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Artificial Intelligence (AI) Chatbots and Critical Thinking: Gen Z's Perspective on Completing Tasks in the Era of Society 5.0.

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Abstract

Critical thinking plays a crucial role in the academic and professional development of students. The integration of artificial intelligence (AI) in the context of Society 5.0 is particularly noteworthy, especially with the emergence of AI Chatbot tools that are transforming how students engage in learning. This study aims to explore students' perceptions of using chatbots concerning their critical thinking abilities when completing assignments. To achieve this, a descriptive quantitative research method was employed, utilizing survey questionnaires distributed to students. The analysis involved collecting, structuring, and interpreting quantitative descriptive data, with instrument validity ensured through expert review. The results indicate that Chatbot AI can support Gen Z students in developing critical thinking skills by helping them clarify problems, categorize information, and structure their answers. However, it should not replace the importance of discussion and reflection. Therefore, its use should be balanced with learning strategies that promote information verification, academic discussions, and practical application. Educational institutions must ensure that chatbot AI usage fosters reflection, provides contextualized solutions, and encourages ethical practices.
Keywords: Chatbot, ChatGPT, Critical Thinking, Gen Z

Abstrak

Berpikir kritis memiliki peran yang sangat penting dalam perkembangan akademik dan profesional mahasiswa. Pada akhirnya analisis kritis, pemanfaatan *Artificial Intelligent* (AI) dalam kaitanya Era Society 5.0 menjadi hal yang menarik. Munculnya alat bantu Chatbot AI merubah pola kerja mahasiswa dalam melaksanakan pembelajaran terkhusus dalam penyelsaian tugas mereka. Tujuan penelitian ini adalah untuk menyajikan persepsi mahasiswa tentang pemakaian Chatbot AI kaitanya dengan berpikir kritis. Metode yang digunakan dalam penelitian ini adalah kuantitatif deskriptif dengan Angket Survei yang dibagikan kepada mahasiswa. Metode analisis yang dilakukan adalah pengumpulan, penataan, dan interpretasi data kuantitatif secara deskriptif. Validitas instrumen dengan justifikasi ahli. Instrumen yang dipakai adalah angket. Hasil Penelitian menunjukkan secara keseluruhan menunjukkan bahwa mahasiswa cenderung memiliki persepsi positif terhadap penggunaan Chatbot AI dalam mendukung berpikir kritis. Hasil penelitian ini Chatbot AI berperan dalam mendukung berpikir kritis mahasiswa Gen Z, terutama dalam klarifikasi masalah, kategorisasi informasi, dan penyusunan jawaban, tetapi tidak dapat menggantikan diskusi dan refleksi. Oleh karena itu, penggunaannya perlu diimbangi dengan strategi pembelajaran yang mendorong verifikasi informasi, diskusi akademik, serta penerapan praktis. Institusi pendidikan harus memastikan pemanfaatan Chatbot AI mendukung refleksi, solusi kontekstual, dan penggunaan yang etis.
Kata Kunci: Chatbot, ChatGPT, Berpikir Kritis, Era Society 5.0.

INTRODUCTION

The Industrial Revolution 4.0 era marks a massive transformation across various sectors, including education. The advancement of sophisticated technology, such as Artificial Intelligence (AI), opens new opportunities for innovation in the teaching and learning process. AI technology can provide a more adaptive, personalized, and efficient approach to learning. Some applications of AI in education include data-driven learning, interactive educational platforms, and student learning behavior analysis. All of these enable the education system to be not only more responsive to individual needs but also more focused on enhancing students' competencies in accordance with the demands of the times. AI plays a crucial role in transforming the educational landscape by introducing more personalized and interactive learning models, aligning with the concept of Education 4.0. This technology allows for the integration of digital tools that enrich the learning experience, such as the

use of virtual reality and augmented reality in smart classrooms (Mulyani et al., 2021; Shahroom & Hussin, 2018).

