Díaz-Noguera, M.ª D., Hervás-Gómez, C., & Sánchez-Vera, F. (Coords.) (2024). *Artificial Intelligence and Education: Enhancing Human Capabilities, Protecting Rights, and Fostering Effective Collaboration Between Humans and Machines in Life, Learning, and Work.* Octaedro. https://doi.org/10.36006/09643-1
ISBN: 978-84-10282-45-2

M. Dolores Díaz-Noguera
Carlos Hervás-Gómez
Fulgencio Sánchez-Vera
(Coords.)

# Artificial Intelligence and Education

## Enhancing Human Capabilities, Protecting Rights, and Fostering Effective Collaboration between Humans and Machines in Life, Learning, and Work

Horizontes Universidad

Octaedro

# Artificial Intelligence and Education

## Enhancing Human Capabilities, Protecting Rights, and Fostering Effective Collaboration between Humans and Machines in Life, Learning, and Work

M. Dolores Díaz-Noguera
Carlos Hervás-Gómez
Fulgencio Sánchez-Vera
(Coords.)

# Artificial Intelligence and Education

## Enhancing Human Capabilities, Protecting Rights, and Fostering Effective Collaboration between Humans and Machines in Life, Learning, and Work

Díaz-Noguera, M.ª D., Hervás-Gómez, C., & Sánchez-Vera, F. (Coords.) (2024). *Artificial Intelligence and Education: Enhancing Human Capabilities, Protecting Rights, and Fostering Effective Collaboration Between Humans and Machines in Life, Learning, and Work*. Octaedro. https://doi.org/10.36006/09643-1
ISBN: 978-84-10282-45-2

Octaedro

Collection Horizontes-Universidad

Title: *Artificial Intelligence and Education: Enhancing Human Capabilities, Protecting Rights, and Fostering Effective Collaboration between Humans and Machines in Life, Learning, and Work*

First published: november 2024



© From this edition:
Ediciones OCTAEDRO, S.L.
C/ Bailén, 5 – 08010 Barcelona
Tel.: 93 246 40 02
octaedro@octaedro.com
www.octaedro.com



ISBN: 978-84-10282-45-2
DOI: https://doi.org/10.36006/09643-1

Typeset by: Fotocomposición gama, sl
Production: Octaedro Editorial

Open Access

# Summary

Díaz-Noguera, M.ª D., Hervás-Gómez, C., & Sánchez-Vera, F. (Coords.) (2024). *Artificial Intelligence and Education: Enhancing Human Capabilities, Protecting Rights, and Fostering Effective Collaboration Between Humans and Machines in Life, Learning, and Work.* Octaedro. https://doi.org/10.36006/09643-1
ISBN: 978-84-10282-45-2

Díaz-Noguera, M.ª. D., Hervás-Gómez, C., & Sánchez-Vera, F. (Coords.) (2024). *Artificial Intelligence and Education: Enhancing Human Capabilities, Protecting Rights, and Fostering Effective Collaboration Between Humans and Machines in Life, Learning, and Work.* Octaedro. https://doi.org/10.36006/09643-1
ISBN: 978-84-10282-45-2

Díaz-Noguera, M.ª. D., Hervás-Gómez, C., & Sánchez-Vera, F. (Coords.) (2024). *Artificial Intelligence and Education: Enhancing Human Capabilities, Protecting Rights, and Fostering Effective Collaboration Between Humans and Machines in Life, Learning, and Work*. Octaedro. https://doi.org/10.36006/09643-1
ISBN: 978-84-10282-45-2

# Prologue

At the intersection of emerging technology and the educational horizon, *Artificial Intelligence and Education: Enhancing Human Capabilities, Protecting Rights, and Fostering Effective Collaboration between Humans and Machines in Life, Learning, and Work* is unveiled as an enlightening work. This book transcends the mere analysis of artificial intelligence (AI) as a technological tool, to explore its role as a catalyst in transforming education, enhancing accessibility, and promoting digital well-being.

Through its meticulously selected and articulated chapters, the work invites readers to dive into a deep and varied exploration of how AI is redefining the contours of education and learning. From analyzing AI training programs for college students to assessing future teachers' attitudes and perceptions of AI, each section offers unique perspectives and expansive horizons on the intersection of technology and pedagogy.

