

**NOVA**

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# MDDDM

Master's Degree Program in  
**Data-Driven Marketing**

**Critical Thinking and Artificial Intelligence in Education**

Ana Filipa Andrade da Silva

Master Thesis

presented as partial requirement for obtaining a Master's Degree in Data-Driven Marketing

**NOVA Information Management School**  
**Instituto Superior de Estatística e Gestão de Informação**

Universidade Nova de Lisboa

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by

Ana Filipa Andrade da Silva

Master Thesis presented as partial requirement for obtaining the Master's degree in Data-Driven Marketing, with a specialization in Marketing Intelligence.

**Supervised by**

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July, 2024

## STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism, any form of undue use of information or falsification of results along the process leading to its elaboration. I further declare that I have fully acknowledged the Rules of Conduct and Code of Honor from the NOVA Information Management School.

*[Lisbon, 2024]*

## DEDICATION

This thesis is dedicated to my family, whose unwavering support and encouragement have been the foundation of my academic journey. To my parents, thank you for believing in me and for the countless sacrifices you have made to ensure I had the best opportunities. Your love and guidance have been my greatest inspiration.

To my friends, who have been my pillars of strength, thank you for your constant encouragement, understanding, and for always being there to share in both my triumphs and challenges. Your companionship has made this journey both enjoyable and memorable.

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## **ABSTRACT**

This study investigates the impact of Artificial Intelligence in Education (AIEd) on critical thinking skills among higher education students. Utilizing both literature review and focus group discussions, the research aims to understand students' perspectives on the benefits and challenges of integrating AI tools in learning environments. The methodology involved structured focus groups with bachelor's and master's degree students to capture qualitative data on their experiences and opinions. The main findings indicate that while AI tools can enhance learning efficiency and provide personalized educational experiences, they may also contribute to passive learning and over-reliance, potentially diminishing students' critical thinking, creativity, and problem-solving abilities. Ethical concerns such as data privacy, algorithmic bias, and the risk of plagiarism were also highlighted. The study emphasizes the need for active learning strategies and educator involvement to foster critical thinking skills, suggesting that educational institutions should carefully integrate AI tools while addressing these limitations to maximize benefits and minimize potential negative impacts.

## **KEYWORDS**

Artificial Intelligence; AIEd; Critical Thinking; Artificial Intelligence in Education; Critical Thinking in Education.

### **Sustainable Development Goals (SDG):**



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## LIST OF ABBREVIATIONS AND ACRONYMS

<b>AIEd</b>	Artificial Intelligence in Education
<b>AI</b>	Artificial Intelligence
<b>CT</b>	Critical Thinking

# 1. INTRODUCTION

Artificial Intelligence has been having an exponential growth in the past years contributing to our daily lives and helping students academically. Although the positive outcomes it has been showing, there are unexplored consequences to this new technology. Having in mind the future of higher education, (Popenici,2017) advances in artificial intelligence open new possibilities for teaching and learning and the potential to change the internal architecture of institutions. There are opponents to the positive outcomes of using artificial intelligence (AI) in educational contexts due to the possible inadequate practices and ethical issues. Another important factor to consider is that ChatGPT was the most popular artificial intelligence tool in the past year of 2023, and this brings other concerns. ChatGPT does not understand the context and doesn't take time to evaluate the information's relevance because it is a text generating machine that is creating imitations of knowledge being shared (Warner, 2022).

We are facing a new world full of challenges and uncertainties, and students must act in response to these changes. Artificial intelligence in education (AIEd) faces ethics and integrity implications that must be addressed, the main concern, associated with ChatGPT, is the increased risk of plagiarism and cheating to write essays and exams, as well as lack of regulations, ethical principles because this tool cannot distinguish right or wrong, true or false. (UNESCO 2023). It is relevant to mention how AI can improve in literacy and numeracy - related to key cognitive skills of humans - important for our daily lives, education, work and acquiring new skills. These areas are predicted to further improve in the next few years. It is crucial to think about how AI will disturb the use of skills, due to its capabilities evolving beyond the cognitive skills mentioned. According to OECD (2023) AI is capable of solving 94% of questions that need information identifying, 71% of questions involving interpreting relations in text and 44% of questions where it is expected to evaluate and reflect.

After an analysis of the existing literature and studies, it is noticeable the lack of a deeper analysis of the students' perspectives and opinion relative to AIEd and an analysis of the challenges and limitations these new technologies may have on school performance and their futures. One of the aspects that are influenced by the use of AIEd is critical thinking, a multi-dimensional and multifaceted human capability. These skills enable individuals to be likely to achieve a desired outcome in a challenging situation (Spector, 2019). With such easy and fast information at hand students might start lacking the element of critical thinking. To acknowledge these aspects, it will be used in the Delphi report (Facione, 1990). There are also drawbacks when using ChatGPT and generative AI and institutions are required to rethink teachers' roles and teaching methods, although AI is not ready to replace teachers and education is human-centric not a technology solution ( Popenici, 2017). When developing AI for education inclusion and equity should represent core values of the policies and how can AIEd be provided for groups in disadvantage in order to minimize the educational gap between students worldwide, the objective would be to avoid AI being a disruptive technology that would deepen the inequalities (UNESCO, 2019).

There are three models that should be considered in AIEd: pedagogical, domain and learner model. The algorithms are able to process the knowledge in the models mentioned previously, and in addition to these researchers developed models to show emotional, social and meta cognitive aspects of learning (Luckin, 2016).

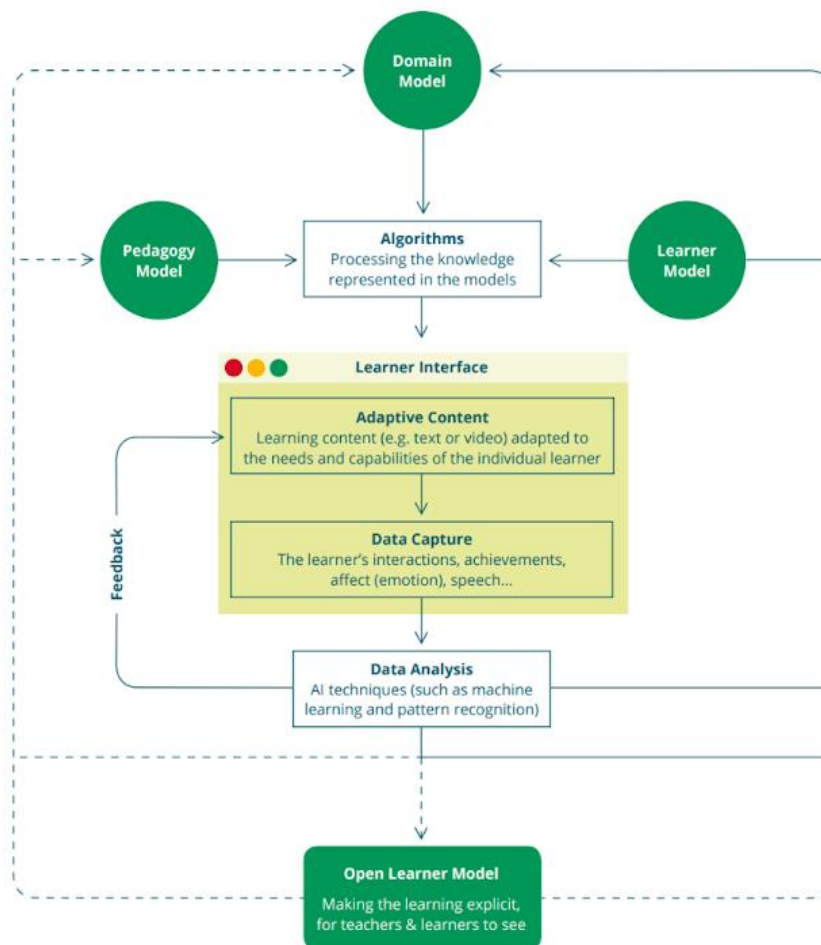
In this study a Focus Group will be conducted in order to provide insights into the students' perspective of AIEd and what impact it has on learning, and a data-driven approach is going to be carried out to analyze how previous studies compare to what students in higher education think. The studies that are important for this research are the framework created by Luckin, representing the key models of AIEd and the future implications for learning, the OECD , AI and adults performance in PIAAC - programme of assessment and analysis of adult skills -, critical thinking: a statement of expert consensus for purposes of educational assessment and instruction and delphi report (Facione, 1990).

