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REVIEW ARTICLE

Artificial Intelligence and Critical Thinking in University Students

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Abstract

The objective of this research was to explore the Critical Thinking (CT) skills of university students and the terms related to Artificial Intelligence (AI) that this population reports knowing. A three-part instrument was administered: analysis variables, a scale to assess Critical Thinking [1] and a scale for Artificial Intelligence, created by the authors. A total of 236 students from various universities, both public and private, located in Choluteca, Honduras, participated. The CT results reveal critical judgment skills, such as questioning information, but a low level of argumentation based on statistical or scientific evidence. Although general knowledge of AI is reported, in-depth knowledge of its constituent elements and its evolution is lacking. Certain skills are identified in the use of these technologies, such as writing academic papers and using automated assistants, among others. It is concluded that the surveyed population is not unfamiliar with AI, and that critical judgment should be fostered in educational processes from secondary education to university. Keywords: Critical thinking, artificial intelligence, university students.

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Abbreviations

CT: Critical thinking; AI: Artificial Intelligence; US: University Students; CNB: National Basic Curriculum.

Introduction

Artificial Intelligence (AI) and Critical Thinking (CT) are current topics with a significant impact on the education system. Artificial Intelligence (AI) refers to systems that perceive their environment, learn from data, reason, and take actions to achieve specific goals autonomously [2] an issue that entails many challenges and opportunities [3]. This convergence between AI and CT underscores the importance of a reflective and critical approach to technological innovation.

However, although reflections appear abundant, little is known about the CT and AI skills that students possess, at least in descriptive terms, translated into statistics. Therefore, a single objective has been

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formulated: to explore the CT construct in university students and the AI concepts that this population reports understanding. The relevance of this objective is based on two facts. First, CT is classified as one of the key soft skills in the 21st century, especially in the workplace, as it allows for developing strategies and achieving goals under optimal conditions, minimizing errors, adaptability, and emotional intelligence with flexible practices [4]. CT allows for the evaluation of information quality in critical and relevant ways, thus considering different perspectives and points of view.

Second, Artificial Intelligence (AI) represents a constantly evolving field of research. Its impact on everyday life is undeniable, from virtual assistants that simplify interactions and chatbots to recommendation algorithms that personalize online experiences [5]. It is a multidisciplinary field that encompasses various branches, with machine learning and natural language processing being two central areas of study. But are university students familiar with AI and do they do so with critical thinking? Although seeking evidence on CP and AI is not a new idea, no history of explorations of these constructs has been found in the Honduran context.

The Integration of AI in Everyday Life and Education

AI has become deeply intertwined with everyday life and education through technologies such as voice-based assistants like Siri and Alexa, which are often perceived as intelligent social agents [6]. Also advanced recommendation systems used by platforms like Netflix and Amazon that rely on deep learning architectures to personalize content and improve user experience [7].

Artificial Intelligence (AI) is commonly classified into two fundamental categories: weak AI and strong AI. The philosophical distinction between these concepts was famously introduced by Searle through his “Chinese Room” argument [8]. Weak AI refers to systems designed to perform specific tasks efficiently, such as virtual assistants or recommendation engines, without possessing genuine understanding or consciousness [9]. In contrast, strong AI aspires to replicate human-like cognition and awareness, aiming to achieve a level of general intelligence comparable to that of humans. While strong AI remains largely theoretical, recent advances in machine learning continue to challenge the boundaries of what weak AI systems can achieve, though they are still considered highly specialized and non-sentient.

Ethics and Responsibility in the Use of AI

In 2021, UNESCO adopted its first global standard on AI ethics—the Recommendation on the Ethics of Artificial Intelligence—which was endorsed by all 194 member states. This document urges governments to establish clear regulatory frameworks that include ethical impact assessments for AI systems, with the aim of anticipating repercussions, mitigating risks, avoiding harmful consequences, promoting citizen participation, and addressing broader societal challenges [10]. On the other hand, Nguyen A. et al, [11] identify several ethical principles that can be compromised in the use of AI: Beneficence, Governance, Nonmaleficence, Justice, Competence, and Responsibility.