The book addresses the responsible implementation of AI as a tool for educational transformation, emphasizing the importance of protecting rights and promoting digital well-being. By exploring the use of AI tools to enhance education accessibility for people with disabilities, the inclusive potential of technology is highlighted. The implementation and evaluation of a chatbot designed to enhance inclusive learning through Universal Design for Learning emphasizes the need for innovative pedagogical approaches that align with the capabilities and needs of all students.

The work also delves into the social impact of AI, examining its use in the educational process and its association with personality traits among college students. The exploration of AI in digital learning contexts, including assessing the emotional and pedagogical impact of historical simulations through ChatGPT, offers a window into the pedagogical possibilities of technology.

Furthermore, training GPT as a standardized patient and using AI to assess cognitive complexity in didactic tasks reflect the versatility of AI in educational settings. The application of new technologies to enhance human anatomy learning demonstrates the untapped potential of AI in specific areas of knowledge.

*Artificial Intelligence and Education* is not merely a book about the convergence of technology and pedagogy but also a call to educators, technology developers, students, and policymakers. This work challenges us to reflect on the ways in which we can employ artificial intelligence to not only optimize and revolutionize teaching methods but also to enrich the human experience as a whole, safeguard essential rights, and foster effective and ethical synergy between humans and intelligent systems.

This book is an invitation to imagine a future where AI and education coexist in harmony, enhancing human capabilities and opening new pathways for learning and work in the digital age. It challenges us all to actively participate in shaping this future, ensuring that technology serves as a bridge to a more inclusive, fair, and humane world.

# 1

# Impact of Artificial Intelligence on Academic Integrity: Perspectives of Faculty Members in Spain

Fulgencio Sánchez-Vera
Universidad de la Laguna, Spain
fsanchev@ull.edu.es
https://orcid.org/0000-0002-0697-9120

Inmaculada Perdomo Reyes
Universidad de La Laguna, Spain
mperdomo@ull.edu.es
https://orcid.org/0000-0003-4838-7278

Betty Estévez Cedeño
Universidad de la Laguna, Spain
bestevec@ull.edu.es
https://orcid.org/0000-0002-1590-952X

**Abstract**
This chapter delves into the growing role of artificial intelligence (AI) within the context of academic integrity, focusing on the perceptions of university faculty in Spain. It highlights the importance of AI tool training for educators, illustrating how such training can not only enhance teaching and learning processes but also address ethical challenges related to using advanced technologies. Through a descriptive methodology based on survey data collection, the study uncovers a significant gap in understanding and effectively applying AI in educational settings, emphasizing the urgency for implementing specific training programs. Furthermore, the ethical implications of AI use, such as plagiarism, are discussed, proposing comprehensive strategies to prevent academic dishonesty. This analysis demonstrates the need for ongoing dialogue between technology and ethics, advocating for a more conscious and responsible integration of AI in higher education.

https://doi.org/10.36006/09643-1-01 

**Keywords:** Artificial Intelligence, academic integrity, higher education, faculty training, AI ethics, plagiarism prevention.

## 1.1. Introduction

The phenomenon of digitalization, together with the emergence of generative artificial intelligence (GAI), constitutes a formidable challenge for teaching and learning paradigms within higher education. Despite the obvious advantages and promising perspectives, they offer, these technological advances introduce profound complexities in terms of academic integrity, an indispensable cornerstone in the construction and dissemination of knowledge (Cotton, Cotton & Shipaway, 2023; Liao, Palvia & Lin, 2021; UNESCO, 2019b). In this scenario, teacher training for the effective and ethical use of AI becomes an essential component to maximize the educational benefits of these tools while simultaneously mitigating the risks associated with their implementation.

UNESCO (2019a, 2021b) emphasizes the need for a deep understanding of how AI can support learning objectives without compromising academic ethics and intended learning outcomes. Thus, the organization sees AI's potential to address some of today's education challenges: innovating teaching-learning practices and advancing towards achieving Sustainable Development Goal 4, which aims to ensure inclusive, equitable quality education and promote lifelong learning opportunities for all. However, it is also crucial to acknowledge that the impact of AI in Education presents various facets and challenges. Research by Tal Waltzer et al. (2023) offers a critical view of the ethical implications of AI in the educational context, highlighting the increasingly present dilemma between innovation and ethics in university classrooms. This theoretical discussion underscores the importance of developing pedagogical strategies and institutional policies that balance these aspects.