Industry 4.0 and Society 5.0 are interconnected in creating a more advanced future through technology. Industry 4.0 focuses on the digital revolution in the industrial sector, utilizing automation, big data, artificial intelligence (AI), and the Internet of Things (IoT) to enhance efficiency and productivity in manufacturing. These technologies also serve as the foundation for building Society 5.0, a concept aimed at creating a smarter, more inclusive, and sustainable society by integrating technology into all aspects of human life. While Industry 4.0 supports economic progress and industrial efficiency, Society 5.0 expands the application of these technologies to address social challenges such as healthcare, education, transportation, and the environment. Thus, Industry 4.0 acts as the primary driver enabling the formation of Society 5.0, which prioritizes human well-being by utilizing technology to improve quality of life across various fields. Both work together to create a more productive and sustainable ecosystem that not only focuses on industrial efficiency but also on overall societal well-being. While Industry 4.0 is more machine-oriented, Society 5.0 shifts the focus toward human-centered innovation, ensuring that technological advancements benefit society as a whole. This includes addressing social issues and enhancing quality of life (Mourtzis et al., 2022; Pereira et al., 2020).

In Society 5.0, technology, particularly AI, is used to improve human quality of life by solving various social, economic, and environmental challenges. AI enables society to be more connected and efficient in managing resources, improving transportation systems, modernizing healthcare, and facilitating access to education and public services. AI plays a crucial role in the transformation toward Society 5.0 by leveraging technology to tackle social and ecological problems while creating innovative platforms that utilize the working potential of the elderly population (Islam et al., 2020). Additionally, AI can enhance creativity skills in the Society 5.0 era, as this technology allows machines to learn from experience and adapt to new inputs, fostering creative skills to address challenges and opportunities (Oktradiksa et al., 2021).

AI optimizes various sectors in Society 5.0. For instance, in healthcare, AI can diagnose diseases more quickly and accurately, provide personalized treatment, and support the efficient management of healthcare systems (Secinaro et al., 2021). In transportation, AI helps manage smarter and more efficient transportation systems and contributes to the development of smart cities that integrate AI to improve quality of life (Cubric, 2020). AI supports the advancement of autonomous vehicles and intelligent transportation systems that reduce congestion and enhance safety. In education, AI automates tasks and generates content quickly, although it cannot fully replace teachers in monitoring students' character development (Oktavian et al., 2024). AI helps create personalized learning experiences tailored to individual needs, improving access to and quality of education. The Society 5.0 era requires three key skills for individuals: creativity, critical thinking, communication, and collaboration.

In the Society 5.0 era, technologies such as AI, robotics, and automation have replaced many routine and mechanical jobs. As a result, humans need creativity to generate new ideas, innovations, and solutions that can address existing social and economic problems. Creativity is the key for individuals to adapt and create new opportunities in an increasingly digitalized world, enabling them to solve complex social and economic challenges (Susanto et al., 2024). AI plays a crucial role in enhancing creativity skills in the Society 5.0 era by helping individuals innovate and adapt to social changes (Oktradiksa et al., 2021).

Critical thinking and collaboration are essential in facing rapid technological advancements. Critical thinking allows individuals to evaluate information wisely, filter relevant data, and solve complex problems that cannot be addressed solely by algorithms or automation (Hayati, 2024). This skill also helps the digital generation reflect on received data, question its validity, and assess its

reliability (Lasmana et al., 2024). Additionally, collaboration between individuals, groups, and technology is necessary to support effective communication and strengthen cross-disciplinary cooperation in addressing increasingly complex social, economic, and industrial challenges (Ramadhana, 2024)..

The rapid development of AI in recent years has led to significant changes, particularly in the evolution of chatbots that interact with users in an automated and responsive manner. Chatbots use natural language processing (NLP) and machine learning to understand and respond to natural language queries. There are two main types of chatbots: rule-based chatbots, which respond based on pre-programmed scripts, and AI-based chatbots, which can learn from user interactions to provide more flexible responses. AI-powered chatbots can now perform more complex tasks than earlier AI systems, including decision-making and big data analysis.

In education, chatbots have great potential to assist students in completing assignments and supporting self-directed learning. Chatbots can provide explanations of material, guide students step by step in solving problems, and offer references from educational databases such as online encyclopedias and academic journals (Dewi, Qudratuddarsi, Ningthias and Cinthami, 2024). Additionally, chatbots serve as deadline reminders and automated feedback providers, helping students manage their academic workload more efficiently. With these features, chatbots not only improve information accessibility but also promote the development of critical thinking and problem-solving skills among learners.

