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The Impact of Artificial Intelligence on the Development of Critical Thinking Skills in Students

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Abstract:

Purpose: *The aim of this article is to address a significant issue related to the use of modern technologies, whose influence can have a range of positive effects on students' skills, while also presenting certain risks. In today's digital educational environment, artificial intelligence (AI) plays an increasingly prominent role in teaching and learning processes. One of the key aspects of education is the development of critical thinking and problem-solving skills among students. However, a question arises: how do AI-based tools influence these essential academic competencies? Addressing this question will be one of the primary goals of this study.*

Design/Methodology/Approach: *A survey was conducted among students to explore their perceptions of the use of artificial intelligence in education and to assess their levels of critical thinking and problem-solving skills. The chosen method was a survey, implemented through the technique of an online questionnaire with the following research questions: What are the benefits and limitations of using artificial intelligence in the educational process? Can the presence of artificial intelligence in education influence the development of independent thinking skills? How can artificial intelligence support the process of creative thinking and solving unconventional problems? What are the best practices for using artificial intelligence to develop analytical skills in students? Can artificial intelligence adapt to the individual needs of students in developing critical thinking skills? What are the potential risks associated with excessive reliance on artificial intelligence in the educational process?*

Findings: *AI-based tools are perceived by students as helpful in developing information analysis skills and constructing arguments, though they are aware of their limitations and potential risks. The majority of students rate their critical thinking skills as high or moderate. However, as many as 83% express concern that excessive reliance on AI could weaken their ability to think independently and make responsible decisions. Students value the importance of critically evaluating their own and others' beliefs, acknowledging that AI can support this process but cannot replace traditional teaching methods, which remain essential for fostering autonomous thinking.*

Practical recommendations: *The research findings may have significant implications for educational practice, suggesting ways in which artificial intelligence can be effectively used to support the development of critical thinking and problem-solving skills in students.*

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Additionally, the study may contribute to a better understanding of the role of technology in the learning process and help identify areas that require further research and development.
Originality value: *The study represents an attempt to fill the gap in the literature regarding the impact of artificial intelligence on critical thinking. The authors acknowledge that the results obtained are merely a starting point for further exploration of the complexity of this issue.*

Keywords: *Education, teachers, creativity, analysis, automation.*

JEL Code: *I21, D83, O33.*

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1. Introduction

The use of advanced algorithms for data analysis or problem-solving can encourage students to adopt a more analytical approach to learning. Moreover, interaction with intelligent systems can stimulate creative thinking and enhance the ability to tackle complex problems. However, this technology may also lead to overdependence and a limitation in the capacity for independent thinking and problem-solving. Additionally, there is a risk that AI algorithms may introduce incorrect assumptions or amplify existing biases.

In the face of dynamic changes occurring in the business world, the question of "skills for the future" becomes crucial—more specifically, what type of thinking companies currently expect and will demand in the future, and what traits define a person who thinks according to these new standards. The impact of artificial intelligence on the development of critical thinking and problem-solving skills in students is a multifaceted issue. Therefore, it is essential to use AI-based technologies appropriately to support the development of these skills. However, this requires a cautious approach to avoid potential negative consequences.

2. Introduction to the Topic of Artificial Intelligence – Literature Review

The term "artificial intelligence" was first introduced in 1956 by John McCarthy, an assistant professor at Dartmouth College in Hanover, New Hampshire, who specialised in mathematics (Kaplan, 2019, p. 29). At the Dartmouth Conference, he defined artificial intelligence as "the ability of a system to correctly interpret data from external sources, learn from it, and use this knowledge to perform specific tasks and achieve goals through flexible adaptation" (Kurp, 2023).

Artificial Intelligence (AI) is a field of science and technology dedicated to creating computer systems capable of performing tasks that traditionally required human intelligence, such as image recognition, decision-making, and learning (Minsky, 1985). It is a rapidly evolving discipline gaining increasing importance in various areas, including education (Russell and Norvig, 2020). The primary goal of AI is to develop machines that can understand their environment, make decisions, and adapt to changing conditions in a way similar to the human mind (Nilsson, 1998).

Key components of artificial intelligence include machine learning, natural language processing, image recognition, and process automation. Machine learning enables AI systems to analyse data and learn independently, without the need for manual programming (Bishop, 2006). Natural language processing allows AI systems to interact with humans in a manner similar to human communication (Jurafsky and Martin, 2023). Image recognition facilitates the identification and classification of visual objects, while process automation ensures the efficient execution of repetitive tasks (Goodfellow, Bengio and Courville, 2016; Tyagi *et al.*, 2023).