The analysis of AI's role in promoting academic integrity has gained increasing relevance. Studies like those by Rodriguez et al. (2023) and Dupps (2023) explore how advanced tools can assist in plagiarism detection and the maintenance of academic integrity, while research by Chan (2023) introduces the term "AI-giarism", highlighting the need to develop effective strategies against this form of academic dishonesty.

The relationship between AI and plagiarism is inherently complex (Sarkar, 2023; Yeo, 2023; Quidwai, Chunhui and Dube, 2023). On the one hand, AI serves a facilitating role that naturally integrates into academic practices; recent research suggests that plagiarism of AI-generated content is perceived as less unethical (Longoni, Tully, and Sharif, 2023). On the other hand, it acts as a control tool; studies like that by Santra (2023) propose an AI vs. AI showdown in plagiarism detection, moving towards more sophisticated systems for identifying plagiarized content. Therefore, to combat plagiarism and promote academic integrity, it is crucial to integrate AI tools with pedagogical approaches, in order to leverage their facilitative value in the learning experience while reinforcing academic integrity.

It is essential to highlight the importance of focusing efforts on education about the ethical use of artificial intelligence (AI) and its application to preserve the authenticity and educational value of academic activities. The studies conducted by Sullivan et al. (2023) and Perkins (2023) emphasize the urgency of adapting educational policies to effectively address the various challenges and opportunities arising from the integration of AI in higher education.[1]

In this study we aimed to explore and analyze the perceptions and experiences of faculty members in Spain about the impact of Artificial Intelligence on academic integrity, focusing especially on the prevention and detection of plagiarism. We sought to understand how educators perceive the relationship between AI and academic ethics, identifying both the benefits and challenges that this technology introduces in the context of higher education, and evaluate current strategies used to integrate AI into teaching practices.

## 1.2. Methodology

In this research, a descriptive methodology was used with the purpose of analyzing the perceptions and opinions of faculty

1. UNESCO's Recommendation on the Ethics of Artificial Intelligence (2021b) is an essential reference, as is the Beijing Consensus on Artificial Intelligence and Education (2019b) and the guide on Artificial Intelligence and education for those responsible politicians (UNESCO,2021a).

members in Spain about AI and the challenges it presents for higher education. The methodological approach was designed to obtain a detailed and systematic view of teachers' attitudes and views in this specific context. The main methodological aspects of the research are described below:

- Survey design: A structured questionnaire was designed, addressing relevant aspects related to the faculty's perception of AI and its impact on university education. The questionnaire was constructed with reference to existing academic literature and adapted to the characteristics and needs of the target population, Spanish university faculty. The design was validated by a group of experts comprising specialists in AI, in educational research methodologies, and in the sociology of education.
- Sample selection: In Spain, for the 2021-22 academic year, the teaching and research staff comprised 133,484 faculty members, thus the sample considered 95% confidence margin and 9% margin of error. The target population were faculty members of different disciplines and categories recognized in the Spanish university. The sample was selected through an open invitation to participate in the survey, without stratified restrictions. A total of 140 responses were received from faculty members from various areas of knowledge and different public and private academic institutions, which, after screening, amounted to 135. The stratification was as follows: 74 women and 61 men, from 16 universities.
- Data collection: The survey was administered online through a digital platform, allowing participants to respond conveniently. The responses were obtained by inviting the teachers to participate voluntarily.
- Data analysis: For data analysis, descriptive statistical techniques were used. In addition, statistical software tools were used to process and visualize the results effectively.
- Ethical considerations: Informed consent was obtained from all participants, and the confidentiality of their responses was guaranteed. The study was conducted in compliance with the applicable ethical and legal standards in research with human beings. The survey was reviewed and validated by the Research Ethics and Animal Welfare Committee of the University of La Laguna.

This framework proposes an inclusive strategy, inviting faculty members from a wide range of disciplines and universities in Spain to participate without applying stratified restrictions. While this approach might introduce some variability in the representativeness of the sample, it is important to recognize its potential to capture a wide diversity of perspectives and experiences. This approach allows us to obtain a valuable preliminary insight into the perceptions and opinions of the faculty, establishing a starting point for future research.

## 1.3. Results and discussion

We break down our analysis into three sections that we determine are critical to appreciating both the opportunities and challenges introduced by AI in academia. The first section explores faculty training in AI tools, as this is an imperative for the effective integration of this technology in the teaching and learning processes, and for the promotion of academic integrity. The second section delves into the risks associated with implementing AI in education, especially as it relates to plagiarism, examining how, despite its advantages, AI can facilitate dishonest academic behavior. Through the analysis of the risks and benefits indicated by faculty, we sought to understand how to use AI in a way that it promotes academic integrity without undermining educational quality. Finally, in the last section, we discuss the strategies used to prevent plagiarism in student work and how educators can prepare to detect the use of AI among students, thus ensuring the preservation of academic integrity.