Critical thinking involves reasoning and reflective thinking, emphasizing decision-making about what to believe or do (Ennis, 2011). Therefore, it can be concluded that thinking skills require cognitive processes, where knowledge is gained through systematic hypothesis testing, ultimately leading to accurate conclusions. Indicators of critical thinking include providing simple explanations, determining decision-making foundations, making conclusions, offering further explanations, predicting, and integrating information (Ennis, 2011).

Critical thinking plays a vital role in students' academic and professional development, particularly in analyzing, evaluating, and solving problems logically and objectively. This ability prepares students to face challenges in education and the workforce while also fostering personal growth by encouraging creativity, better decision-making, and constructive and ethical interactions. Critical thinking enables students to filter information, select relevant facts, and draw logical conclusions—skills that are highly valuable in both professional and personal life (Ashimova & Turekhanova, 2022). This article aims to present students' perceptions of the use of chatbots in completing academic assignments related to critical thinking. The findings of this research are expected to serve as a reference for educators and other stakeholders in AI-based chatbot learning processes.

METHOD

This study employs a quantitative descriptive method, using a survey questionnaire to collect data from students. The objective is to analyze how AI Chatbots influence students' critical thinking skills in an academic setting. A total of 429 respondents participated in the study, selected through purposive random sampling to ensure that the participants met the criteria relevant to the research objectives. The respondents belong to the Gen Z category, which includes students born between 1997 and 2012. This generational group is known for its familiarity with digital technology, frequent use of artificial intelligence tools, and preference for online learning environments. Understanding how this group interacts with AI Chatbots in the learning process is crucial in assessing their role in supporting critical thinking development.

The research was conducted over two months, from May to June 2024, at the end of the even semester of the 2023/2024 academic year. The timing was selected to ensure that students had

sufficient experience using AI Chatbots throughout the semester, allowing for a more comprehensive assessment of their impact. The survey questionnaire was distributed at the end of the semester, after students had completed one full semester of coursework, ensuring that their responses were based on actual interactions with AI Chatbots during their studies. The use of Google Forms facilitated efficient data collection, allowing students to participate remotely and at their convenience.

The survey questionnaire was designed based on research indicators related to critical thinking skills, such as problem clarification, information evaluation, argument construction, and decision-making. The questions aimed to measure students' perceptions of AI Chatbots in assisting their cognitive processes, particularly in structuring responses, analyzing concepts, and synthesizing information. The responses were collected and analyzed using descriptive statistical methods, which involved organizing, summarizing, and interpreting the quantitative data. This method allowed researchers to identify trends and patterns in students' perspectives regarding the effectiveness of AI Chatbots in enhancing their critical thinking abilities.

To ensure the validity and reliability of the survey, the instrument underwent an expert justification process, in which specialists in education, technology, and cognitive psychology reviewed the questionnaire. Their insights helped refine the survey items to align with the research objectives and ensure that the questions accurately reflected the components of critical thinking. This validation process was essential in confirming the credibility of the data collected and minimizing potential biases.

Additionally, ethical considerations were taken into account during the research process. Participation in the survey was voluntary, and respondents were informed about the purpose of the study, data confidentiality, and their right to withdraw at any time. These measures ensured that the study adhered to ethical research standards while maintaining the integrity of the findings. By adopting this methodological approach, the study aims to provide a comprehensive and structured analysis of how AI Chatbots influence students' ability to think critically. The results will contribute to a better understanding of the role of technology in higher education and offer insights into how AI-driven tools can be further optimized to support students' academic success.

RESULT

This study involved 429 student respondents from the Basic Educational Courses, all of whom belong to Generation Z. The research was conducted in May and June 2024, within the context of learning during the even semester of the 2023/2024 academic year. The study was carried out by distributing survey questionnaires to students to explore their experiences throughout the course and their use of AI Chatbot tools. The questionnaire was designed using Google Forms, allowing for easier and more efficient data collection from respondents.

Based on the survey results, the first question asked was whether students used AI to complete their assignments. The responses indicated that 78.79% of the respondents answered "Yes," while 21.21% answered "No." This finding suggests that the majority of students have utilized AI technology to support their academic tasks. The data highlights the increasing reliance on AI tools in education, reflecting the growing role of technology in assisting students with their coursework.