Consequently, ChatGPT, the most popular language model, and generative AI models are trained on large amounts of data that will reflect bias on the output. If the data was biased, language models aren't perfect and may generate errors. One of the main challenges is the possibility of plagiarism. These language models can produce essays based on certain parameters that can be used to cheat on tests or assignments, submitting work that is not from their authorship and defeating the purpose of higher education. And although the capacity of producing human-like text also produces incorrect information, affects and could reduce critical thinking on the scope of its advances and minimize problem solving skills ( Ray, 2023). Among these challenges, one of the findings that is of main relevance are the ethical considerations when using language models in AIEd, specially in areas like data privacy, security, bias, responsibility and misinformation. This research contributes to the institution's way of regulating AIEd and provides insights into students' perspectives and ethical considerations when using language models.

## 2. LITERATURE REVIEW

### 2.1. ARTIFICIAL INTELLIGENCE IN EDUCATION

The application of AIEd has been a subject of academic research for over thirty years, and it brings together learning sciences and AI to promote the advance of adaptive learning systems and other AIEd tools (Tan, 2020). AIEd also represents a tool that allows us to better understand how learning actually happens, these can be applied to develop software and see the steps that learners have to go through when learning (Luckin, 2016). The main approach this study will follow, in AIEd, are the following models: pedagogical, domain and learner. The pedagogical model represents effective approaches to teaching - this model allows students to explore a concept and make mistakes before giving the correct answers, feedback triggered by students, inform and measure learning-, the domain model represents the subject that is being learned - how to calculate fractions, Newton's law (forces), different reading approaches- and the learner model represents the student - previous achievements and difficulties, emotional state, engagement in learning. According to Luckin (2016) adaptive AIEd systems have the advantage of gathering large amounts of data that can be computed to improve two of the previous models: the pedagogical and the domain.



*Figure 1: Three models of AIEd (Luckin, 2016)*

Having in mind the three models, additionally three others were created that represent the social, emotional and meta-cognitive - contains two elements: being aware of thinking and control or regulating thinking - aspects of learning. Artificial Intelligence in the context of education has become a part of the students daily lives but it is necessary to address the social problems it awakes. In current times AIEd is lacking the ability to fill the gap between students' achievements, this meaning that students from poorer backgrounds have more difficulties and have less opportunities for achievements. At present, the AIEd developments are coming from private sectors and a major part of governments are struggling to manage AIEd and the private sector engagement. The institution of public policies in AIEd is still in the beginning but the tendency is to have an exponential growth in the next ten years (UNESCO, 2019). Due to the fast evolution in the field of AI public policies aren't able to cope with this pace without a change of the traditional institutions.

A challenge that AIEd is facing is inclusion. As mentioned, artificial intelligence can be disruptive and extend the inequalities in education and this will cause a division in data based knowledge (Hilbert, 2016). For this aspect it is important to ask what infrastructure conditions are important to develop to make AIEd possible and accessible for students around the world and how can AIEd grow to close the existing educational gap. The gap is supported by the fact that there are many countries where students don't have available hardware, the data costs can't be covered and lack of skills, as well as a lack of infrastructures to use the data based knowledge, mentioned by Hilbert.

A critical point of artificial intelligence in education is the teacher training. Many teachers don't yet have the competencies necessary to use AI technologies. Teachers need to prepare for these new technological possibilities and the future developments in education should close this gap, due to the fact they need to be central agents in this phase of AIEd so that are able to tell when and how to use AI tools, and in order to have this transformation take place teachers need to: understand what AIEd can do, interpret data and new teamwork skills since the provision is for teachers to have an AI assistant.

ChatGPT is trained on a large corpus of text data, this training allows ChatGPT to learn patterns and relationships in natural language, which makes it an efficient and realistic language model. ChatGPT is able to understand the context of text-based sentences and phrases, and it can be adapted to a wide range of tasks across several domains. One of the most important features of this language model is the prompt engineering, (Ray, 2023), using this technique users can guide the model to provide more accurate, specific and useful responses. The steps mentioned are: start with a clear and specific prompt, provide context, provide background information, specify format and set boundaries.

When applying the tools ChatGPT provides in education it is possible to have personalized materials and lessons, feedback, quizzes, exercises and multiple others. It is known to be a valuable instrument for scientific research but it also provides challenges and concerns like reliability, in the case of the use in education this is a major factor, students are using this language model to produce assignments and although most of the time it generates human-like text others provides incorrect information; as described above ChatGPT is trained on textual data, this data can contain biased information that will impact the direction of the research and results shown. A risk to consider relative to AIEd is the overreliance on artificial intelligence and the low quality responses it may provide to prompts, since most of the time students don't check the information provided.