Two primary objectives of artificial intelligence can be identified: the first is technological in nature, while the second is scientific, involving the use of AI concepts and models to address questions about humans and other living beings (Boden, 2020, p. 14). AI enables psychologists and neuroscientists to develop theories of the mind-brain connection. Biologists, on the other hand, utilise AI in the form of "artificial life" (A-life), and many contemporary philosophers base their conceptions of the mind on AI principles (Boden, 2020, pp. 14-15).

At this point, it is worth noting the growing popularity of AI-based generators, such as ChatGPT, which prompts reflection on the future of education. ChatGPT is increasingly used by students as a support tool in the learning process, particularly for tasks such as analysing information, writing essays, and solving problem-based assignments. Many students appreciate its potential to accelerate work and enhance skills, although they remain aware of the limitations and risks associated with excessive reliance on AI.

An important milestone in AI development occurred on 14 March 2023, when OpenAI released the fourth generation of the GPT model (Czerski, 2023).

The Walton Family Foundation (2023) report highlights that both students and teachers consider tools like ChatGPT essential for adapting education to contemporary realities and ensuring students' success in higher education and the workforce. A study (Half of College..., 2024) conducted on 1,000 students in 2023 revealed that 43% of them use AI-based tools in their educational processes, with 50% employing them for writing essays or exams. Furthermore, 61% of surveyed students agree that AI will soon become a standard in the education system (Nieścior, Radziszewska, Wróbel, and Szydło, 2024; Velinov *et al.*, 2023).

Artificial intelligence (AI) has become a significant element of everyday life, influencing almost all aspects of our existence, including education. With the advancement of digital technologies and the growing accessibility of AI-based tools, both teachers and students have the opportunity to integrate these innovations into teaching and learning processes. However, a critical question that must be addressed concerns the impact AI may have on the development of critical thinking skills among students.

3. The Effectiveness of Teaching with AI

The use of artificial intelligence in teaching can significantly enhance its effectiveness (Holmes, Bialik and Fadel, 2019). By enabling the personalisation of content, as well as adjusting the pace and level of difficulty to the individual needs of each student, AI optimises the learning process. Research shows that students who utilise AI-based tools achieve better academic results, demonstrate higher levels of engagement and motivation, and absorb new information more quickly.

This technology also provides immediate feedback, progress analysis, and identifies areas requiring additional support (Zawacki-Richter, Marín, Bond and Gouverneur, 2019). In this way, AI assists teachers in monitoring and tailoring their teaching methods to meet the individual needs of students, contributing to greater overall efficiency in the educational process.

4. The Importance of Critical Thinking Skills in Contemporary Education

Socrates is considered the father of critical thinking. The great Greek philosopher would pose questions to his students to encourage deeper reflection, such as: "Do you truly know what you are talking about?" (Winiarek, 2022). It is from his inquiries and method of questioning that the term socratic questioning originates, which best illustrates the practice and development of a critical thinking mindset (Winiarek, 2022).

Critical thinking is a fundamental skill that enables effective problem-solving, informed decision-making, and accurate judgment (Brookfield, 2012). In the context of education, the development of these skills plays a crucial role in preparing students to function in a rapidly changing world (Paul and Elder, 2006). Critical thinking involves the ability to analyse information, draw conclusions, question assumptions, and consider alternative perspectives (Ennis, 1996).

These skills allow students not only to memorise and recall information but also to deeply understand issues, solve problems creatively, and make independent and well-reasoned decisions (Halpern, 2014). Developing such competencies enables students to actively participate in their own learning process, thereby achieving better educational outcomes (Fisher, 2011).

"Critical thinking is a form of realistic thinking aimed at a specific goal, which is evaluation. (…) The purpose of critical thinking is a reliable and realistic assessment of the key aspects of human intellectual activity."(Nęcka, Orzechowski, Szymura, Wichary, 2020).

In conclusion, one must ask: how can the concept of critical thinking be defined? What exactly is it? The answer reveals itself as a specific mental action (thought process) aimed at consciously understanding information in a way that enables making the best possible decision at a given moment. Ten critical thinking attitudes can be identified (Winiarek, 2022):

- You verify facts.
- You can analyse, create hypotheses, and evaluate.
- You understand logical connections.
- You distinguish facts from opinions.
- You solve problems.
- You recognise your own and others' emotions (needs).
- Thinking about thinking.
- You think about consequences.
- You question assumptions and self-evident truths.
- You can process information.

The attitudes outlined above are closely tied to the times we live and work in. Today, we operate in a world of informational noise, manipulation, and fake news. This is why the ability to select and sift through information is so critical. The primary goal of the Institute of Critical Thinking is to focus on developing critical thinking as a future competency in children and young people.

