of Chemical Education*, *100*(8), 2965–2971. https://doi.org/10.1021/acs.jchemed.3c00323

Alsaleh, N. J. (2020). Teaching critical thinking skills: Literature review. *Turkish Online Journal of Educational Technology-TOJET*, *19*(1), 21–39. https://eric.ed.gov/?id=EJ1239945

Anggraini, M. P., Cahyono, B. Y., Anugerahwati, M., & Ivone, F. M. (2022, February). Correlation patterns among online reading, offline reading, metacognitive reading strategy awareness, and General English proficiency. *67th TEFLIN International Virtual Conference & the 9th ICOELT 2021 (TEFLIN ICOELT 2021)* (pp. 170–175). Atlantis Press. https://doi.org/10.2991/assehr.k.220201.030

Bahufite, E., Kasonde Ng'andu, S., & Akakandelwa, A. (2023). The relationships between learners' academic achievement due to the use of constructivist methods in physical science and their self-esteem in zambian secondary schools. *Social Sciences & Humanities Open*, *8*(1), 100632–8. https://doi.org/10.1016/j.ssaho.2023.100632

Baidoo-Anu, D., & Ansah, L. O. (2023). Education in the era of generative artificial intelligence (AI): Understanding the potential benefits of ChatGPT in promoting teaching and learning. *SSRN Electronic Journal*, *7*(1), 52–62. https://doi.org/10.2139/ssrn.4337484

Berberich, N., Nishida, T., & Suzuki, S. (2020). Harmonizing Artificial Intelligence for Social Good. *Philosophy & Technology*, *33*(4), 613–638. https://doi.org/10.1007/s13347-020-00421-8

Bezanilla, M. J., Nogueira, D. F., Poblete, M., & Galindo-Domínguez, H. (2019). Methodologies for teaching-learning critical thinking in higher education: The teacher's view. *Thinking Skills and Creativity*, *33*(3), 1–10. https://doi.org/10.1016/j.tsc.2019.100584

Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Budhwar, P., Chowdhury, S., Wood, G., Aguinis, H., Bamber, G. J., Beltran, J. R., & Varma, A. (2023). Human resource management in the age of generative artificial intelligence: Perspectives and research directions on ChatGPT. *Human Resource Management Journal*, *33*(3), 606–659. https://doi.org/10.1111/1748-8583.12524

Caena, F., & Redecker, C. (2019). Aligning teacher competence frameworks to 21st century challenges: The case for the European digital competence framework for educators (digcompedu). *European Journal of Education*, *54*(3), 356–369. https://doi.org/10.1111/ejed.12345

Christensen, J., Ekelund, N., Melin, M., & Widén, P. (2021). The beautiful risk of collaborative and interdisciplinary research. A challenging collaborative and critical approach toward sustainable learning processes in academic profession. *Sustainability*, *13*(9), 2–20. https://doi.org/10.3390/su13094723

Daniswara, L. D., & Cahyono, B. Y. (2023). Investigation of university students' critical thinking in debate: Justification for the "AREL" argumentation process. *JEES (Journal of English Educators Society)*, *8*(2), 142–152. https://doi.org/10.21070/jees.v8i2.1766

DiGiacomo, D., Muetterties, C., & Taylor, C. (2023). Insights on information literacy from social studies classrooms in the southeast. *Journal of Research on Technology in Education*, *55*(1), 1–16. https://doi.org/10.1080/15391523.2023.2264965

Duman, M. Ç., & Akdemir, B. (2021). A study to determine the effects of industry 4.0 technology components on organizational performance. *Technological Forecasting and Social Change*, *167*(6), 1–14. https://doi.org/10.1016/j.techfore.2021.120615

Gao, Y. (2020). The application of artificial neural network in watch modeling design with network community media. *Journal of Ambient Intelligence and Humanized Computing*, *12*(12), 1–10. https://doi.org/10.1007/s12652-020-01689-6