Table 1 AI usage for assignment completion

Option	Total	Percentage
Yes	338	78.79%
No	91	21.21%
Total	429	100.00%

Table 2 Frequency of Chatbot usage for task completion

Frequency	Total	Percentage
1 (Very rarely)	44	10.26
2 (Rarely)	235	54.78
3 (Frequent)	133	31.00
4 (Very frequent)	17	3.96
Total	429	100

The survey results regarding the frequency of AI assistance usage by students in completing assignments show that the majority of respondents fall into the "Rarely" category, with 235 people (54.78%). This category is followed by 133 people (31.00%) who admitted to "Often" using AI. Meanwhile, 44 respondents (10.26%) stated that they "Very Rarely" used AI, and only 17 respondents (3.96%) were in the "Very Often" category. This data shows that more than half of the respondents (54.78%) tend to rarely use AI, while only a small portion (3.96%) use it very often. This may indicate that although AI technology is already familiar to students, its utilization level is still low for most of them. Factors such as limited knowledge, lack of trust in the technology, or a mismatch between task requirements and AI capabilities might be reasons for the low usage frequency. However, with 31.00% of respondents falling into the "Often" category, there is an indication that AI is beginning to be considered relevant and useful by some students in supporting their task completion.

The majority of students use AI-powered chatbot technology, such as ChatGPT, to complete their assignments, making this the most dominant category. However, some students reported not using AI at all, indicating that there is still a segment that feels more comfortable with traditional methods. Additionally, some students use voice-based AI analysis, while others utilize platforms like Perplexity, Gemini, or Copilot. Some also combine various AI tools with manual references such as journals, Google Scholar, or online articles to enrich their assignment outcomes. The combination of multiple AI tools is becoming more common, reflecting a diversification in their approach to academic work.

ChatGPT is the primary choice among students due to its user-friendly interface, ease of access, and ability to quickly generate relevant responses. However, the response "not using any AI" reflects the presence of barriers or a preference for traditional methods, which may be caused by a lack of understanding of AI, distrust in its accuracy, or personal preferences for manual sources. Additionally, some students have started to explore other AI technologies, such as Gemini, Perplexity, and Copilot, showing an adaptation to specific academic needs. Nevertheless, many students still rely on manual references from Google Scholar, journals, or articles, indicating that non-AI sources remain an important part of academic work.

The critical thinking aspects in the use of AI chatbots applied in this study include the following indicators:

1. Activating and fostering students' curiosity.
2. Helping students create classifications/categorizations to analyze a problem.
3. Assisting students in clarifying and answering encountered problems.

4. Enhancing interaction among students.
5. Encouraging follow-up questions on the issue.
6. Providing students with time to reflect on the questions posed or problems given.
7. Developing new abilities in students to address or find solutions to problems.
8. Guiding students toward conclusions about the problems they face or seek to solve.
9. Enabling students to propose hypothetical solutions.
10. Helping students summarize answers accurately and restate them in their own words.
11. Encouraging students to relate their answers to real-life experiences and problems they face.
12. Helping students internalize answers and apply them in daily life.

Table 3 Results of Critical Thinking Perceptions in the Use of AI Chatbots

Perception	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**
1 (Very Disagree)	48	15	14	124	33	27	27	17	34	22	29	32
2 (Disagree)	159	132	120	215	155	170	155	131	182	141	163	212
3 (Agree)	185	222	227	72	196	193	209	222	181	205	191	155
4 (Very Agree)	37	60	68	18	45	39	38	59	32	61	46	30
Total	429	429	429	429	429	429	429	429	429	429	429	429

Table 4 Percentage of Critical Thinking Perceptions in the Use of AI Chatbots

Perception	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**
1 (Very Diagree)	11.19	3.50	3.26	28.90	7.69	6.29	6.29	3.96	7.93	5.13	6.76	7.46
2 (Disagree)	37.06	30.77	27.97	50.12	36.13	39.63	36.13	30.54	42.42	32.87	38.00	49.42