5. The Impact of AI on the Development of Critical Thinking

Artificial intelligence (AI) can have both positive and negative effects on the development of critical thinking skills among students. On one hand, AI provides tools and features that can support learning and stimulate critical thinking. On the other hand, excessive reliance on AI may limit students' ability to solve problems independently and reduce their capacity for critical evaluation of information.

Positive aspects of AI utilisation: AI can assist students in analysing large datasets, generating hypotheses, exploring alternative solutions, and evaluating the consequences of their decisions. Interactive AI tools can also stimulate reflection and discussion, encouraging students to question assumptions and seek deeper understanding.

Negative aspects of AI utilisation: overdependence on AI may lead to passive attitudes among students, who might expect ready-made solutions from the system rather than engaging in independent thought. Additionally, poorly designed or biased

AI algorithms could introduce incorrect assumptions, negatively impacting critical thinking.

To balance these effects, it is essential to find the right equilibrium between using AI and fostering critical thinking skills. Teachers should integrate AI into the teaching process thoughtfully, while emphasising the importance of practising independent problem-solving, analysis, and evaluation of information.

6. The Balance Between Using AI and Developing Critical Thinking Skills

A key challenge in using artificial intelligence (AI) in education is finding the right balance between the benefits of its application and the development of fundamental critical thinking skills among students. It is crucial to avoid situations where excessive reliance on AI limits students' ability to solve problems independently, draw conclusions, and critically analyse information (SMART-SENS.ORG).

Personalisation of learning with AI should support, not replace, students' reasoning processes (Artificial Intelligence in Education…).

- *Balancing automation and stimulating thinking:* AI can facilitate routine tasks, but it must leave room for students to reflect, question, and reach conclusions independently (*Critical Thinking in the AI Era…*).
- *Developing metacognition:* Alongside AI use, emphasis should be placed on learning skills, self-regulation, and students' ability to monitor their own learning processes (*What is Critical Thinking?*).
- *The teacher's role as a moderator:* Teachers must skillfully integrate AI tools with discussions, questioning, and engaging students in critical thinking (*Developing Critical Thinking…*).
- *Adapting to individual needs:* Implementing AI should consider differences in learning styles and student proficiency levels to support their individual development (*AI in Education – A Guide…*).

Only through conscious and balanced use of AI, combined with traditional teaching methods, can the harmonious development of critical thinking skills among students be ensured.

7. Empirical Research

7.1 Research Tool

The primary research was conducted between March and April 2024 using a survey method. The technique employed was an online survey created using Google Forms. The study utilized a questionnaire consisting of 14 questions, but for the purposes of this article, 10 questions were presented and discussed. The omitted questions support the conclusions drawn from the 10 presented and analyzed topics. The

questions in the survey questionnaire addressed issues related to the use of artificial intelligence by students in education. The study aimed to assess their level of critical thinking and problem-solving skills.

7.2 Characteristics of Respondents Participating in the Study

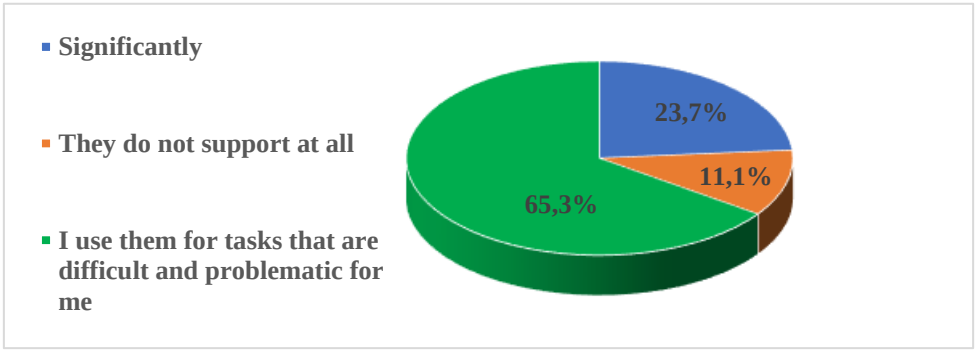
The study was directed at students from Polish universities, with a total of 190 students participating. The research group consisted of full-time first- and second-cycle students (159 individuals), integrated full-time master's program students (6 individuals), and part-time first- and second-cycle students (25 individuals). Respondents represented the following fields of study: Philology (57 individuals), Management (37 individuals), Mechatronics, Mechanics, and Machine Design (45 individuals), Logistics (15 individuals), and other fields (36 individuals).

Among the respondents, there were 93 women, 96 men, and 1 individual who identified as another gender. The age distribution was as follows: 18–22 years: 107 individuals, 23–26 years: 67 individuals, 27–30 years: 8 individuals, 36–40 years: 2 individuals, and over 41 years: 6 individuals.