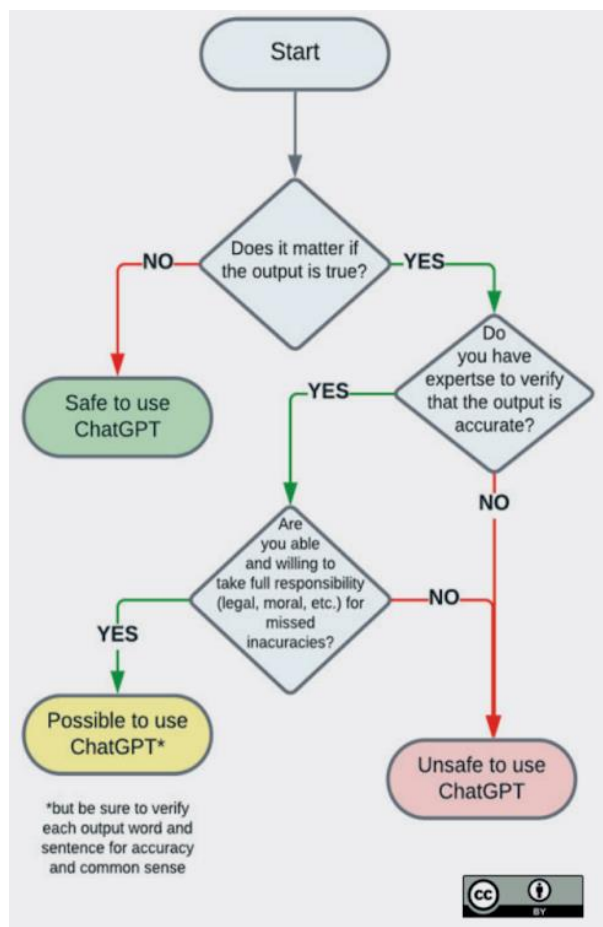


Figure 2: Safe use of ChatGPT (Valentini, 2023)

Considering ethics in AIEd and ChatGPT, intellectual property and authorship are very relevant topics to this study, language models generate written content that is being used academically putting in perspective the rights of content attribution.

There is still a study gap about in which ways ChatGPT can be used in education and would be considered acceptable and what is not. While it can be useful for some things when it comes

to directly copying the information it provides it isn't because it's not adding value and can be considered deceptive or misleading ( Qadir, 2023 ). A concern for ChatGPT in academic applications is the integrity of exams and assignments due to the high risk of using these tools to cheat and plagiarize, it is likely that with the evolution of AI in education the definitions and rules of change in the context of what is and isn't acceptable, as well as different methods of evaluation assessment. This topic can follow up with the careless use and plagiarism detectors, when submitting a work academically, there are already several systems to detect the use of artificial intelligence on essays since most language models leave some sort of trace.

Summarizing, it is important to remember that ChatGPT is not perfect, it makes mistakes and can provide incorrect information and make assumptions. Is also important to mention that education will have to adopt strategies in order to minimize unethical use of language models and provide equal access to all communities.

## **2.2. CRITICAL THINKING**

In this new era, it is important to search for information and resources on our own, since this enables the ability to think critically and can lead to a better understanding and retention of information (Qadir, 2023). With the evolving technology advances, critical thinking can become less important.

Critical thinking involves cumulative and related abilities - motivation, criteria, context, knowledge -, and this method acts from experience - observation -, and inquiries, investigation, argumentation, reflection, and many more (Spector, 2019).

Apart from the mentioned method, critical thinking has two cognitive capabilities: meta-cognition and self-regulation. Meta-cognition enables the understanding and cognition of the learner processes. Motivation includes beliefs that influence the development of metacognitive skills. Metacognition is of high importance due to the capability of enabling students to monitor knowledge and skills. As for self-regulation, these components aren't enough, it also requires motivation , cognition and metacognition. (Schraw et al. 2006)

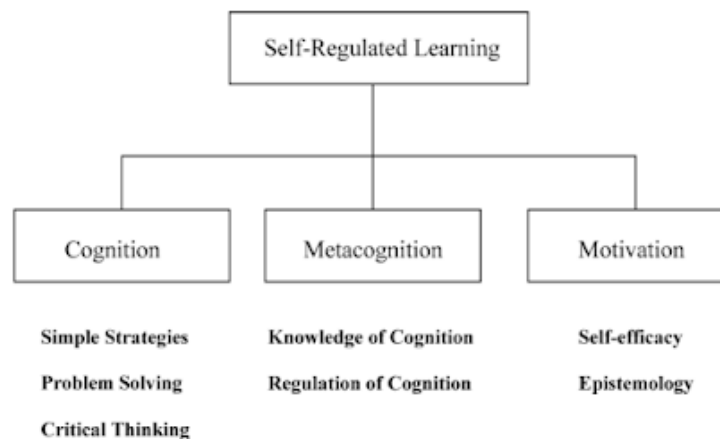


Figure 3: Components of self-regulation (Crippen, 2006)

Skills like searching for information sources, analyzing, identifying the credibility of information, and arriving at conclusions are critical points for thinking critically. Students tend to fail at these aspects so it is crucial to help them improve the skills needed, through reflection and monitorization.

Qadir (2023) conducted a study on the pitfalls of AIED, prompts are given to ChatGPT to answer. Regarding the AIED and ChatGPT it is mentioned that the overreliance on the language model will lead to a lack of the skill of critical thinking and problem solving. And in this technology era it is fundamental to ask our own questions and be resourceful - these are also key components of critical thinking.

Spector (2019) created a framework to apply to critical thinking and defines it as a multidimensional and multifaceted human ability that can be interpreted from three perspectives - education, psychology and epistemology. Spector guided the study based on the metacognition of Schraw previously mentioned. For Spector metacognition should involve awareness and self-regulation appropriate control, the two concepts together enable a mechanism that monitors critical thinking. What is defended in the framework is that for an individual to achieve a high level of expertise it needs a high level of knowledge to become a critical thinker.

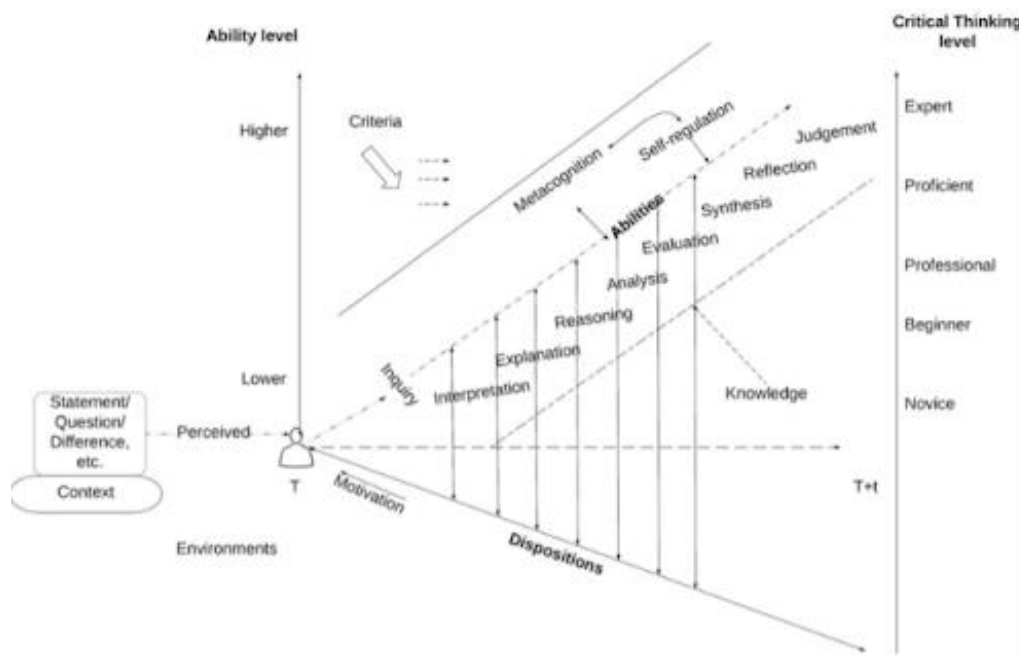


Figure 4: Framework of critical thinking (Spector, 2019)

This process goes through multiple levels of critical thinking - from novice to expert -, and requires motivation, disposition, open-mindedness and seeking of the truth.