### Teacher education: experience and training

In the survey conducted, we investigated teachers' knowledge and mastery of a variety of artificial intelligence tools. Table 1.1 presents the responses, providing valuable information about the extent of these skills among educators.

**Table 1.1.** Experience with AI tools

| Application | Women | Men | Total |
|---|---|---|---|
| Conversational AI | 73.77% | 76.00% | 75.00% |
| AI that transforms text into scientific reasoning | 1.64% | 1.33% | 1.47% |
| AI for literary writing | 31.15% | 26.67% | 28.68% |
| AI for medical advice | 0.00% | 5.33% | 2.94% |
| Creating travel itineraries | 8.20% | 6.67% | 7.35% |
| Extracting information from documents | 21.31% | 24.00% | 22.79% |
| Translation | 75.41% | 72.00% | 73.53% |
| Image editing | 0.00% | 8.00% | 4.41% |
| Artistic creation from texts | 11.48% | 28.00% | 20.59% |
| From text to video | 6.56% | 6.67% | 6.62% |
| From text to 3D | 0.00% | 1.33% | 0.74% |
| From text to code | 1.64% | 12.00% | 7.35% |
| From text to spoken speech | 1.64% | 8.00% | 5.15% |
| From spoken speech to spoken speech: voice imitators | 0.00% | 2.67% | 1.47% |
| From spoken speech to text | 1.64% | 12.00% | 7.35% |
| From images to texts | 1.64% | 0.00% | 0.74% |
| From video to text | 0.00% | 2.67% | 1.47% |
| From text to music | 1.64% | 1.33% | 1.47% |
| Music editing | 3.28% | 4.00% | 3.68% |

Source: developed by authors.

Table 1.1 reveals a high valuation of tools that facilitate communication and access to information in different languages, with conversational AI and translation tools standing out in particular, with 75% and 73.53% total usage, respectively.

On the other hand, certain AI tools show very low adoption, such as AI that transforms text into scientific reasoning and the conversion of text to 3D, with only 1.47% and 0.74% usage, respectively. This could indicate a perception of lesser practical relevance or a lack of knowledge about these applications among teachers. However, there is moderate interest in creative and productivity applications, such as literary writing, extracting infor-

mation from documents, and artistic creation from texts, underscoring the potential seen in AI to facilitate creative tasks and information management.

Regarding gender distribution, participation in the use of AI tools shows variability between men and women, with areas of significant disparity suggesting unequal preference or access. For example, in artistic creation from texts, a higher male participation was observed. Moreover, certain tools were not used by the surveyed women. Despite these differences, in applications such as conversational AI, nearly equal participation between genders was noted, indicating areas of inclusion and equity in the use of these technologies.

This analysis reflects a complex panorama of how AI tools are being integrated into the educational field, with clear preferences towards applications that support communication and access to information, while identifying opportunity areas to increase awareness and training in less used AI tools. The gender distribution in the adoption of these tools also underscores the need to investigate and address the barriers that limit equitable participation in the use of AI.

When teachers were asked about the specific AI training they had received, the data revealed a concerning scenario. The percentage distribution of the training received is presented below (Table 1.2).

**Table 1.2.** Training received

| Training received | Women | Men | Total |
|---|---|---|---|
| No, I have not received | 70.49% | 77.33% | 74.26% |
| Yes, quite a bit | 4.92% | 1.33% | 2.94% |
| Yes, but insufficient | 24.59% | 21.33% | 22.79% |

Source: developed by authors.

As is evident from the data, a substantial majority of educators, comprising 70.49% of women and 77.33% of men, had not received any form of AI training. This disparity underscores a notable deficiency in the preparation required for effective AI integration within educational contexts.

Conversely, a minority of faculty members, representing 4.92% of women and 1.33% of men, reported having received

extensive AI training. However, despite this, the overall percentage of educators equipped with comprehensive training remains strikingly low, standing at merely 2.94%.

Moreover, a significant segment of the teaching cohort, encompassing 24.59% of women and 21.33% of men, admits to receiving some level of AI training but deems it insufficient. This underscores the urgent imperative for educational institutions to enhance existing AI training initiatives, ensuring that educators are adequately equipped with the requisite skills for proficient AI integration into their teaching methodologies.

