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ARTIFICIAL INTELLIGENCE, CRITICAL THINKING, AND UNIVERSITY STUDENTS

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Abstract. *In this study, the authors explore the intricate relationship between **Artificial Intelligence (AI)**, **critical thinking**, and **students' educational development**. The research examines how AI technologies influence students' ability to think critically, solve problems, and make informed decisions in academic and real-world contexts. The study begins by reviewing the main concepts that define AI and its growing role in education, particularly how intelligent systems are reshaping learning environments. The authors analyze the essential elements of **AI literacy**, emphasizing skills such as understanding algorithms, interpreting data outputs, and evaluating ethical implications. A central focus of the paper is the connection between **AI and critical thinking**, exploring how the integration of AI tools in classrooms, that is more and more present, can either enhance or challenge students' reasoning and analytical skills. The study identifies specific aspects of AI that support students' ongoing education and career preparation, suggesting that exposure to AI-driven systems can encourage deeper inquiry, adaptability, and problem-solving capabilities. The results of the article analysis reveal that **natural language processing (NLP)** is the most frequently examined aspect in this context. NLP's role in education—through chatbots, automated feedback, and language analysis—demonstrates how AI technologies can foster personalized learning experiences while promoting critical engagement with information.*

Keywords*: artificial intelligence, artificial intelligence literacy, critical thinking, university students*

INTRODUCTION

Artificial Intelligence (AI), a branch of computer science that deals with the creation of machines and programs capable of simulating human cognitive processes, is integrated into a variety of industries and continues to evolve rapidly, offering new opportunities and challenges and aims to develop systems that can learn, plan, reason, and process information in ways similar to humans. Key concepts of AI include:

- ***machine learning*****, which is a**subset of AI that involves training algorithms on data sets to make decisions or predictions without being explicitly programmed for each individual task;
- ***natural language processing*****, which they**allows machines to understand and interpret human language (for example, virtual assistants Alexa and Siri);
- ***robotics*****, which** involves the development of robots that can perform various tasks, from simple (repetitive) actions to complex activities (requiring autonomy and adaptability);
- ***expert-systems,***that mimics the decision-making process of a human expert in certain fields (e.g., medical diagnosis or financial planning);
- ***computational vision,***which allows machines to interpret and understand visual information from the real world (e.g., identifying objects in images and videos and recognizing faces).

Critical thinking, the mental process of systematically evaluating information and arguments in order to make well-founded decisions, is characterized by the rigorous and

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objective analysis of evidence before accepting or rejecting a claim. In essence, critical thinking helps us to be more rational and make informed decisions, avoiding the pitfalls of faulty logic and external influences, and is an essential skill in everyday life, education, and career, helping us approach problems and situations with an open and analytical mind. The most important key aspects of critical thinking are:

- ***analysis*, which**involves breaking down complex information into simpler components for better understanding;
- ***evaluation*, which**involves evaluating the quality and validity of information, sources and arguments presented;
- ***interpretation*, which**helps us understand and explain the meaning of information and conclusions;
- ***deduction*, which**involves drawing logical conclusions based on evidence and sound reasoning;
- ***Auto-Correction*,**which involves recognizing and correcting one's own errors and prejudices.

Students are individuals enrolled in an institution of higher education (e.g., university or college) to obtain an academic degree, for which they complete various programs of study that may include a bachelor's, master's, doctoral, or post-doctoral degree. Essentially, students are individuals dedicated to education and preparation for career and life. The most important aspects about students include:

- ***personal development*,p**a period of significant personal growth in which students learn to be more independent, manage their time and responsibilities, and explore their interests and identities;
- ***involvement in research,practical experiences, projects and internships***which allow them to apply theoretical knowledge in real situations;
- ***career preparation*, which implies**specific qualifications and experiences through part-time jobs, networking opportunities and internships to improve their employability;
- ***academic studies*, by attending**courses and seminars in various fields of study (e.g. business, arts, engineering, sciences or humanities) to acquire the specific knowledge and skills needed in your future career;
- ***campus life*, which includes**joint participation in extracurricular activities (e.g. clubs, student organizations, sports, and volunteering) that contribute to students' personal and social development.

In the analysis below, the authors attempt to determine to what extent the involvement of AI in academia affects students' critical thinking.

MATERIAL AND METHODS

The material used in this study consists of articles about AI and critical thinking in students, and the research method consists of analyzing the content of the results presented in these researches.

RESULTS AND DISCUSSIONS

According to NG ET AL. (2021), in order to create future employment opportunities, improve work efficiency, and enhance the user experience of Artificial Intelligence (AI), a “literacy” in the field is necessary. This process should consider four important aspects: knowledge and understanding, use/utilization and application, evaluation and creation, and ethical problem solving.

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1. AI Literacy

1.1. Knowledge and understanding of AI

Knowledge and understanding of AIrefers to knowledge of the basic functions of AI and how AI applications should be used because, while the public has recognized the transparency of algorithms and AI in general as important from an ethical point of view, it does not even understand the basic functions of artificial intelligence – which requires efforts to make AI easier to understand. Technical and conceptual understanding of basic AI concepts means understanding the basic concepts and origins of AI (e.g. machine learning, deep learning and neural network).

1.2. Use / use and application of AI

Use/use and application of AIrefers to the application of AI knowledge, concepts, and applications in different scenarios (e.g., in scientific contexts) by exploring the mapping relationship between facial features and data values and applying the concept to brainstorm other objects (e.g., Lego). AI practices include the techniques and strategies used in applying AI, specifically appreciating real-world applications of AI concepts (e.g., speech recognition, robotics); training, validation, and testing; and remixing or reusing code.