*Q = question or statement

The table above shows the percentage of students' perceptions regarding the use of AI chatbots in supporting critical thinking, with Q as the critical thinking indicator. Perceptions are measured in four categories: Strongly Disagree, Disagree, Agree, and Strongly Agree. Below is a detailed explanation: 1) Dominant Category. In most indicators (Q1 to Q12), the majority of students chose the Agree category. The highest percentage for this category is found in Q3 (52.91%) and Q2 (51.75%), which indicate that AI chatbots help students classify/categorize problems and clarify or answer encountered issues. These findings suggest that AI chatbots are perceived as relevant in supporting critical thinking. 2) Disagreement (Strongly Disagree and Disagree) Q4 (enhancing student interaction) has the highest disagreement rate, with a combined percentage of Strongly Disagree (28.90%) and Disagree (50.12%). This indicates that many students find AI chatbots less relevant for this indicator. Other indicators, such as Q9 (helping students propose hypothetical solutions) and Q12 (helping students internalize answers and apply them in daily life), also show relatively high levels of disagreement. 3) High Agreement (Strongly Agree) Although the Strongly Agree category has a lower percentage overall, Q10 (helping students summarize answers accurately and restate them in their own words) records the highest percentage in this category (14.22%), followed by Q12 (helping students internalize answers and apply them in daily life) at 13.99%. This indicates that a small proportion of students strongly support using AI chatbots for these indicators. General Pattern. Q3 (helping students clarify problems or answer encountered issues) has the highest overall agreement, both in the Agree and combined Strongly Agree categories. On the other hand, Q4 (enhancing student interaction) has the lowest agreement

level, indicating that students' perceptions of this indicator differ significantly from the others. Below is a data presentation to facilitate understanding of the research findings:

Table 5 Research findings

Category	Indicator	Main Findings
Dominant category (Agree)	Q3 (52.91%) dan Q2 (51.75%)	AI chatbots are considered helpful for students in making classifications/categorizations as well as clarifying and answering problems, demonstrating high relevance in supporting critical thinking.
Diagreement (Very Disagree and Disagree)	Q4 (28.90% very disagree, 50.12% disagree), Q9, Q12	Students are less likely to agree that AI chatbots can enhance student interaction, propose hypothetical solutions, and internalize answers for real-life application.
High Agreement (Very Agree)	Q10 (14.22%) and Q2 (13.99%)	A small portion of students strongly support AI chatbots in helping to summarize answers and internalize them for application in daily life.
General Pattern	Q3 has the highest level of agreement, while Q4 has the lowest level of agreement.	Students are more receptive to the role of chatbots in problem clarification than as a tool for social interaction.

Based on this, it can be concluded that AI chatbots are more accepted as a tool for critical thinking in terms of categorization and problem clarification, while their effectiveness in enhancing social interaction among students remains doubtful.

DISCUSSION

Critical thinking is a complex skill that involves a series of cognitive processes to analyze, evaluate, and make decisions based on logical reasoning. This ability begins with curiosity, which drives individuals to delve deeper into information, thereby building intrinsic motivation to explore and acquire new understanding (Nurdiana et al., 2023; Şeker & Kömür, 2008). In the academic world, critical thinking helps students clarify concepts, identify hidden assumptions, and explore alternative interpretations through reflective skepticism (Kramer, 1993). Additionally, categorization training has been proven to enhance critical thinking skills by enabling individuals to recognize biased and flawed reasoning patterns (Motz et al., 2021). Structural and semantic differences in classification and categorization systems also influence how individuals comprehend information and shape their thinking patterns (Martínez, 2024).

In an academic context, students often struggle to distinguish between essential and secondary information and to compose effective summaries (Ivanova, 2020). Teaching effective summarization skills can help students identify main ideas, understand key details, and systematically paraphrase and integrate ideas (Ahn, 2022). With technological advancements, the use of AI Chatbots has become increasingly relevant as a tool to support critical thinking. This technology assists students in clarifying problems, organizing information, and structuring responses more systematically. However, critical thinking skills do not rely solely on technological tools but also require evaluation, reflection, and broader academic interaction. In various aspects of life, critical thinking plays a crucial

role, including in decision-making within health, politics, and social relationships (Butler, 2024). Therefore, students should not solely rely on AI Chatbots as an information source but must also develop critical skills that enable them to filter relevant information and build a deeper understanding.

Generation Z (Gen Z) students are a group that has grown up in a digitally dominated environment. They are accustomed to instant access to information and using artificial intelligence (AI) to assist them in various aspects of life, including education. AI Chatbots have become one of the tools that can help students analyze problems, clarify concepts, and structure responses more systematically. However, the extent to which AI Chatbots can truly support students' critical thinking remains a subject of debate.