8. Study Results

The essence of the study was to collect information about students' experiences and feelings related to the use of artificial intelligence in the learning process and their critical thinking and problem-solving skills.

Figure 1. *The degree of support for the learning process by AI-based tools*



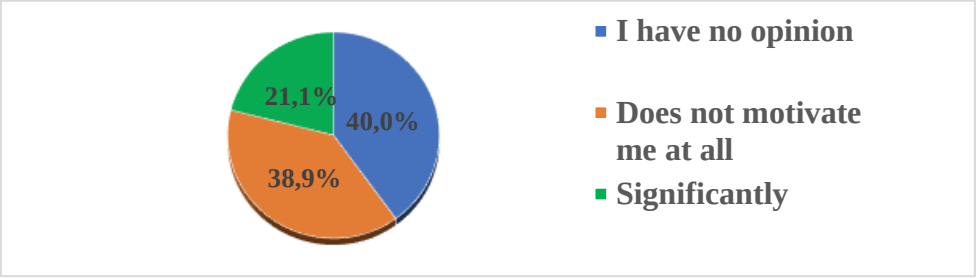
Source: *Own elaboration.*

The opening question of the survey was: *"To what extent do you believe that AI-based tools support your learning process?"* Analyzing the results collected in this section (Figure 1), it can be concluded that the vast majority of respondents—nearly 90%—believe (including responses about using these tools for difficult tasks) that

such tools support the learning process. At the same time, 11.1% of respondents reported that they do not perceive any such support.

The significant assistance provided by AI-based tools in the learning process, as emphasized by students, will also be confirmed in responses to questions discussed later and in the perspective that *"Artificial intelligence can facilitate, streamline, and make the teaching process more effective at all levels—for students, teachers, and the entire education system. [...] Learners can acquire knowledge and skills more quickly and with less effort, and they can do so at a time and place convenient for them"* (Singapore Ministry of Education…). However, it is important to remember that *"the use of artificial intelligence in education is likely associated with a greater set of risks than in other areas"* (Fazlagić, 2022, pp. 27-28).

Figure 2. *Using AI technology in the teaching process and motivation to learn*



Source: *Own elaboration.*

Data collected based on the next survey question, which was "Does the use of AI technology in the teaching process increase your motivation to learn?" Chart 2 allows us to notice that the relationship between the use of AI technology and the increase in motivation among learners is declared by 21% of the study participants, and nearly 79% of the responses include the respondents' indications "I have no opinion" (40%) and "I am not motivated at all" ” (38.9%).

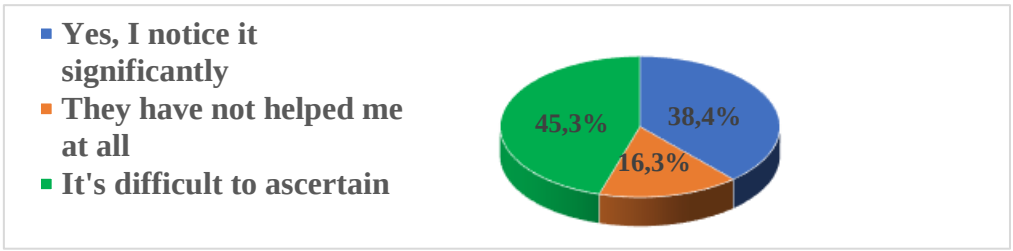
The above chart therefore illustrates that in the eyes of the vast majority of people surveyed (nearly 79%) the level of motivation to learn does not increase when using AI solutions. The conclusions resulting from the data presented here suggest the need for a deeper analysis. It seems necessary to investigate the reasons for such a high percentage of neutral and negative responses. Is this due to limited access to effective AI solutions, lack of knowledge about their functioning, or their inappropriate implementation?

Next, attention should be paid to potential challenges for educators and technology creators - the results may indicate the need to better adapt AI tools to the needs of

learners so that these technologies can support motivational processes more effectively. Considering information campaigns or training that shows how AI can support learners' development could increase awareness of the potential benefits and change respondents' attitudes.

Taken together, the data shows a significant gap between the potential of AI in education and its perception by learners. Therefore, in the future, it is worth focusing on activities that will make AI technology more understandable, friendly and effective in increasing motivation to learn.