Addressing this subject in terms of education, students need to monitor their levels of awareness and train increasingly to recognize and view things on a holistic level. Although, with more experience students are going to become more independent of abstract principles, this way critical thinking would become a habit. This description, from Spector, shows the developing process from a novice to expert.

The implementation of AI in education has been a concern and topic of study for years, and at the present time learning environments are starting to shift towards smart learning environments and relying more on AI technology and tools. For Spector, it is important to give more emphasis to human intelligence development and use AI tools to help increase the resources for expansion and progress of HI but we cannot overlook the fact that AI techniques and tools might not yet support large-scale development.

### 2.3. ETHICS AND INTEGRITY OF AIED

The diversity of data provided by artificial intelligence systems awakens ethical concerns. Luckin (2016), raises the new found responsibility of having AIED literacy to be able to use the technology in a correct and effective way.

Ethical considerations referring to ChatGPT for educational research are mainly connected to data and security with the increased use of AI, the main challenge is to ensure that personal

preferences and identifiable information is protected. As already mentioned intellectual property and authorship have great importance due to questions related to who the context generated should be attributed.

ChatGPT, like other language models, due to being trained on large amounts of data can tend to develop bias that may lead to unfair outcomes, this topic can be linked with misuse and abuse and the creation of inappropriate content and fake information (Ray, 2023). ChatGPT is not regulated and is not governed by ethical implications, it is not able to distinguish the right from the wrong, and is mandatory to analyze the provided results.

Unesco (2019) mentions that AI ethical concerns impact education when there are privacy risks - large concentration of data can be target of a cyberattack -, liability - students rely on the information provided but what if this information is wrong? -, also raises the issue of impact on work, both for students and teachers - AI is capable of performing tasks attributed to teachers, it is also capable of producing assignments and answers to exams.

Higher education institutions are concerned with the academic integrity of students, with the high risk of plagiarism and cheating being detected with the use of ChatGPT to perform essays, this has more impact on subjects that are more theoretical and where language models can perform better, another uncertainty are the tools to evaluate and detect plagiarism may not be totally effective what is causing language models to be banned. There are requests to AIED to be regulated. (UNESCO, 2023)

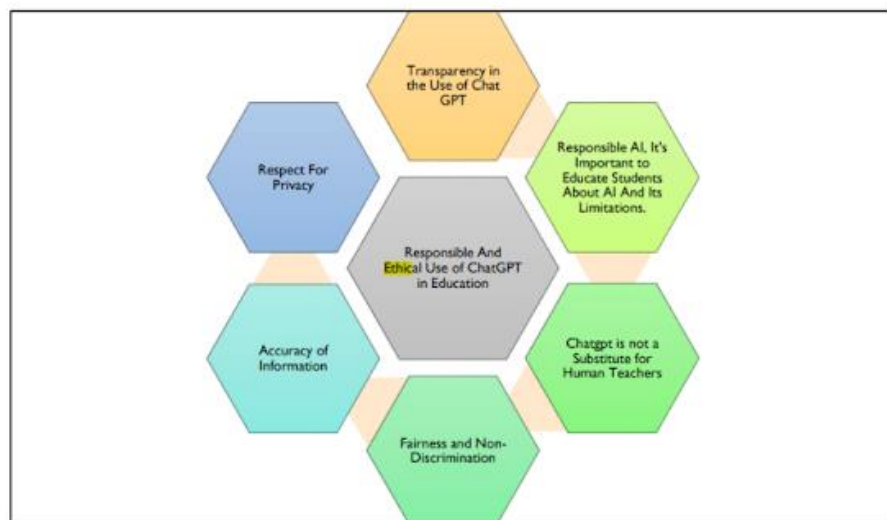


Figure 5: Ethical use of ChatGPT in AIEd (Valentin, 2023)

Mhalanga (2006) proposes that students should challenge the outputs of ChatGPT, while teachers have the role of helping students develop critical skills on the application of AI in schools. It is critical that students also understand the ethical ramifications of AI. Students need

to be cautious of these problems and be able to adapt to the ever changing technological landscape. Accessibility has to be taken into account since some countries have restrictions to the use of these new tools.

#### **2.4. INSTITUTIONS REFORMATION**

With the rapid pace technology is evolving it will need new ways to measure achievements. Colleges and other educational institutions can use the implementation of data standards and data sharing requirements to provide an in depth analysis of subjects. Educational systems need to take advantage of analyzing available systems. (Luckin, 2016) AIED is going to have a major role in the intuitions of education reform, and the answers they have for the current problems can be quickly outdated. (Tuomi, 2018)

Educational systems have been already reforming themselves to guarantee that students are acquiring skills to apply in a future that will be ruled by AI applications. This process of reformation and rethinking of the educational programs needs to be continuous. These reforms also want to achieve a bridge in the existing gaps and develop future professionals capable of dealing with the needs of the AI industry (UNESCO, 2018). It is important to promote the perspectives of AI in education. Following Luckin (2016), we can use AIED to reform the educational system. According to his model AI tools will be useful for this reform but with ethical cautions mentioned previously.


In 15 years time...	The implication for learning...	How AIEd can help...
Many of the new jobs created will be much more cognitively demanding than those currently available	Students will need to learn as efficiently and effectively as possible	Give every learner their own personal tutor, in every subject Provide every teacher with their own AI teaching assistant AIEd to deliver timely, smarter, teacher professional development AIEd tools that help every parent support their child's learning
	We will need to seriously attend to the non-cognitive factors that influence learning – grit, tenacity and perseverance; affect; 'mindset'	AIEd tools that embody new insights from neuroscience or psychology Making available new insights into how learning is going for an individual and the factors that make it more likely to occur In light of that, providing the right support, at the right time, to keep learning on track
	 Students will need to achieve higher-order skills – e.g. problem solving – alongside 'knowing what'	Intelligent Virtual Reality to allow learners to be supported to learn in authentic environments – and to transfer that learning back to the real world
Social skills will be where humans continue to excel	Students need to be effective collaborative problem solvers and makers, able to build on others' ideas and extend and sensitively critique an argument	Intelligent support for collaborative learning
	The ability to get on with others, to empathise and create a human connection, will continue to be valued	AIEd techniques to help us understand better how to deliver a wider variety of attributes, and how well a learner is acquiring them
We will need to re-skill large parts of the current workforce – in essence, creating a learning society	We will need new ways of equipping adult learners with new skills – more frequently, quickly, and effectively	AIEd tools that support learners to become effective, self-regulated learners for lifelong learning Lifelong learning companions to advise, recommend, and track learning More flexible learning environments, allowing learners to learn at a time and a place that works best for them

Figure 6: AIEd system reform (Luckin, 2016)

AIEd is going to mix the school learning spaces with digital technologies, and keeping in mind that AIEd is not a nightmare but instead a new learning system that has challenges, limitations and ethical implications, it is needed to address the flaws and gaps that the current educational system has in order to perform the change. To find the right solution to carry out the reform is to tackle the main issues and evolve students and teachers in the new learning system design.