Gardner, J., O'Leary, M., & Li, Y. (2021). Artificial intelligence in educational assessment: 'breakthrough? Or buncombe and ballyhoo? *Journal of Computer Assisted Learning*, *37*(5), 1207–1216. https://doi.org/10.1111/jcal.12577

Grassini, S. (2023). Shaping the future of education: Exploring the potential and consequences of AI and ChatGPT in educational settings. *Education Sciences*, *13*(7), 1–13. https://doi.org/10.3390/educsci13070692

Hafifah, G. N., Ivone, F. M., & Cahyono, B. Y. (2021). Developing a teacher cognition on ICT instrument: A confirmatory factor analysis. *Proceedings of the 67th TEFLIN international virtual conference & the 9th ICOELT 2021 (TEFLIN ICOELT 2021)* (1st ed., pp. 115–122). Atlantis Press SARL. https://doi.org/10.2991/assehr.k.220201.021

Halpern, D. F., & Dunn, D. S. (2021). Critical thinking: A model of intelligence for solving real-world problems. *Journal of Intelligence*, *9*(2), 22–7. https://doi.org/10.3390/jintelligence9020022

Hapsari, I. P., & Wu, T. (2022). AI chatbots learning model in English speaking skill: Alleviating speaking anxiety, boosting enjoyment, and fostering critical thinking. In *Lecture Notes in Computer Science* (pp. 444–453). https://doi.org/10.1007/978-3-031-15273-3_49

Heimerl, A., Weitz, K., Baur, T., & André, E. (2022). Unraveling ML models of emotion with NOVA: Multi-level explainable AI for non-experts. *IEEE Transactions on Affective Computing*, *13*(3), 1155–1167. https://doi.org/10.1109/taffc.2020.3043603

Hwang, G. J., & Chien, S. Y. (2022). Definition, roles, and potential research issues of the metaverse in education: An artificial intelligence perspective. *Computers and Education: Artificial Intelligence*, *3*(1), 100082–6. https://doi.org/10.1016/j.caeai.2022.100082

Janssen, M., Hartog, M. H. D., Matheus, R., Ding, A. Y., & Kuk, G. (2020). Will algorithms blind people? The effect of explainable AI and decision-makers' experience on AI-supported decision-making in government. *Social Science Computer Review*, *40*(2), 478–493. https://doi.org/10.1177/0894439320980118

Kamalov, F., Calonge, D. S., & Gurrib, I. (2023). New era of Artificial intelligence in education: Towards a sustainable multifaceted revolution. *Sustainability*, *15*(16), 1–27. https://doi.org/10.3390/su151612451

Kasneci, E., Seßler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Kasneci, E., Gasser, U., Groh, G., Günnemann, S., Hüllermeier, E., Krusche, S., Kutyniok, G., Michaeli, T., Nerdel, C., Pfeffer, J., Poquet, O., Sailer, M. … Kuhn, J.… Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences*, *103*(3), 1–13. https://doi.org/10.1016/j.lindif.2023.102274

Keyes, O., Hitzig, Z., & Blell, M. (2021). Truth from the machine: Artificial intelligence and the materialization of identity. *Interdisciplinary Science Reviews*, *46* (1–2), 158–175. https://doi.org/10.1080/03080188.2020.1840224

Kooli, C. (2023). Chatbots in education and research: A critical examination of ethical implications and solutions. *Sustainability*, *15*(7), 5614–15. https://doi.org/10.3390/su15075614

Kreps, S., McCain, R., & Brundage, M. (2020). All the news that's fit to fabricate: AI-Generated text as a tool of media misinformation. *Journal of Experimental Political Science*, *9*(1), 104–117. https://doi.org/10.1017/XPS.2020.37

Kusters, R., Misevic, D., Berry, H., Cully, A., Cunff, Y., Dandoy, L., Díaz-Rodríguez, N., Ficher, M., Grizou, J., Othmani, A., Palpanas, T., Komorowski, M., Loiseau, P., Frier, C., Nanini, S., Quercia, D., Sebag, M., Fogelman, F. … Wehbi, F. (2020). Interdisciplinary research in Artificial intelligence: Challenges and opportunities. *Frontiers in Big Data*, *3*(1), 1–7. https://doi.org/10.3389/fdata.2020.577974