Figure 3. *AI technology in the teaching process and identification of areas requiring improvement*



Source: *Own elaboration.*

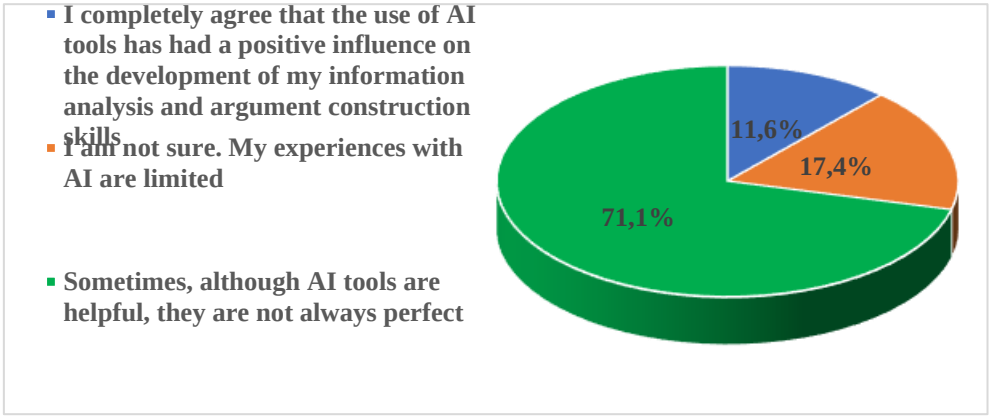
With regard to the relationship expressed between AI-based tools and the identification of areas requiring improvement in learning (Figure 3), the most indicated answer was "I have difficulty determining it" (45.3%), which may suggest a lack of sufficient knowledge about capabilities of such tools or insufficient experience in using them.

However, over 38% see a positive impact of AI in this area, which indicates the potential of these technologies in facilitating the analysis of one's own learning weaknesses. For over 16% of interested people, AI-based tools are not helpful in this respect at all, which may suggest the existence of barriers such as lack of personalization, difficulty in use or mismatch to users' needs.

According to the surveyed students, the use of AI tools is mostly (i.e., 71.1%) helpful in developing skills in analysing information and formulating arguments only occasionally. Even though AI tools provide support in this regard, they are not always perfect.

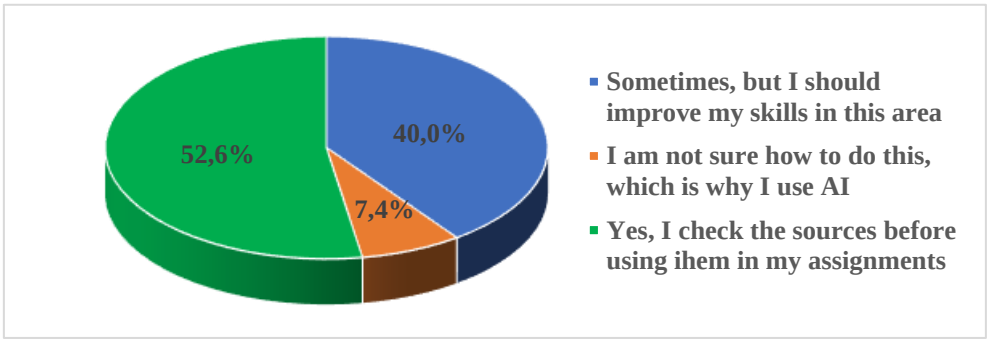
For just under 12% of respondents, using these tools has a positive impact on the development of information analysis and argumentation skills. Meanwhile, 17.4% of respondents are unsure about this matter, as their experience with AI tools is limited (Figure 4).

Figure 4. *Using AI technology in the teaching process and developing the ability to analyze information and formulate arguments*



Source: *Own elaboration.*

Figure 5. *Reliability of information sources used in the learning process*

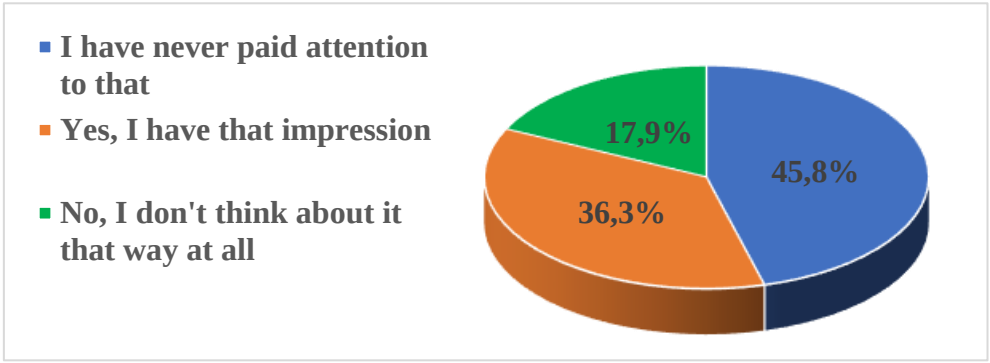


Source: *Own elaboration.*

Examining the responses to the next question: *"Are you able to assess the credibility of the information sources you use in the learning process, writing assignments, etc.?"* (Figure 5), it is noteworthy that over half of the surveyed students (52.6%) are capable of accurately assessing the credibility of sources before using them, while 40% recognize the need to improve their skills in this area. In comparison, 7.4% of respondents are unsure how to do this and therefore rely on AI.