Critical Thinking

Thought is the substantive embodiment of the verb "to think," which implies action, that is, "to form and combine ideas or judgments in the mind". In this sense, every person thinks; it is inherent to human nature, "as a rational living being, human beings must be able to think whenever they want" [12]. Although philosophical reflections address the difficulty that thinking entails for human beings, due to all its complexity [13], as a faculty, it is innate.

However, thinking is learned; although it constitutes a human faculty, it requires education and instruction. This is because much of our thinking, on its own, tends to be arbitrary, distorted, biased, uninformed, or prejudiced. But our quality of life and what we produce, do, or build depend precisely on the quality of our thinking. Poor-quality thinking has a cost both in terms of money and quality of life. Excellence in thinking, on the other hand, must be cultivated systematically [14].

The term "critical" directs thinking, explicitly stating analysis and reflection as its characteristics. Therefore, CT has been associated with reflective thinking, but some semantic convergences and divergences around the concept, acknowledging that both terms have been explored in empirical studies from different perspectives [15]. The classic definition of reflective thinking, which was later revisited as CP, was first developed by Dewey in the last century. He

stated that it is "the active, persistent, and careful examination of any belief or supposed form of knowledge in light of the foundations that support it and the conclusions to which it tends" [16]. Although this definition has a marked philosophical bent, it has laid the groundwork for the empirical approaches that have been developed.

What Defines A Critical Individual?

There are four basic characteristics of critical thinkers: They gather information, examine data, analyze it, and determine the best intervention for a given situation [17]. These generalities are operationalized in concrete skills such as thinking deeply about a certain topic, asking questions, that is, questioning information to, in turn, find relevant information. In addition to re-expanding these skills, according to Mendoza [18], critical thinkers seek well-founded solutions, form solid, rigorously informed opinions, verify the veracity of data, reach their own conclusions based on the cause and effect of problems, use scientific data and understand statistics, avoid repeating unfounded rumors, and avoid expressing opinions on unfamiliar topics, distinguishing between central and superficial issues, exhibiting responsible behavior.

Finally, critical thinking skills allow us to recognize the limits of our own knowledge and to be aware of the importance of informing ourselves before expressing opinions. Although the cognitive bias investigated by Kruger-Dunning describes people with limited skills who tend to overestimate their competence, highly competent people tend to underestimate their ability compared to others. In short, as knowledge on a topic increases, the perception of one's own competence is likely to decrease, and *vice versa* [19].

CT and University

Considering the formative nature of the university, the dilemma can be posed as follows: Can CT be taught? If this were possible, it would be like trying to teach breathing and the most basic faculties of life [20]. Only the ways in which people think can be described, although offers an option for how to improve it. Therefore, the question is formulated as follows: How can CT skills be strengthened in the university? From there, interventions and their evaluation are proposed to determine if any effect is produced [21]. All of this is geared toward protecting against manipulation and emotional persuasion, analyzing real-life cases with students, or applying problem-solving strategies.

The training that aims to strengthen CT skills should aim to foster an ideal critical thinker. Some skills students must develop must revolve around being well-informed, judging the credibility of the sources they consult, considering the overall picture and not being biased, consciously reflecting on their initial beliefs, etc. Those who define CT as a reflective process oriented toward informed decision-making also recognize problem-solving as a characteristic [22].

Methods and Materials

The guiding objective of this research was to explore the CT construct in university students and the concepts of EI that this population reports understanding. A quantitative approach was adopted with a non-experimental, cross-sectional design with an exploratory-descriptive scope, since no relationships between the proposed variables are sought. Hernández R. et al, [23], point out that there is no such thing as a pure design or scope, as research can address more than one scope. In this case, the research begins with an exploratory scope, which is used when examining a little-studied topic. Furthermore, it is considered descriptive, as it identifies a situation, describes it, and serves as a basis for future research that requires greater depth. Given that this research constitutes one of the first attempts to explore variables in the context of the study, it establishes itself as a valuable precedent for studies of this nature. The choice of a quantitative approach is justified by its ability to provide numerical data and statistics that facilitate the objective analysis of the variables involved. This methodology allows for the measurement and quantification of the elements studied. Furthermore, the non-experimental cross-sectional design was selected to collect data at a single point in time, providing a snapshot of the situation under investigation without intervening in it.