### 3. THEORETICAL MODEL AND PROPOSITIONS DEVELOPMENT

Critical thinking in the context of AIEd involves the ability to evaluate and reflect on information and form arguments, serving as a focus point for assessing the impact of artificial intelligence. The aim is to highlight the less explored sides of AIEd and the possible repercussions on critical thinking (CT) skills. The overreliance and dependence on AI tools is leading to an exponential lack of critical thinking and engagement and, while AIEd can optimize learning it can also limit opportunities to pursue approaches outside the scope of AI algorithms. Critical thinking is multifaceted and it will serve as the main point for assessing the impact of AIEd in students cognitive development.

Overreliance on AIEd can negatively impact skills like critical thinking among students in higher education. The students are becoming dependent on AI tools, this will lead to an increase in the number of passive learners - this model only allows the student to absorb and assimilate knowledge, not to face challenges, and the student is only retaining information, many times not knowing how to use it properly - instead of having an active learning that provides the opportunity to challenge bias and develop critical thinking skills, as well as being able to debate and have discussions, this model is more appropriate since it is student centered. Another point to have in consideration is that when using AI tools most students are limiting their engagement with the learning materials since the work is being done with artificial intelligence and they are not questioning the information being provided by it.

Cognitive development is an important aspect for critical thinking, it applies meta-cognition and self-regulation. Meta-cognition is the ability to monitor and control cognitive processes, while self-regulation is the ability to control thoughts and processes.

As previously mentioned, AI algorithms contain biased information since it is based on training data that includes human decisions that can reflect inequalities for various variables including gender and race. Algorithm bias happens when the algorithm performs systematic errors that lead to inadequate outcomes. This aspect connects and serves as mediator with the overreliance due to the impact it has on the ability to think critically; bias can lead to a change of perspectives and limit the scope of ideas.

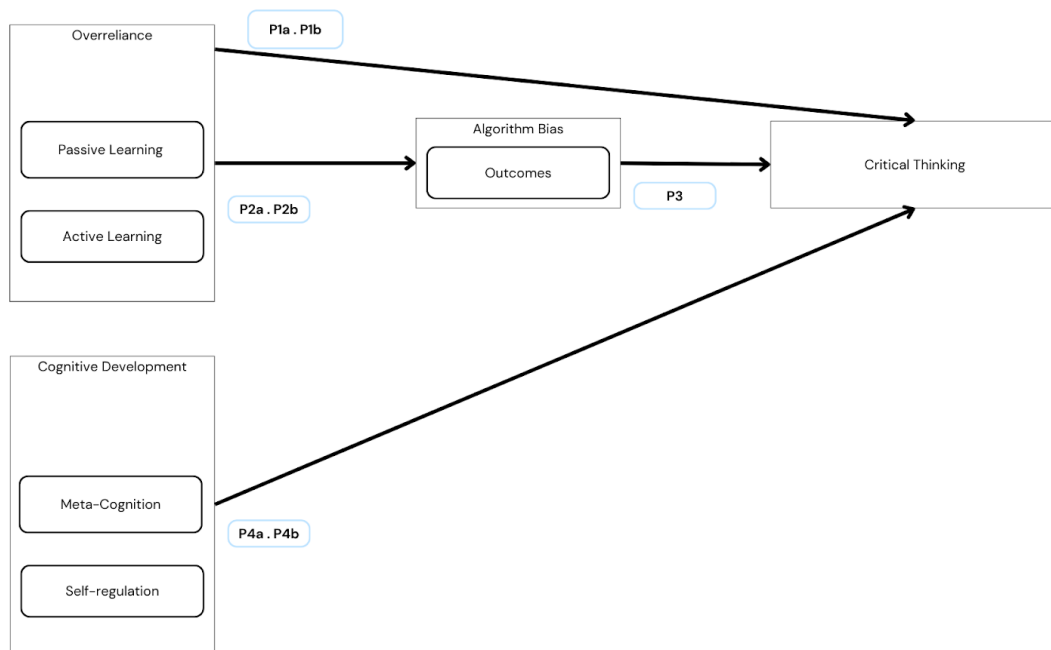


Figure 7: Critical Thinking in AIED

There are two main learning models - passive learning and active learning. The main difference between these two models is who is doing the work in order to learn. In the active learning model the students discuss the learning materials in class and work individually to form ideas, this way it is possible to start developing critical thinking skills. When it comes to the use of AIED, passive learning comes from language models who can provide fast solutions to challenges and essays. Students absorb the knowledge provided by AI tools, most of the time without checking for accuracy. This fast and easy way of learning negatively impacts CT skills. Active learning is student centered, having the student developing useful skills, and passive learning is AI centered, the students consider the information provided. These learning models are connected directly with biases, since in active learning students have the change to challenge themselves and think about them. In passive learning, biases are not confronting it, just assimilating the information that is given and using it whether it is true or false. Overreliance is what leads to passive learning with AI, students don't challenge themselves to search and engage in learning experiences.

Cognitive development, is an important learning and critical thinking skill, contains learning stages where the human can obtain, organize and be able to learn how to use this knowledge. Meta-cognition, or thinking of thinking, is when students are aware of the processes and can monitor and control them, the regulation of thoughts allows for a better understanding and problem solving capabilities. Self-regulation comes after the meta-cognition where, in this case, students can apply the previous monitored processes and control them to achieve a goal. When considering AIED to these theories, critical thinking may suffer an impact, due to the change in the way of getting information and learning. The reliance on these theories can lead

to overconfidence and the misuse of information provided by AI tools that can lead to lack of capacity of thought and analysis, another problem is the meta-cognitions processes not always being able to address algorithm bias in AI tools. The constant use of AIEd may eventually lead to a loss of cognitive skills, due to the students using less regulating and monitoring.

Data contains biased information that affects decision making processes and CT. Students are presented with information and they lack understanding of different perspectives due to the absence of critical thinking. This will perpetuate the use of incorrect information and biases, those relying on the biases will face challenges when approaching misleading narratives. Bias limit the scope of learning that students are exposed to and the outcomes provided may influence the critical thinking and decision making process, bias outcomes lead to misuse of information if the students aren't able to critically analyze what was provided by the algorithms. Critical thinking in higher education is fundamental and involves the ability of researching and analyzing, bias will affect these skills.