Lamb, R., Hand, B., & Kavner, A. (2020). Computational modeling of the effects of the Science writing heuristic on student critical thinking in Science using machine learning. *Journal of Science Education and Technology*, *30*(1), 283–297. https://doi.org/10.1007/s10956-020-09871-3

Liang, W. (2022). Towards a set of design principles for technology-assisted critical-thinking cultivation: A synthesis of research in English language education. *Thinking Skills and Creativity*, *47*(1), 101203–10. https://doi.org/10.1016/j.tsc.2022.101203

Liu, C., Hou, J., Tu, Y. F., Wang, Y., & Hwang, G. J. (2021). Incorporating a reflective thinking promoting mechanism into artificial intelligence-supported English writing environments. *Interactive Learning Environments*, *1*(1), 1–19. https://doi.org/10.1080/10494820.2021.2012812

Liu, C. C., Liu, S. J., Hwang, G. J., Tu, Y. F., Wang, Y., & Wang, N. (2023). Engaging EFL students' critical thinking tendency and in-depth reflection in technology-based writing contexts: A peer assessment-incorporated automatic evaluation approach. *Education and Information Technologies*, *28*(10), 13027–13052. https://doi.org/10.1007/s10639-023-11697-6

Mafulah, S., Basthomi, Y., Cahyono, B. Y., & Suryati, N. (2023). Exploring Indonesian EFL teacher-student interactions in online learning. *Studies in English Language and Education*, *10*(2), 686–703. https://doi.org/10.24815/siele.v10i2.23804

Marzuki, W., Rusdin, U., Darwin, D., & Indrawati, I. (2023). The impact of AI writing tools on the content and organization of students' writing: EFL teachers' perspective. *Cogent Education*, *10*(2), 1–17. https://doi.org/10.1080/2331186X.2023.2236469

Mathisen, A., Horak, T., Klokmose, C., Grønbæk, K., & Elmqvist, N. (2019). InsideInsights: Integrating data-driven reporting in collaborative visual analytics. *Computer Graphics Forum*, *38*(3), 649–661. https://doi.org/10.1111/cgf.13717

Mieczkowski, H., Hancock, J., Naaman, M., Jung, M., & Hohenstein, J. (2021). AI-Mediated communication. *Proceedings of the ACM on Human-Computer Interaction*, *5*(CSCW1), 1–14. https://doi.org/10.1145/3449091

Miller, V., Murphy, E., Cronley, C., Fields, N., & Keaton, C. (2019). Student experiences engaging in interdisciplinary research collaborations: A case study for social work education. *Journal of Social Work Education*, *55*(4), 750–766. https://doi.org/10.1080/10437797.2019.1627260

Mohamed, A. M. (2023). Exploring the potential of an AI-based Chatbot (ChatGPT) in enhancing English as a Foreign language (EFL) teaching: Perceptions of EFL Faculty members. *Education and Information Technologies*, *8*(6)1–23. https://doi.org/10.1007/s10639-023-11917-z

Mohseni, F., Seifoori, Z., Ahangari, S., & Khajavi, Y. (2020). The impact of metacognitive strategy training and critical thinking awareness-raising on reading comprehension. *Cogent Education*, *7*(1), 1–22. https://doi.org/10.1080/2331186X.2020.1720946

Muthmainnah, S., Ibna Seraj, P. M., Oteir, I., & Balakrishnan, B. (2022). Playing with AI to investigate human-Computer interaction technology and improving critical thinking skills to pursue 21st Century age. *Education Research International*, *2022* (10), 1–17. https://doi.org/10.1155/2022/6468995

Nguyen, A., Ngo, H. N., Hong, Y., Dang, B., & Nguyen, B. P. T. (2023). Ethical principles for artificial intelligence in education. *Education and Information Technologies*, *28*(4), 4221–4241. https://doi.org/10.1007/s10639-022-11316-w