It is worth emphasizing that the surveyed students are, firstly, aware of the necessity to verify the information sources they consult and, secondly, are either able to do so, express a willingness to improve their skills in this regard, or, due to a lack of confidence, use artificial intelligence as a support.

Figure 6. *AI-based tools and individual educational needs*

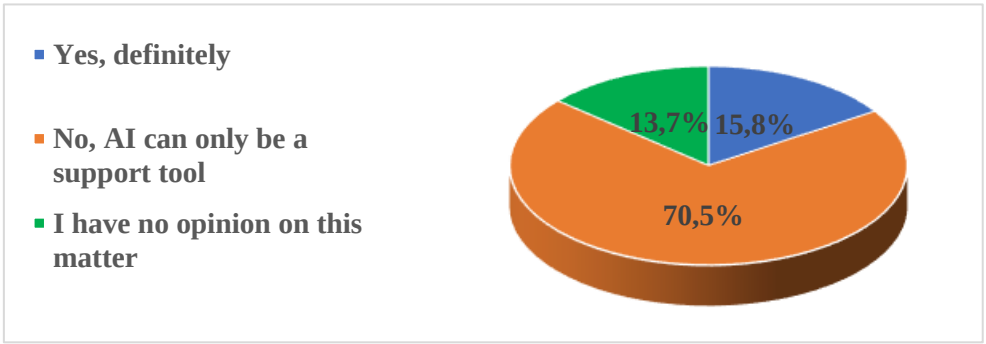


Source: *Own elaboration.*

An analysis of the responses to the question: *"Do you believe that AI-based tools adapt to your individual educational needs?"* (Figure 6) reveals that opinions on the ability of AI-based tools to tailor to individual educational needs are varied, with a significant proportion of respondents having no clear opinion on the matter. Nearly 46% of participants had never considered this aspect, which may indicate a low level of user awareness regarding the personalization capabilities offered by AI in education.

Over 36% of respondents believe that AI tools indeed adapt to their individual needs, showing that a considerable group of users recognizes the personalization potential of these solutions. On the other hand, close to 18% of respondents feel that these tools do not meet their expectations in terms of individualization. This could point to certain technological limitations, a mismatch between tool functions and user needs, or issues with their implementation.

Figure 7. *Traditional teaching methods in developing critical thinking skills and AI*



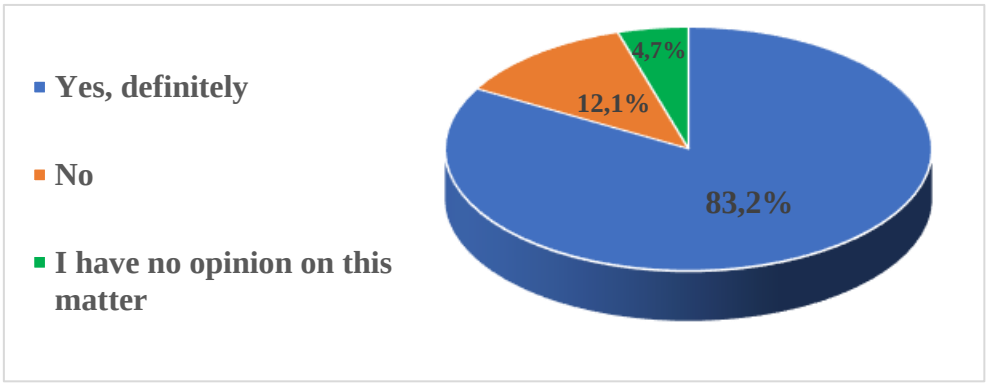
Source: *Own elaboration.*

Regarding the possibility of AI replacing traditional teaching methods in developing critical thinking skills (Figure 7), the vast majority of students (70.5%) declare that

such a scenario will not occur, and AI can only serve as a supporting tool. However, approximately 16% of respondents believe that such a replacement is definitely possible. Nearly 14% of respondents expressed no opinion on the matter.

The above data indicate that the majority of respondents are convinced that artificial intelligence cannot supplant traditional teaching methods in developing critical thinking skills, and its role will remain complementary.