## **4. FOCUS GROUP – BACHELOR DEGREE VERSUS MASTER DEGREE**

Focus groups are a technique to gather qualitative data used among academics and research areas, including marketing and education to hear from groups / potential targets to learn more about them and reach their interests more effectively. According to Morgan and Krueger (1993) focus groups provide insights into complex behaviors and motivations and participants are able to question each other as well as explain their points of view to others. This type of interaction will enable valuable data and emphasize the diversity among the group.

For this study, a comparison between two groups was conducted- bachelor versus master degrees- to show evidence and specific discrepancy amongst them. The focus groups conducted consisted of structured discussions with five students of each group in a formal setting. The group size is smaller so that the participants generate higher levels of involvement, this way providing participants with more time to discuss topics and their own experiences in each they were involved.

For both focus groups a presentation of the topic was provided, with explanation of the main terms and propositions for the study. Then a set of questions were asked to the students- it is important to note that both the presentations and questions were the same for both groups.

### **4.1. SET OF QUESTIONS AND EXPLANATION APPLIED DURING THE STUDY**

Familiarity with critical thinking and artificial intelligence in education:

- 1) How would you define critical thinking and its importance in education?
- 2) Have you used artificial intelligence/language models in the context of education? If so, please describe how it has been used.

Introduction to the topic of focus group:

Critical thinking in the context of artificial intelligence in education involves the ability to evaluate and reflect on information and form arguments. The overreliance and dependence on AI tools is leading to an exponential lack of critical thinking and engagement and can limit opportunities to pursue approaches outside the scope of AI algorithms. Critical thinking is multifaceted.

More specific questions related to the constructs of the theoretical model (given a short introduction to each point before these questions)

Overreliance:

Passive Learning: How does overreliance on AI tools for fast solutions and information in education impact students' abilities to think critically or evaluate the accuracy of the knowledge provided?

Active Learning: How does active learning contribute to the development of critical thinking and the ability to identify biases present in the content?

Cognitive Development:

Meta-Cognition: How do you perceive the role of Meta-Cognition in AIEd? What challenges students may face when aware of algorithmic biases in the information provided by AI tools?

Self-Regulation: How can Self-Regulation prevent overreliance on AI tools in education and ensure that students analyze the information provided to improve their own critical thinking skills?

Algorithm Bias:

Outcomes: How does the presence of bias algorithms in AIEd outcomes impact students' abilities to develop different perspectives, and how can influence critical thinking in the decision making process? / How can universities foster a better environment for students to be able to critically analyze information for potential biases in the data?

#### **4.2. FOCUS GROUP - BACHELOR DEGREE**

The focus group comprises an interview discussing the engagement between critical thinking, artificial intelligence, and education. Participants include students from various academic backgrounds: Civil Engineering at Instituto Superior Técnico (IST); Human Resource Management at Instituto Politécnico de Setúbal; Visual and Technological Arts at Instituto Politécnico de Lisboa; Documentary Cinema at Escola Superior de Tecnologia de Abrantes.

##### **1) Defining Critical Thinking and its importance**

I. Defining Critical Thinking and its importance Respondent D.C emphasizes that developing critical thinking in students prepares them for professional and daily life by encouraging them to form and articulate their own opinions. She asserts, "Critical thinking is fundamental for personal and professional development." B.P concurs, adding that critical thinking is crucial for both personal and educational development, benefiting both students and teachers. C.S, while discussing her usage of ChatGPT, illustrates a practical application of critical thinking by comparing AI-generated solutions with her own notes to ensure accuracy. "I use AI to cross-check, not to replace my own analysis," she explains.

##### **2) AI in Education: Usage and Impacts**

Participants discuss their experiences with AI tools like ChatGPT. C.S and D.C note that while AI can provide quick answers, it is essential to question and verify these responses, particularly in fields requiring precise calculations, like C.S engineering studies. B.P and D.M also use AI, but primarily as a starting point, emphasizing the importance of reviewing and refining AI-generated content. D.C states, "AI can assist, but human verification is indispensable."

### 3) Theoretical Framework: Over-Reliance and Cognitive Development

The interviewer introduces the concept of over-reliance on AI, which can hinder the development of critical thinking. Excessive use of AI tools can lead to passive learning, where students absorb information without engaging deeply or developing problem-solving skills. This is contrasted with active learning, where students engage more directly with the material, fostering better critical thinking and cognitive skills. B.P comments, "Relying too much on AI can make students passive learners."

### 4) Challenges and Solutions in AI-Assisted Learning

The discussion shifts to the hypothetical scenario of universities adopting AI platforms that could potentially reinforce biases and limit critical thinking. D.C argues that AI should only complement study and research, advocating for a balanced approach that includes human interaction and discernment. "AI should be a supplement, not a substitute," she insists. C.S highlights the practical advantages of AI but underscores the importance of comparing AI responses with other sources to avoid over-reliance.

### 5) Active Learning vs. Passive Learning

Active learning, as described by D.M and C.S, involves direct engagement with professors and peers, which enhances critical thinking and helps identify biases in content. B.P notes that while active learning requires more effort, it leads to a deeper understanding and retention of knowledge. "Active learning promotes a deeper grasp of subjects," he observes. In contrast, passive learning, which often involves copying AI-generated answers without scrutiny, can lead to superficial understanding and diminished critical thinking skills.

### 6) Metacognition and Self-Regulation in AI Use

Metacognition, the ability to monitor and control one's cognitive processes, is crucial when using AI in education. C.S views AI as a tool similar to slides or study groups, emphasizing the need to evaluate its reliability actively. Self-regulation helps prevent over-reliance on AI by fostering a healthy skepticism and the habit of verifying information independently. "AI is just another tool; it requires critical oversight," C.S notes.

### 7) Algorithmic Biases and Developing Different Perspectives

Participants discuss the impact of biased algorithms on students' ability to develop diverse perspectives. D.C warns that reliance on AI might impair decision-making skills in professional

settings. "Biases in AI can shape and limit our viewpoints," she cautions. H.C adds that students accustomed to quick AI solutions may struggle to apply theoretical knowledge in practical scenarios. B.P points out that AI often provides repetitive answers, which can stifle the development of different viewpoints. "AI can narrow our thinking if we're not careful," he reflects.

#### 8) Promoting Critical Analysis in Universities

The conversation concludes with suggestions for universities to foster environments that promote critical thinking and the identification of algorithmic biases. B.P suggests using AI detection tools and educating students on the advantages and disadvantages of AI. "Awareness of AI's limits should be part of the curriculum," he advises. H.C and D.C propose creating university-specific AI platforms that integrate with existing academic resources while encouraging traditional study methods. C.S advocates for more interactive teaching methods that challenge students to think critically and independently. "Interactive learning fosters critical analysis and independent thinking," she emphasizes.

In summary, the discussion highlights the critical balance required in integrating AI into education. While AI can be a valuable tool, its overuse can obstruct the development of critical thinking and lead to passive learning. Universities should aim to promote active learning and critical analysis, ensuring that AI serves as a complement rather than a replacement for traditional educational methods.