Quinn, S., Hogan, M., Dwyer, C., Finn, P., & Fogarty, E. (2020). Development and validation of the student-educator negotiated critical thinking dispositions scale (SENCTDS). *Thinking Skills and Creativity*, *38*(4), 100710–17. https://doi.org/10.1016/j.tsc.2020.100710

Raharjana, I. K., Siahaan, D., & Fatichah, C. (2021). User stories and natural language processing: A systematic literature review. *Institute of Electrical and Electronics Engineers Access*, *9*(1), 53811–53826. https://doi.org/10.1109/access.2021.3070606

Rampersad, G. (2020). Robot will take your job: Innovation for an era of artificial intelligence. *Journal of Business Research*, *116*(1), 68–74. https://doi.org/10.1016/j.jbusres.2020.05.019

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*(1), 121–154. https://doi.org/10.1016/j.iotcps.2023.04.003

Ryan, M. (2020). In AI we trust: Ethics, Artificial intelligence, and reliability. *Science and Engineering Ethics*, *26*(5), 2749–2767 . https://doi.org/10.1007/s11948-020-00228-y

Sasahara, K., Chen, W., Peng, H., Ciampaglia, G., Flammini, A., & Menczer, F. (2019). Social influence and unfollowing accelerate the emergence of echo chambers. *Journal of Computational Social Science*, *4* (1), 381–402. https://doi.org/10.1007/s42001-020-00084-7

Segun, S. (2020). From machine ethics to computational ethics. *AI & Society*, *36*(1), 263–276. https://doi.org/10.1007/s00146-020-01010-1

Shanta, S., & Wells, J. G. (2022). T/E design based learning: Assessing student critical thinking and problem solving abilities. *International Journal of Technology and Design Education*, *32*(1), 267–285. https://doi.org/10.1007/s10798-020-09608-8

Shaw, A., Liu, O. L., Gu, L., Kardonova, E., Chirikov, I., Li, G., Hu, S., Yu, N., Ma, L., Guo, F., Su, Q., Shi, J., Shi, H., & Loyalka, P. (2020). Thinking critically about critical thinking: Validating the Russian HEIghten® critical thinking assessment. *Studies in Higher Education*, *45* (9), 1933–1948. https://doi.org/10.1080/03075079.2019.1672640

Silaigwana, B., & Wassenaar, D. (2019). Research ethics committees' oversight of biomedical research in

South Africa: A thematic analysis of ethical issues raised during ethics review of non-expedited protocols. *Journal of Empirical Research on Human Research Ethics*, *14*(2), 107–116. https://doi.org/10.1177/1556264618824921

Slavin, R. E., Cheung, A., & Zhuang, T. (2021). How could evidence-based reform advance education? *ECNU Review of Education*, *4*(1), 7–24. https://doi.org/10.1177/2096531120976060

Spector, J., & Ma, S. (2019). Inquiry and critical thinking skills for the next generation: From artificial intelligence back to human intelligence. *Smart Learning Environments*, *6*(1), 1–11. https://doi.org/10.1186/s40561-019-0088-z

Suhirman, S., Prayogi, S., & Asy'ari, M. (2021). Problem-based learning with character-emphasis and naturalist intelligence: Examining students critical thinking and curiosity. *International Journal of Instruction*, *14*(2), 217–232. https://doi.org/10.29333/IJI.2021.14213A

Xiao, Y., & Zhi, Y. (2023). An exploratory study of EFL learners' use of ChatGPT for language learning tasks: Experience and perceptions. *Languages*, *8*(3), 1–12. https://doi.org/10.3390/languages8030212

Yin, R. K. (2009). *Case study research: Design and methods* (4th ed.). Sage Publications.

Yuan, R. (2023). The other side of the coin: A socio-cultural analysis of pre-service language teachers' learning to teach critical thinking. *Thinking Skills and Creativity*, *48*(1), 1–10. https://doi.org/10.1016/j.tsc.2023.101265