1.3. Evaluation and creation with AI

Evaluation and creation with AIinvolves higher-order thinking skills (e.g., estimation, evaluation, prediction, design) with the help of AI applications. Thus, experiences of exploring and creating technology help students understand the basic concepts of AI.

1.4. Resolving ethical issues in the use of AI

Resolving ethical issues in the use of AIinvolves human-centered considerations (e.g., fairness, ethics, responsibility, safety, transparency). Thus, the use of AI for the good of society measures the individual's perception of the social environment of behavior, which is linked to subjective norms. This aspect includes the attitudes and dispositions adopted in solving problems, in which case collaboration in problem solving should be considered, understanding technology as a tool for solving problems, and considering ethical and safety issues in the use of AI technologies in real-world applications.

2. AI, critical thinking and students

A first correlation of AI with critical thinking in students is that made by NG ET AL. (2021): they mention a machine learning model – called LearningML – that teaches children from kindergarten to 12th grade the fundamentals of AI necessary to understand AI applications, how it affects our lives, and the ethical issues created by AI technologies.

CHAN (2023) proposes an AI-ecological education policy framework that promotes a nuanced understanding of the implications of integrating AI into academic environments, to address the multiple implications of integrating AI into academia, organized into three dimensions: pedagogical (focused on using AI to improve teaching and learning outcomes), administrative (focused on privacy, accountability, and security issues), and operational (focused on infrastructure and training issues). Regarding the opportunities of natural language processing models, Chan mentions critical thinking in relation to developing generic skills (holistic competencies) of students, encouraging a balanced approach to adopting AI, and rethinking assessments and examinations; Regarding challenges, Chan points out that the use of generative AI may lead to a decline in students' writing and critical thinking skills as they become more dependent on automated tools to complete their work, which could have a negative impact on the quality of education and learning outcomes. FUCHS (2023) explores the ethical opportunities and challenges of natural language processing models in academia and

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questions whether Chat GPT (a large language model chatbot developed by OpenAI based on GPT-3.5, with a remarkable ability to interact in a conversational dialogue and provide surprisingly human-like responses) is a blessing or a curse. Among the challenges, Fuchs mentions considering natural language processing models as an aid to learning and not a substitute for critical thinking; the need for students to acquire higher-order thinking skills (e.g., critical thinking or problem solving); and the risk of technology dependency, which could undermine the development of important critical thinking skills. TAM ET AL. (2023), in turn, questions whether we are ready for AI-powered chatbot (ChatGPT) nursing education and examines the same challenges as Chan – including learning through problem-solving through independent inquiry and critical thinking and the risk of limiting critical thinking skills.

ALADINI ET AL. (2024) examine the impact of developing self-directed writing through computer-based and AI-based tasks on writing outcomes, increasing awareness and grammatical knowledge of a foreign language and found positive effects on self-efficacy, autonomy, collaboration in developing English language learning, critical thinking, time management, engagement, personalized learning, motivation and enjoyment in students. ALMASSAAD, ALAJLAN & ALEBAIKAN (2024) highlight the following benefits of GenIA in academia: saving time, improving learning experiences through automated and personalized assistance and feedback, providing quality explanations and clarifications, enabling access to information from different fields and promoting critical thinking skills. According to Batista, MESQUITA & CARNAZ (2024), generative AI tools can help students develop skills in various dimensions – coding, critical thinking and motivation, and they emphasize the importance of integrating the LLM (Large Language Model, a type of artificial intelligence algorithm designed to understand and generate human language) in a way that promotes, rather than diminishes, critical thinking skills. BOUCHARD (2024) recalls that ChatGPT is seen as a threat to the development of knowledge, critical thinking and ethical reasoning. ESSIEN ET AL. (2024) investigate the influence of generative artificial intelligence (GAI), in particular AI text generators (ChatGPT), on critical thinking skills in graduate business school students from the perspective of the complex relationship between AI technologies and critical thinking skills (which should be further stimulated). QAWQZEH (2024) explores the influence of students' interaction with ChatGPT on critical thinking, problem solving and creativity and makes remarkable findings around tangible improvements in cognitive domains that suggest the potential of ChatGPT as an augmentative tool for improving learning capabilities in educational settings – creativity, critical thinking, problem solving and learning. SALIMI & HAJINIA (2024) mention concerns about the ethical implications of relying on AI in education, questioning the issue of accountability and the potential impact on critical thinking skills. SINGH & NGAI (2024) mention the fear that students using ChatGPT to behave dishonestly to plagiarize, write their assignments or cheat, which can affect students' creativity, research, critical thinking and writing skills. SUGLO ET AL. (2024) also share the fear that students' critical thinking and curiosity to learn could suffer if they rely too heavily on GenAI technologies.WANG & LI (2024) recall that social sciences – specifically, economics, law, and management – emphasize critical thinking and the analysis of social phenomena.

CONCLUSIONS

The analysis of articles about the relationship between artificial intelligence and creative thinking in academia allowed the following conclusions:

- Artificial Intelligence, critical thinking, and students have their own key concepts;
- students must be literate in the field of artificial intelligence;

- interest in the relationship between artificial intelligence and critical thinking among students increased exponentially in 2024;
- The main positive impact of artificial intelligence on critical thinking is that of natural language processing models as a support in learning, especially LLM;
- artificial intelligence also has a positive impact on creativity, problem solving, creative writing,
- the main concern expressed by researchers is the risk of a negative impact of artificial intelligence on critical thinking;
- The star of the analyses presented in the analyzed articles is the impact of ChatGPT on critical thinking;
- the ethical aspect in the use of artificial intelligence is present in all the articles investigated;
- Artificial Intelligence must be used with caution in academia.

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