Procedure

A questionnaire was implemented using QR codes, structured in three sections. The first section collected sociodemographic variables, such as age, sex, and profession (graduate degrees and theoretical disciplines), providing a framework for subsequent analysis, as the objective was to explore and describe both constructs in the participating student population. The second section contained 19 items aimed at investigating and describing existing knowledge about AI. The third section of questions

focused on the construct of Critical Thinking and was based on an adaptation of the scale validated in El Salvador by. This section included 18 items that explored the construct through dichotomous scale questions with Yes/No response options. The same scale was used to inquire about knowledge of Artificial Intelligence, seeking the respondent's statement regarding whether or not they have knowledge of the constructs raised in each item.

This methodological approach allows for obtaining data on the participating population's understanding of AI and CT. The inclusion of sociodemographic variables strengthens the analysis by considering possible correlations between individual characteristics and levels of knowledge in both constructs. Furthermore, the adaptation of the scale validated in El Salvador contributes to the instrument's validity and reliability, providing a solid basis for evaluating the results.

Participating Population

A non-probability sample of 236 students from various universities, both public and private, located in Choluteca, Honduras, was selected. This student population represented a variety of disciplines and was at different stages of their academic training. They were classified into two main categories: graduate degrees and theoretical disciplines. The choice of a non-probability sample is justified by the convenience and accessibility of participants, as well as the diversity it brings to the research by including students from different majors and academic levels. This sampling strategy allows for obtaining representative information from the Choluteca student population, providing a comprehensive perspective on AI and CT knowledge in the aforementioned university context.

The research was conducted under the following ethical considerations: informed consent, expressed in the introduction to the instrument and in the first item, which allowed participants to freely participate or not, thus respecting the principle of autonomy of the participating population. Furthermore, participation in the research did not entail any risk or harm, and the integrity and transparency of the data collected was guaranteed.

Data Analysis

To analyze the results, version 25 of the Software Package for the Social Sciences (SPSS), a tool specialized in statistical calculations, was used. Frequencies were used as reference points for the analysis of each item of the variables. It is important to note that this statistical approach provides a robust quantitative view, allowing patterns and trends to be identified in the collected data.

The reliability of the instrument, measured through Cronbach's alpha coefficient, was evaluated at .82 for the Artificial Intelligence variable and .78 for Critical Thinking, using the Kuder-Richardson index, which supports the internal consistency of the questionnaire. These values indicate adequate internal consistency of the measurement scales, suggesting that the instrument is reliable for assessing participants' knowledge of Artificial Intelligence and Critical Thinking.

Results

Of the participating population, 91 students reported being male, while 145 were female. Regarding age, the student population was segmented into different age groups: 15-17, 18-20, 21-23, 24-26, and over 26 years old. In terms of academic disciplines, 146 graduate degrees, and 90 for theoretical disciplines. Diversity in terms of gender, academic background, age, and years of university study contributes to the representativeness of the sample, allowing for a more accurate assessment of knowledge about Artificial Intelligence and Critical Thinking among different student segments table 1.

In general terms, the surveyed population shows low levels of active participation in solving community problems, according to the frequencies found. However, the search for a possible correlation with years of education suggests that awareness of community social problems or their implications increases with the number of years of university education. As the student population spends more time at the institution, they tend to increase their frequency of participation in solving community problems. However, when analyzing these results by gender, no significant differences are observed between men and women, as both groups tend to have little involvement in these issues (64/85 for men and 37/50 for women). In the case of item 17, which asks about the ease of providing a reasoned opinion, a greater tendency is evident among women, with the majority of women surveyed (134 out of 145) stating that they find it easy to provide a reasoned opinion, while 11 responded negatively. Among men, 75 stated that they find it easy, compared to 16 who did not.

Table 1: Frequencies for items on Critical Thinking.