Figure 8. *Dependence on AI and the ability to think independently*



Source: *Own elaboration.*

Let us move on to the next question: *"Do you fear that excessive reliance on AI could weaken your ability to think independently?"* The responses provided (Figure 8) clearly indicate that such reliance could indeed lead to this outcome, and to a significant extent (83.2% of respondents selected this option). On the other hand, 12.1% of respondents believe that AI will not weaken independent thinking skills. Those who have no opinion on the matter make up 4.7% of the survey participants.

The percentage breakdown in this question demonstrates that respondents clearly perceive the risk of AI negatively affecting independent thinking. They consequently agree with the assertion that *"the influence of AI on the decision-making process may lead to a situation where people engage less in critical thinking, relying instead on algorithmic recommendations"* (Kissinger, Schmidt, and Huttenlocher, 2023).

Table 1. *Summary of respondents' answers regarding the impact of AI on their behavior*

Do you agree with the following statements?	**1**	**2**	**3**	**4**	**5**
AI helps me analyze and solve problems that I struggle with in college	24	36	**67**	44	19
AI influences my critical thinking abilities	48	**54**	**64**	20	4
AI helps me be more independent in solving problems	**70**	**50**	40	24	6
I have an ability to judge the risks of using AI	6	20	39	**66**	**59**

I am able to critically assess my views and observations	7	14	43	**69**	**57**
I am unable to think critically	**80**	**58**	39	8	5

Source: *Own elaboration.*

In the next part of the survey, students answered questions on a scale from 1 to 5, where 1 meant "I strongly disagree" and 5 meant "I strongly agree". The results are presented in Table 1.

The data analysis shows several important conclusions regarding the perception of the role of artificial intelligence (AI) in the learning process and independence and critical thinking among the respondents.

1. AI and Analysis and Problem-Solving

- The majority of respondents selected a rating of "3" (67 responses), indicating a moderate perception of AI's role in helping with analysis and problem-solving.
- Extreme ratings ("1" - 24 and "5" - 19) are less frequent, suggesting a lack of strong positive or negative opinions in this area.
- AI is perceived as helpful in this regard but not as a decisive tool.

2. AI and Critical Thinking

- A moderate impact of AI on critical thinking ("3" - 64 responses) dominates over extreme opinions.
- Few respondents believe that AI has a very negative ("1" - 48) or very positive ("5" - 4) impact on critical thinking.
- This suggests that AI generally supports the process, but its role in shaping critical thinking may be limited.

3. AI and Independence

- Most ratings indicate a positive impact of AI on independence in task-solving ("1" - 70 and "2" - 50).
- Few respondents believe that AI negatively affects their independence ("5" - 6).
- AI can be an effective tool for supporting the development of independence in learning.

4. Risk Assessment of Using AI

- A significant number of respondents rate their skills in assessing AI-related risks highly ("4" - 66 and "5" - 59).
- A small group ("1" - 6) struggles with this assessment.
- This indicates relatively good awareness of potential risks associated with AI use.

5. Critical Evaluation of One's Own Views

- Most respondents rate their ability to critically analyse their own views highly ("4" - 69 and "5" - 57).
- Very few individuals have difficulty in this area ("1" - 7).

- This suggests that respondents are aware and capable of critically analysing their views, which may be supported by AI tools.

6. Issues with Critical Thinking

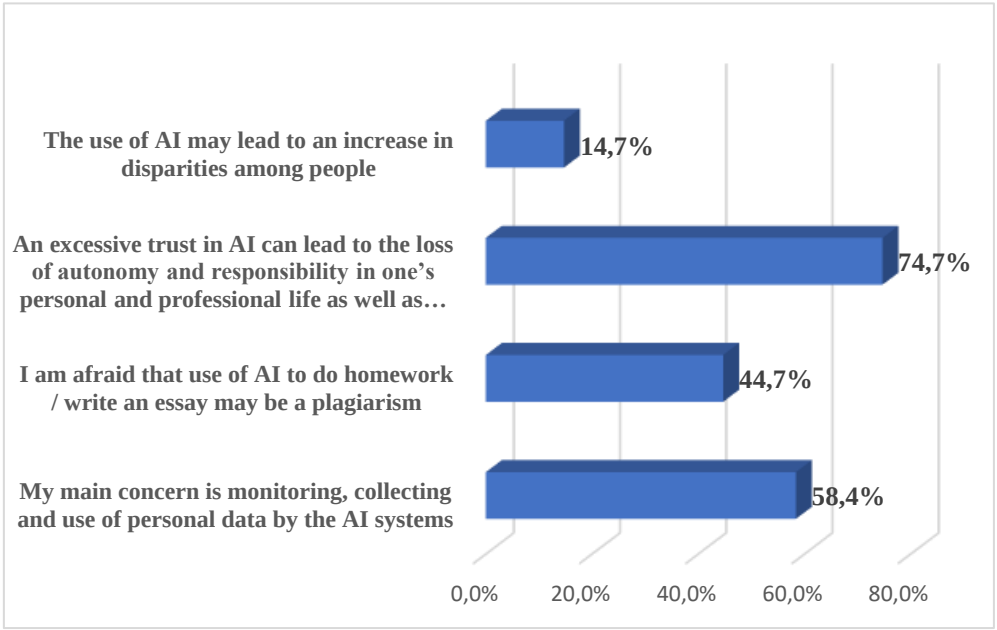
- A large percentage of respondents ("1" - 80 and "2" - 58) report no issues with critical thinking.
- Only a small group acknowledges having difficulties in this area ("5" - 5).
- This indicates that respondents believe they possess well-developed critical thinking skills.