## Ethical challenges

The analysis of faculty responses regarding the risks associated with AI education highlights a diversity of concerns. The following table provides a detailed breakdown of these perceived risks, highlighting notable differences in the perspectives of men and women (Table 1.3).

**Table 1.3.** Risk of AI education

| Type of risk | Women | Men | Total |
|---|---|---|---|
| Displacement of teachers | 3.28% | 9.33% | 6.62% |
| Plagiarism | 29.51% | 44.00% | 37.50% |
| Overuse of technology | 14.75% | 2.67% | 8.09% |
| Access to technology gap | 27.87% | 32.00% | 30.15% |
| Algorithmic discrimination | 16.39% | 14.67% | 15.44% |
| Digital skills gap to use AI | 32.79% | 20.00% | 25.74% |
| Excessive dependence on technology | 32.79% | 42.67% | 38.24% |
| Lack of transparency of its decisions | 11.48% | 29.33% | 21.32% |
| Loss of important skills | 45.90% | 46.67% | 46.32% |
| Privacy and data security | 31.15% | 28.00% | 29.41% |
| Biases | 29.51% | 28.00% | 28.68% |
| I do not perceive medium-term risks | 1.64% | 0.00% | 0.74% |

Source: developed by authors.

Table 1.3 shows that plagiarism is considered one of the main risks by the faculty members, with 37.5% of respondents indicating this concern. This percentage demonstrates the perception that AI tools can facilitate dishonest practices. The loss of critical skills (46.32%) and the excessive dependence on technology (38.24%) are also worrying aspects, but in terms of academic integrity, it is plagiarism that stands out as a particularly relevant challenge.

Addressing this concern involves developing strategies for the detection and sanctioning of plagiarism, but also preventive measures. This includes integrating ethical principles into the educational curriculum, promoting a deep understanding of intellectual property, and cultivating critical skills that allow students and faculty members to evaluate and create content responsibly and originally.

Moreover, the response requires multidisciplinary collaboration, involving technologists, educators, and legislators, to create a framework that not only addresses the consequences of plagiarism but also fosters a culture of honesty and respect for intellectual property. This joint effort can include the development of more sophisticated plagiarism detection technologies, the implementation of educational policies that emphasize originality and ethics in academic work, and the creation of training programs for teachers and students on the ethical use of AI.

In the inquiry regarding the advantages that artificial intelligence contributes to the academic assignment preparation process, the faculty's responses exhibit a complex and varied perspective, as detailed in Table 1.4.

**Table 1.4.** Benefits of AI for completing assignments

| Response | Men | Women | Total |
|---|---|---|---|
| Depends on the type of work | 88.52% | 61.33% | 73.53% |
| Not sure | 1.64% | 10.67% | 6.62% |
| No, never | 16.39% | 5.33% | 10.29% |
| Yes, always | 16.39% | 4.00% | 9.56% |

Source: developed by authors.

The responses reveal that a majority of teachers, 88.52% of men and 61.33% of women, agree that the effectiveness of AI in education is contingent on the specific type of academic task. This stance suggests a careful valuation of the technology, emphasizing the importance of applying it in a way that aligns with specific pedagogical objectives.

A significant difference was detected regarding uncertainty about the benefits of AI, with 10.67% of women showing indecision, in contrast to only 1.64% of men. On the other hand, a higher percentage of men (16.39%) expressed a negative stance towards the incorporation of AI in academic tasks, compared with 5.33% of women. The unconditional acceptance of AI as a pedagogical tool turns out to be less common, with small fractions of both genders (16.39% of men and 4.00% of women).

This spectrum of responses underscores the predominance of an attitude that considers the specific context in the application of AI in academia, while revealing significant variations in the level of certainty and openness towards the technology between men and women. Collectively, these findings reinforce the need for a reflective and adaptive approach towards the integration of AI in the educational realm, promoting a balance between innovative possibilities and ethical and pedagogical considerations.

To the question of whether AI for academic work can encourage plagiarism, the responses offer an insightful view into the ethical and practical implications of this technology in the field of education (Table 1.5).