### 4.3. FOCUS GROUP - MASTER DEGREE

The dialogue among the participants provides a comprehensive exploration of critical thinking and the use of artificial intelligence in education. The conversation touches on definitions, practical applications, and the potential consequences of AI integration in educational contexts.. Participants include students from various academic backgrounds: Criticism, Curation, and Art Theories at the Faculty of Fine Arts; Tourism and Strategic Event Management at ESHTe (School of Hospitality and Tourism of Estoril); Clinical Psychoanalytic Psychology at ISPA (Instituto Universitário de Ciências Psicológicas, Sociais e da Vida); Clinical Psychology at ISPA; Fashion Design at the Faculty of Architecture.

#### 1) Defining Critical Thinking and its importance

I.F defines critical thinking as a "tool for success," emphasizing its necessity for producing high-quality work. L.L adds that critical thinking is crucial in group work to foster better development and success. M.F critiques the traditional education system's focus on memorization, advocating for critical thinking to challenge and evaluate received information: "the education we have is very much about memorizing material and then regurgitating it."

These perspectives underline the fundamental role of critical thinking in education, moving beyond rote learning to engage students in deeper analysis and understanding.

## 2) Use of Language Models in Education

R.F uses Chat GPT to enhance the academic correctness of his writing but cautions against over-reliance: "I ask it only to make it more academically correct." M.S finds Chat GPT helpful for outlining assignments but stresses the importance of verifying the information: "I ask Chat GPT about the topic and then it gives points and I see, then cover all those points in the assignment." L.L expresses skepticism about the accuracy of information provided by Chat GPT, emphasizing the need for independent verification: "I've seen many times that the information Chat GPT provides is wrong."

These reflections illustrate the practical applications of AI tools while highlighting the necessity of critical engagement with the content provided by such technologies.

## 3) Hypothetical Scenario: AI Platforms in Universities

When discussing a hypothetical AI platform that adapts study material but reinforces biases, I.F acknowledges both potential benefits and drawbacks, particularly concerning biases related to "age, gender determination, or even racial prejudices." L.L underscores the importance of critical thinking to counteract these biases, sharing an example of a colleague overly reliant on Chat GPT for personal reflections: "I was completely shocked. How are you using Chat GPT to do this exercise that must be done with your critical thinking?"

M.S and M.F both highlight the potential risks of limiting critical thinking abilities through over-reliance on AI, emphasizing the need for AI to serve as a complementary tool rather than a substitute for personal engagement and analysis.

## 4) Overreliance on AI and its Impact on Critical Thinking

R.F links over-reliance on AI to passive acceptance of information: "If we have too much confidence in artificial intelligence tools, then we'll accept everything they tell us without critically thinking." M.F points out that the nature of teaching can either encourage or discourage critical thinking: "Some teachers encourage this type of learning where they have classes where they just lecture and don't interact much." L.L suggests that active learning, such as literature reviews and research, fosters critical thinking by exposing students to diverse perspectives and requiring independent analysis.

## 5) Cognitive Development: Metacognition and Self-regulation

Discussing metacognition, M.S and R.F emphasize the importance of monitoring and questioning AI-provided information to avoid biases. M.F and I.F stress the need for self-regulation to prevent overconfidence in AI tools, advocating for a balanced approach that incorporates AI as a supportive rather than dominant resource.

L.L notes the limitations of AI in providing up-to-date and in-depth information, which can impact decision-making and critical analysis.

#### 6) Addressing Algorithmic Biases

Participants agree that algorithmic biases in AI tools can reinforce confirmation bias and limit perspectives. M.F explains, "the problem with the algorithm in the GPT chat is the problem with all algorithms they use. They basically contribute to confirmation bias." L.L and M.S provide examples of AI generating false or incomplete information, highlighting the necessity of critical evaluation.

#### 7) Promoting a Better Educational Environment

To foster critical analysis, participants suggest several strategies. I.F advocates for teacher encouragement of independent learning and debates to engage students actively. L.L recommends designing assignments that require personal opinions and critical evaluations to reduce reliance on AI. M.F agrees but warns that some students might still use AI even for subjective tasks, highlighting the need for more robust academic integrity measures.

The discussion among the participants underscores the dual role of AI in education as both a helpful tool and a potential hindrance to critical thinking. By integrating critical thinking into educational practices and encouraging active engagement with learning materials, educators can mitigate the risks of over-reliance on AI. This dialogue provides valuable insights into the complex interplay between critical thinking and AI in education, offering a nuanced perspective.

## 5. RESULTS AND DISCUSSION OF THE FOCUS GROUPS

Bachelor Degree:

The discussion on the interplay between critical thinking and artificial intelligence in education reveals diverse student perspectives. Critical thinking, essential for forming well-reasoned arguments, is crucial for preparing students for professional and daily life. D.C emphasizes that engaging students in discussions and encouraging them to develop their opinions readies them for future challenges. B.P highlights its mutual benefits, fostering growth for both students and teachers. C.S acknowledges AI tools like ChatGPT's utility but stresses the necessity of verifying AI-provided information against reliable sources.

Concerns about over-reliance on AI tools were discussed. D.C suggests that such dependence can diminish autonomy, creativity, and logical reasoning. D.M and H.C note that over-reliance might lead students to accept AI-generated information without critical analysis, potentially resulting in incorrect answers. H.C shares an example where students using ChatGPT for quick answers end up with erroneous responses, underscoring the risks of passive learning.

Active learning is praised for fostering critical thinking and identifying biases. C.S and D.M argue that active learners engage more deeply with material, seeking answers from professors and peers, which enhances understanding and critical evaluation skills. B.P illustrates this with an analogy: if ChatGPT erroneously claims an orange is green, active learners would recognize the mistake, while passive learners might accept it unquestioningly. D.C concurs, stating that active engagement promotes independent thinking.

Metacognition and self-regulation are critical components of cognitive development in the context of AI in education. C.S views AI tools as additional resources that require critical evaluation for reliability. She suggests that students practicing metacognition will naturally question AI-provided information. D.M points out that many students lack the ability to critically analyze AI responses, leading to overconfidence in incorrect information. B.P highlights the importance of context and specificity when using AI tools, noting that general queries often yield less accurate results.

Self-regulation is essential in preventing over-reliance on AI. C.S argues that healthy skepticism towards AI tools can naturally limit dependence, while B.P emphasizes the need for critical thinking in analyzing AI-generated responses. D.C highlights the importance of using AI judiciously, integrating it as a complement rather than a replacement for thorough research and personal effort.

Algorithmic biases and their impact on students' ability to develop different perspectives were addressed. D.C and H.C warn that over-reliance on biased algorithms can impair decision-making skills in professional contexts. B.P and C.S add that AI tools, often providing repetitive or outdated information, can limit the development of diverse perspectives. C.S contrasts this

with the dynamic, interactive learning environment provided by human teachers, who can tailor explanations based on student feedback.