Ítems	Yes	No
1. I question information from traditional media	157	79
2. I question information on social media	185	51
3. I actively get involved in solving problems in my community	73	163
4. I find it easy to offer reasoned opinions on a topic in class	129	107
5. I seek information to support my ideas	218	18
6. I verify the veracity of the information I read	196	40
7. I enjoy discussing answers in work groups	172	64
8. I try to reach my own conclusions about the news I receive.	194	42
9. I distinguish between cause and effect of social problems	177	59
10. I express opinions based on scientific data on national issues	101	135
11. I am familiar with national statistics on education, the economy, and health	121	115
12. I tend to repeat rumors without thoroughly investigating the topic being discussed	62	174
13. I can distinguish the central from the superficial aspects of a topic	132	104
14. I reflect on my economic behavior	177	59
15. I reflect on my role as an economically responsible citizen	181	55
16. I express opinions after reflecting on a topic	153	83
17. I avoid commenting on topics I am unfamiliar with	209	27
18. I reflect critically on my own beliefs	201	35

The most significant frequencies indicate that respondents, regardless of their field of study, show a tendency toward confirming that they verify the authenticity of the information they consume. This behavior is consistently observed across various disciplines, whether undergraduate, engineering, or teaching. Regarding knowledge of national statistics on topics such as education, economics, and health (item 11), the results suggest that theoretical disciplines students are the least informed, with 39 stating that they are familiar with these statistics and 51 stating that they are not.

When analyzing trends based on length of university experience, it is observed that those who have been at the institution where they study for two or more years tend to state that they base their opinions on national issues based on scientific data. This trend is also replicated in item 11 for students with two years of university experience. On the other hand, regarding item 13, which asks about the ability to distinguish central from superficial aspects of a topic, the differences in frequencies are notable from the group that claims to have one year of university experience, showing increasing skills as the years at university progress table 2.

In Item 2, which assesses familiarity with the concept of machine learning, the 18-20 and 21-23 age groups are the most likely to report being familiar with the concept. Regarding Item 3, it is observed that, among those surveyed, 48 males and 69 females claim to have written papers using AI, while 43 and 76, respectively, deny having done so. In this regard, the results suggest that males are more likely to use artificial intelligence in writing academic papers.

Considering the majors, in item 5, regarding natural language processing (NLP) and its importance in artificial intelligence, the graduate degrees students presented 75 affirmative responses and 71 negative responses, while theoretical disciplines students had 47 affirmative responses and 43 negative responses. In item 6, related to the use of chatbots or customer service systems based on artificial intelligence, theoretical disciplines students stood out with a higher affirmative frequency than graduate degrees students, with 52 affirmative responses and 38 negative responses.

Regarding item 6, related to the use of chatbots or customer service systems based on artificial intelligence, the results highlight that the 18-20 age group had the highest frequency, with 53 stating that they had used them and 44 denying having done so. The affirmative responses are most notable in the 15-17 and 18-20 age ranges. Negative responses predominate in the 21-23, 24-26, and 26-plus age groups.

Table 2: Frequencies for items on AI.

Ítems	Yes	No
1. Do you know what Artificial Intelligence is?	201	35
2. Are you familiar with the concept of machine learning?	122	114
3. Have you written papers (essays, reports, blogs, etc.) using artificial intelligence?	117	119
4. Do you know common applications of artificial intelligence in everyday life, such as virtual assistants or online product recommendations?	170	66
5. Do you know what natural language processing (NLP) is and its importance in artificial intelligence?	56	180
6. Have you ever used a chatbot or an artificial intelligence-based customer service system?	113	123
7. Do you understand the difference between weak and strong artificial intelligence?	89	147
8. Have you heard about ethics in artificial intelligence and its implications?	91	145
9. Do you know how supervised learning algorithms work in machine learning?	51	185
10. Are you aware of the debates surrounding data privacy in the context of artificial intelligence?	72	164
11. Do you know the importance of labeled datasets in training artificial intelligence models?	56	180
12. Have you ever used a personalized recommendation system on an online platform?	102	134
13. Are you familiar with robotics and process automation with artificial intelligence?	54	182
14. Do you know how artificial intelligence is applied in healthcare and medical diagnosis?	59	177
15. Have you heard about computer vision and its use in object and person recognition?	106	130
16. Are you familiar with the concept of "deep learning" and its relevance to artificial intelligence?	53	183
17. Are you informed about the influence of artificial intelligence on the transportation industry, such as autonomous vehicles?	107	129
18. Have you read about the impact of artificial intelligence on the financial industry and investments?	91	145

Analysis of Results

Critical thinking: One of the critical thinking skills demonstrated in the instrument applied is the ability to question information from the media and social networks. Although the results, based on item frequencies in the surveyed population, indicate that they question it, there is also a high frequency of items that deny reflection on a topic before expressing an opinion on it, repeating rumors without research, or expressing opinions based on scientific data on issues of national reality. Therefore, the initial results could be related to social desirability. A qualitative approach could provide interesting results in this regard.