In conclusion, it can be inferred that:

- AI is perceived as a helpful tool for analysis, problem-solving, and fostering independence, although its role in shaping critical thinking is rated moderately.
- The respondents demonstrate a high awareness of the risks associated with AI and an ability to critically evaluate their own views.
- Most respondents believe they do not have issues with critical thinking, which may indicate a high level of confidence in this area.

A recommendation would be to further utilize AI as a tool to support learning and critical thinking, while also educating users about the full capabilities and potential limitations of AI.

Figure 9. *Ethics and safety in the use of AI in the learning process*



Source: *Own elaboration.*

Analyzing the next issue identified in the survey, related to concerns about the ethics and safety of using AI in the learning process (Figure 9), students were asked to select the two most significant concerns. The top concern, chosen by nearly 75%, was the loss of autonomy and responsibility, both in daily life and in critical decision-making areas. The second most significant concern, cited by over 58%, was related to abuses involving the monitoring, collection, and use of personal data by AI systems. The third concern, expressed by almost 45% of respondents, was plagiarism.

The respondents were also encouraged to share their comments and observations regarding the impact of AI on their own skills. Here are some examples:

- "AI is very helpful to me, especially when I need to perform tasks on a bad day (e.g., due to exhaustion). A positive aspect is also its speed, such as summarizing a 10-page text into 2–3 paragraphs."
- "I finally have a competent teacher. It shows me my mistakes, gives me tasks to solve, and can explain in detail the problem I'm struggling with."
- "AI doesn't so much influence critical thinking ability as it leads to mental laziness and choosing the path of least resistance."
- "AI allows us to look at very complex topics. It provides a general overview, but when it comes to details, it can have problems."
- "AI is an incredibly useful tool in professional work."
- "Artificial intelligence may lead to a lack of independence among students and could have negative consequences in the future."

9. Conclusions from the Conducted Research

- AI-based tools assist students in tackling challenging and problematic tasks.
- Students believe that using AI tools helps them develop skills in analysing information and formulating arguments, although they are aware of the tools' imperfections.
- Half of the respondents stated that they can evaluate the credibility of information sources used in learning and writing assignments, while 40% acknowledged the need to improve in this area.
- Nearly 73% of respondents claim they can critically assess their own and others' beliefs.
- Students rate their critical thinking skills before using AI tools as high or moderate.
- Respondents agreed that AI cannot replace traditional teaching methods in developing critical thinking skills but can serve as a supporting tool.

- 83% of respondents believe that excessive reliance on artificial intelligence can significantly weaken the ability to think independently.
- Overreliance on artificial intelligence may lead to a loss of autonomy and responsibility, both in daily life and in critical decision-making areas.

10. Summary

With the continuous development of artificial intelligence and its growing application in education, numerous promising directions for future research emerge regarding the impact of AI on the development of students' critical thinking skills:

- *Personalisation of AI-based learning:* investigating how advanced AI algorithms can adapt content and teaching strategies to the individual needs and learning profiles of each student while supporting the development of metacognitive skills.
- *The role of teachers in AI integration:* analysing how teachers can best collaborate with AI systems to support students in critical thinking, and identifying the competencies educators need to effectively utilise these technologies.
- *Equity of access and ethics in AI usage:* exploring issues related to ensuring equal access to AI technologies in education and developing ethical guidelines for their use to protect privacy and maintain human agency in the learning process.
- *Measuring AI's impact on critical thinking:* developing effective tools for measuring and evaluating how the use of AI contributes to the long-term development of students' critical thinking skills.

In conclusion, the discussion on the impact of artificial intelligence on the development of students' critical thinking skills highlights the need for a holistic approach. Only through such an approach can AI be effectively implemented to support the cultivation of intellectual competencies in students.

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