B.P and D.C propose that professors educate students about the pros and cons of AI tools and implement detection mechanisms for AI-generated content. H.C suggests developing university-specific AI platforms that provide reliable information and direct students to professors for further guidance. C.S emphasizes the need for a balanced approach, using AI as an additional resource while fostering human interaction and collaborative learning. D.M and D.C advocate for leveraging diverse resources and encouraging self-regulation to enhance critical thinking.

Finally, the group explored ways universities could promote a better environment for critical analysis. Suggestions included integrating AI tools designed by universities, providing guidance on the advantages and disadvantages of AI, and encouraging active engagement in classrooms. H.C suggested creating university-specific AI platforms to offer reliable information while still directing students to human professors when needed. D.C emphasized the need for professors to be trained in recognizing AI-generated work and promoting discussions about AI use in education. C.S and B.P advocated for fostering students' confidence in their abilities to reduce over-reliance on AI.

In summary, the focus group highlighted the dual nature of AI in education. While AI can support learning and stimulate critical thinking, over-reliance on these tools can lead to passive learning and hinder the development of essential cognitive skills. The participants underscored the importance of active learning, metacognition, and self-regulation in mitigating the potential negative impacts of AI on critical thinking. They also emphasized the role of educators and institutions in guiding students to use AI responsibly and effectively.

Master Degree:

Critical thinking, defined as the ability to analyze and evaluate information to form reasoned judgments, is crucial in education. It ensures students actively engage with content, assess its validity, and develop well-supported conclusions. I.F views it as a tool for success, enhancing work quality. L.L emphasizes its importance in group work, aiding idea development, while M.F notes it helps students move beyond mere memorization.

Regarding AI tools like Chat GPT, R.F uses it to refine his writing but doesn't rely entirely on its outputs. M.S finds it useful for assignments but stresses the importance of verifying its information. L.L shares her wariness about its accuracy, highlighting the need for verification.

In a hypothetical scenario where a university adopts an AI platform, I.F sees benefits, especially for students with attention deficits, but warns of risks like reinforcing biases. L.L stresses critical thinking to counter these biases, sharing an example of a classmate overly reliant on Chat GPT. M.S and M.F agree that over-reliance can diminish critical thinking, leading to passive learning.

The discussion highlights the impact of AI on learning. R.F notes that over-reliance leads to accepting information without critical evaluation, problematic given the prevalence of misinformation. M.F adds that teaching styles influence learning types, with lecture-heavy classes often resulting in passive learning.

Active learning is essential for developing critical thinking. L.L explains that research tasks require credible sources and in-depth analysis, which AI cannot provide. I.F emphasizes that critical evaluation is necessary to identify biases and errors.

The role of metacognition in AI and recognizing algorithmic biases is discussed. M.S mentions that metacognition involves questioning AI information. R.F adds that doubting AI outputs is crucial for critical thinking. M.F highlights that AI often presents information without context, requiring students to think critically about its validity.

Self-regulation helps prevent overconfidence in AI tools. M.F suggests self-discipline helps students use AI appropriately. RF and M.S agree, noting that self-regulation involves controlling AI usage to complement critical thinking.

Participants expressed concern about AI's accuracy and reliability. Instances of incorrect AI-generated information underscore the need for critical evaluation. Over-reliance on AI tools was seen as a risk to developing critical thinking skills. Passive learning, where students accept AI information without scrutiny, can erode their ability to think independently.

Active learning fosters critical thinking by encouraging deep engagement with content, multiple perspectives, and personal analysis. This helps students identify biases in AI information, promoting nuanced understanding.

Metacognition and self-regulation are essential for critical thinking in AI contexts. Metacognition involves awareness of cognitive processes, enabling students to adjust learning strategies. Self-regulation ensures students critically evaluate AI information.

Concerns about algorithmic biases in AI tools were addressed. Participants noted that AI might reinforce existing biases, limiting diverse perspectives. They emphasized the need for educational institutions to teach students how to critically analyze AI content.

To promote critical thinking and mitigate AI reliance risks, participants suggested educational institutions should:

1. Encourage active learning through interactive and discussion-based classes.
2. Design assignments requiring personal reflection and critical analysis.
3. Foster deep engagement with learning materials.
4. Implement tools to detect AI-generated content.

5. Provide training on recognizing and counteracting AI biases.

Integrating AI in education presents opportunities and challenges. While AI tools can support learning, judicious use is necessary to avoid undermining critical thinking skills. Educational institutions play a crucial role in guiding students to use AI tools effectively while maintaining a critical, reflective approach to learning.

## 6. CONCLUSIONS, LIMITATIONS AND FUTURE RESEARCH

The study explored the intersection of critical thinking and artificial intelligence in education, specifically focusing on the application of AI tools like ChatGPT in higher education. The findings revealed that while AI has significant potential to enhance learning experiences, there are notable concerns regarding its ethical use, impact on critical thinking skills, and potential for misuse in academic settings. The research emphasized the importance of integrating AI in a way that promotes critical thinking and ethical considerations, ensuring that students not only use AI effectively but also understand its limitations and potential biases.

The study faced several limitations. First, the rapidly evolving nature of AI technology means that some findings may become outdated quickly as new developments emerge. Second, the focus groups were limited in size and scope, which may not fully represent the diverse perspectives of all students and educators. Third, the study relied on qualitative data, which, while rich in detail, may not provide the generalizability that quantitative data could offer. Additionally, the potential biases in participant responses and the researcher's interpretation of qualitative data could affect the study's conclusions.

Future research should expand the scope of study to include a larger and more diverse sample size, encompassing different educational contexts and levels. Longitudinal studies could provide deeper insights into the long-term effects of AI on critical thinking skills. Quantitative research methods could be employed to complement qualitative findings, offering a more comprehensive understanding of the impact of AI in education. Furthermore, exploring the development of specific pedagogical frameworks that integrate AI while fostering critical thinking and ethical awareness is recommended.

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# APPENDIX A

Dear Ana Filipa da Silva  
Dear Professor Mijail Naranjo,

Thank you for filling in the Research Ethics Checklist. After reviewing your request, you can proceed with the study we do not foresee any major ethical concerns with the project.

Project No.: **DDMKT2024-7-148878**

Project Title: **Critical Thinking and Artificial Intelligence in Education**

Principal Researcher: **Ana Filipa Andrade da Silva**

according to the regulations of the Ethics Committee of NOVA IMS and MagIC Research Center this project was considered to meet the requirements of the NOVA IMS Internal Review Board, being considered **APPROVED** on 18/07/2024.

It is the Principal Researcher's responsibility to ensure that all researchers and stakeholders associated with this project are aware of the conditions of approval and which documents have been approved.

The Principal Researcher is required to notify the Ethics Committee, via amendment or progress report, of

- Any significant change to the project and the reason for that change;
- Any unforeseen events or unexpected developments that merit notification;
- The inability of the Principal Researcher to continue in that role or any other change in research personnel involved in the project.

Lisbon, 18/07/2024

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