AI Chatbots as a Support for Students' Critical Thinking

AI Chatbots play a crucial role in helping students understand concepts and complete academic tasks more efficiently. Research findings indicate that most students agree that AI Chatbots contribute to the critical thinking process, particularly in problem clarification, information categorization, and answer structuring. AI Chatbots assist students in clarifying problems and answering questions that arise in their academic tasks. They also help organize information into relevant categories, making it easier to analyze and synthesize. Additionally, AI Chatbots facilitate students in systematically structuring responses and summarizing information in their own words. The critical thinking skills supported by AI Chatbots include exploring new ideas, questioning received information, and building a deeper understanding through information synthesis and evaluation.

Limitations of AI Chatbots in Enhancing Interaction and Collaboration

Although AI Chatbots offer many benefits, there are limitations that make them not yet fully optimal in enhancing students' critical thinking skills. One of the main drawbacks is the lack of social interaction in learning. Survey results indicate that most students disagree that AI Chatbots can improve academic interaction with peers. Critical thinking develops not only through individual reflection but also through discussion and argumentation with others. Therefore, AI Chatbots cannot yet replace the social interaction needed in the critical thinking process.

Integration of Critical Thinking with AI Chatbots in an Academic Context

Learning in the digital era, critical thinking can be developed by combining the use of AI Chatbots with more interactive learning methods. The following strategies can help students optimize AI Chatbots as a tool to support critical thinking, including verification and evaluation of AI answers, where students must be taught to always validate the answers provided by AI by comparing them with other sources. AI-based discussions can also be implemented, using AI Chatbots as a tool to spark academic discussions in which students discuss and evaluate the information obtained from AI. Additionally, the use of AI Chatbots in project-based learning allows students to utilize AI to gather initial information, which is then further developed through project-based learning and collaboration with peers.

CONCLUSION

AI chatbots play a crucial role in supporting Gen Z students' critical thinking in completing college assignments, particularly in problem clarification, information categorization, and answer formulation. However, their limitations in enhancing social interaction and internalizing responses into real-life contexts indicate that AI chatbots cannot fully replace discussions and reflection in the critical thinking process. Therefore, the use of AI chatbots should be balanced with learning strategies that encourage information verification, academic discussions, and practical applications in everyday life. AI chatbots can be an effective tool within a broader learning ecosystem to enhance students' critical thinking skills in the digital era if used appropriately. The implications of this study suggest that while AI chatbots assist students in completing assignments, education is needed to optimize

their use in fostering critical thinking. Educational institutions must ensure that AI chatbots support reflection and the application of solutions in real-world contexts while also considering ethical aspects to promote responsible use of this technology.

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REFERENCES

Ahn, S. (2022). Developing Summary Writing Abilities of Korean EFL University Students Through Teaching Summarizing Skills. *English Teaching*, *77*(2), 25–43. https://doi.org/10.15858/engtea.77.2.202206.25

Ashimova, N., & Turekhanova, A. (2022). Development of critical thinking of students in the learning process. *InterConf, 13(109)*, 110–115. https://doi.org/10.51582/interconf.19-20.05.2022.013

Butler, H. A. (2024). Predicting Everyday Critical Thinking: A Review of Critical Thinking Assessments. *Journal of Intelligence*, *12*(2), 16. https://doi.org/10.3390/jintelligence12020016

Cubric, M. (2020). Drivers, barriers and social considerations for AI adoption in business and management: A tertiary study. *Technology in Society*, *62*, 101257. https://doi.org/10.1016/j.techsoc.2020.101257

Dewi, H. R., Qudratuddarsi, H., Ningthias, D. P., & Cinthami, R. D. D. (2024). The Current Update of ChatGPT Roles in Science Experiment: A Systemic Literature Review. *Saqbe: Jurnal Sains dan Pembelajarannya*, *1*(2), 74-85.

Ennis, R. H. (2011). *The Nature of Critical Thinking : An Outline of Critical Thinking Dispositions*.