Critical thinking is essential for comprehensive education and is in demand in both academic and professional settings. Its study for many years highlights university responsibility. The need to research and express opinions based on scientific data underscores the importance of fostering reflection, analysis, and problem-solving, avoiding unfounded opinions, as evidenced by platforms that privilege uncritical expression. Data verification and the authenticity of the information consumed are very important in the academic context. Although the results show high frequencies in the items that address this, especially the relationship with years of study, more empirical evidence will be needed for more substantiated conclusions. The results suggest future studies focused on this topic.

Artificial intelligence: According to the results, younger people are more familiar with the concept of machine learning. They are also the ones who have used chatbots or AI-based customer service systems the most, but the frequencies do not provide sufficient evidence to indicate the presence of knowledge about how supervised learning algorithms work. The higher the item number, the deeper the level of knowledge about AI. Younger ages stand out in the first items, but regarding item 13, which asks about the use of a personalized recommendation system on online platforms, the older the age, the higher the frequencies for this item. With the phenomenon of social media and platforms like TikTok, so popular among young people graduating from secondary school, it is possible that many are already becoming familiar with these skills.

One aspect that warrants attention is the results for item 3, which addresses the use of AI in writing academic papers such as essays, reports, etc. This requires teachers, regardless of their specialty, to constantly update themselves in order to support them in these processes, deciding whether AI will

be their powerful ally or their executioner. This is worrying considering that, in an analysis by degree program, future teachers are the least familiar with AI. This should put the entire education system on guard.

According to the frequencies for theoretical disciplines students, the more in-depth the questions about AI management are, the more they stand out. However, when it comes to item 14, according to what was stated, there is generally a low level of familiarity with robotics and process automation with artificial intelligence across all degree programs, and no distinction can be established. This study did not seek relationships, but rather empirical evidence of the variables in isolation, laying the groundwork for future relational studies on both constructs.

Conclusion

The exploration of CT has focused on critical judgment, and although it is stated that the surrounding information is questioned, it is not supported with statistical data. There is a lack of scientific data in the arguments presented, and rumors are repeated without first developing a research process. Critical judgment in this aspect can be considered insufficient and something that needs to be strengthened.

It is possible that, due to the scale used for the measurement developed, social desirability is projected in some items; therefore, future quantitative and qualitative efforts will be needed to delve deeper into this construct and perhaps to seek relationships between the two. It has been found that students are familiar with AIs. The analytical variables incorporated have helped to conclude that they already use them to write academic papers, that they know what automated assistants are, and that as they progress through their curriculum, they strengthen their skills in using AIs.

Declaration of Conflicts of Interest

The authors declare no conflicts of interest.

Declaration of Authors' Contributions

Each author's contribution is listed below, using the CRediT.SciELO Taxonomy.

- Santos Federico Osorto Rodriguez: Lead Author, Conceptualization, Formal Analysis, Research, Methodology, Theoretical Discussion, Resources, Writing - original draft, editing, review, and editing.
- Jonatan Rodriguez: Formal Analysis, Methodology, Writing - review and editing.
- Edith Margot Maradiaga Rodriguez: Methodology, Review, Theoretical Discussion, Research.
- Hardy Edilberto Baquedano Perez: Methodology, Review, Theoretical Discussion, Research.
- Felix Alberto Gutierrez Guzman: Methodology, Review, Theoretical Discussion, Research.

Ethics Committee Approval Statement

The study was conducted following the guidelines of the Declaration of Helsinki, and therefore, the Technological University of Honduras has approved the research, authorizing the publication of this work, developed by the four faculty members of this institution in collaboration with doctoral candidate Rodríguez, as specified in the manuscript.

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