Hayati, A. N. (2024). Islamic religious education (pai) learning in the society 5.0 era to improve critical thinking skills. *DAYAH: Journal of Islamic Education*, *7*(2), 140. https://doi.org/10.22373/jie.v7i2.23095

Ivanova, I. (2020). Making sense of research: university students' difficulties in writing academic summaries. *Studies in Linguistics, Culture, and FLT*, *8*(1), 16–34. https://doi.org/10.46687/SILC.2020.v08i01.002

Kramer, M. K. (1993). Concept Clarification and Critical Thinking: Integrated Processes. *Journal of Nursing Education*, *32*(9), 406–414. https://doi.org/10.3928/0148-4834-19931101-06

Lasmana, O., Festiyet, F., Razak, A., & Fadilah, M. (2024). Transforming Education in the 5.0 Era: Utilizing Technology to Improve Critical Thinking and Creativity in The Digital Generation. *Proceedings of the 1st International Conference on Social Science (ICSS)*, *3*(2), 285–294. https://doi.org/10.59188/icss.v3i2.208

Martínez, M. (2024). The Information-Processing Perspective on Categorization. *Cognitive Science*, *48*(2). https://doi.org/10.1111/cogs.13411

Motz, B., Fyfe, E., & Guba, T. P. (2021). *Learning to Call Bullsh*t via Induction: Categorization Training Improves Critical Thinking Performance*. https://doi.org/10.31234/osf.io/65qfj

Mourtzis, D., Angelopoulos, J., & Panopoulos, N. (2022). A Literature Review of the Challenges and Opportunities of the Transition from Industry 4.0 to Society 5.0. *Energies*, *15*(17), 6276. https://doi.org/10.3390/en15176276

Mulyani, M. A., Yusuf, S., Siregar, P., Nurihsan, J., Razzaq, A., & Anshari, M. (2021). Fourth Industrial Revolution and Educational Challenges. *2021 International Conference on Information Management and Technology (ICIMTech)*, 245–249. https://doi.org/10.1109/ICIMTech53080.2021.9535057

Nurdiana, N., Hunaepi, H., Ikhsan, M., Suwono, H., & Sulisetijono, S. (2023). Exploring curiosity and critical thinking skills for prospective biology teacher. *International Journal of Evaluation and Research in Education (IJERE)*, *12*(1), 131. https://doi.org/10.11591/ijere.v12i1.23302

Oktavian, R., Aldya, R. F., & Arifendi, R. F. (2024). Artificial intelligence dan pendidikan era society 5.0. *Inteligensi : Jurnal Ilmu Pendidikan*, *6*(2), 143–150. https://doi.org/10.33366/ilg.v6i2.5798

Oktradiksa, A., Bhakti, C. P., Kurniawan, S. J., Rahman, F. A., & Ani. (2021). Utilization artificial intelligence to improve creativity skills in society 5.0. *Journal of Physics: Conference Series*, *1760*(1), 012032. https://doi.org/10.1088/1742-6596/1760/1/012032

Pereira, A. G., Lima, T. M., & Charrua-Santos, F. (2020). Industry 4.0 and Society 5.0: Opportunities and Threats. *International Journal of Recent Technology and Engineering (IJRTE)*, *8*(5), 3305–3308. https://doi.org/10.35940/ijrte.D8764.018520

Ramadhana, N. (2024). Analisis keterampilan berpikir kritis mahasiswa pada mata kuliah bioteknologi. *Indonesian Journal of Educational Science (IJES)*, *6*(2).

Secinaro, S., Calandra, D., Secinaro, A., Muthurangu, V., & Biancone, P. (2021). The role of artificial intelligence in healthcare: a structured literature review. *BMC Medical Informatics and Decision Making*, *21*(1), 125. https://doi.org/10.1186/s12911-021-01488-9

Şeker, H., & Kömür, S. (2008). The relationship between critical thinking skills and in-class questioning behaviours of English language teaching students. *European Journal of Teacher Education*, *31*(4), 389–402. https://doi.org/10.1080/02619760802420784

Shahroom, A. A., & Hussin, N. (2018). Industrial Revolution 4.0 and Education. *International Journal of Academic Research in Business and Social Sciences*, *8*(9). https://doi.org/10.6007/IJARBSS/v8-i9/4593

Susanto, A. M., Epriliyana, N. N., & Utama, H. H. (2024). Implementation of Learning Innovations in Society 5.0 to Stimulate Creative Thinking Skills at Higher Education. *Jurnal Dimensi Pendidikan Dan Pembelajaran*, *12*(1), 25–36. https://doi.org/10.24269/dpp.v12i1.8282