**Table 1.5.** Perceptions on AI and the promotion of plagiarism in academic works

| | Women | Men | Total |
|---|---|---|---|
| I'm not sure. | 8.20% | 2.67% | 5.15% |
| No, I don't think it encourages plagiarism. | 3.28% | 2.67% | 2.94% |
| Yes, definitely. | 45.90% | 48.00% | 47.06% |
| Maybe, depends on the type of work. | 42.62% | 46.67% | 44.85% |

Source: developed by authors.

The data show that a significant majority of the surveyed participants believe that the use of AI in academic work can encour-

age plagiarism, either definitively (47.06%) or depending on the type of work (44.85%). A smaller number of educators are not sure or do not believe that AI encourages plagiarism in academic work.

This concern reflects an awareness of the possible ethical and practical implications of using AI in education, particularly in relation to plagiarism. These responses suggest the need for clear guidelines, education on the ethical use of AI, and effective tools to detect and prevent plagiarism in the academic context. The ambivalence or uncertainty of some educators also underlines the importance of further discussion and training on the issue.

A pertinent issue examined was how often faculty members encounter plagiarism in student assignments. When questioned on this matter, we received a wide array of responses, which are documented in Table 1.6:

**Table 1.6.** Detection of plagiarism cases in student assignment

| Responses | Women | Men | Total |
|---|---|---|---|
| I have suspected it in some cases, but could not confirm. | 16.39% | 8.00% | 11.76% |
| No, I have never detected plagiarism. | 8.20% | 6.67% | 7.35% |
| Yes, at some point. | 45.90% | 54.67% | 50.74% |
| Yes, although very few times. | 1.64% | 6.67% | 4.41% |
| Yes, on many occasions. | 27.87% | 24.00% | 25.74% |

Source: developed by authors.

The analysis of the data reflects that plagiarism is a situation that educators face frequently face. A total of 50.74% of the respondents had identified cases of plagiarism at least once, and 25.74% indicated having detected it many times. The existence of suspected plagiarism that could not be confirmed suggests a gap in the tools or methods available for effective detection and verification of plagiarism.

The diversity in the detection and management of plagiarism points to the need to strengthen training in this area, ensuring that educators are better prepared to identify and address these situations appropriately, thus contributing to the preservation of academic integrity.

## Prevention and detection strategies

Upon inquiring about the strategies implemented to deter plagiarism in student assignments, the responses indicated a diverse range of preventive measures, as outlined in Table 1.7.

**Table 1.7.** Measures employed to prevent plagiarism

| Strategy | Men | Women | Total |
|---|---|---|---|
| I inform about the effects of dishonest practices. | 76.00% | 76.67% | 76.30% |
| I use anti-plagiarism tools for most of the assignments. | 8.00% | 6.67% | 7.41% |
| I use anti-plagiarism tools only for dissertations I supervise (FYP and FMP). | 36.00% | 33.33% | 34.81% |
| I am able to detect it without the need for anti-plagiarism tools. | 2.67% | 3.33% | 2.96% |
| I do nothing. | 2.67% | 3.33% | 2.96% |

Source: developed by authors.

Table 1.7 reveals a multifaceted and holistic approach in the fight against this practice. Since respondents could select multiple options, the data reflect a combination of strategies used by educators. The most notable option, chosen by approximately 76% of participants, is to inform about the effects of dishonest practices. This high selection underscores the importance that educators place on education and ethical awareness as key tools in preventing plagiarism.

Despite the possibility of choosing multiple answers, the use of anti-plagiarism tools in a generalized manner for all types of work is notably lower, with around 7.41% of respondents indicating their use in most of the assignments and approximately 34.81% in final degree or master's projects. This suggests that, while technological tools are valued, they are possibly not seen as the only or main line of defense. The preference for educational approaches and personal assessment before resorting to technological solutions becomes evident.

Furthermore, a smaller percentage of educators, around 3%, trust their ability to detect plagiarism without the assistance of tools, which, although low, becomes significant in the context of multiple responses. This could be interpreted as a backup approach that complements other measures taken.

The fact that only a minority admit to not taking specific measures against plagiarism is somewhat concerning. This indicates that the majority of educators are actively involved and concerned about preventing plagiarism.

In summary, the results reflect a general preference for a diversified approach in plagiarism prevention, where education and awareness hold a central place, complemented by the selective use of technological tools and trust in personal judgment. This multidimensional approach is indicative of the complexity of the plagiarism problem and the need for a comprehensive approach to combat it effectively.

When inquired about their capability to identify and mitigate plagiarism, the responses unveiled a varied spectrum of confidence and readiness within the academic personnel (Table 1.8).

**Table 1.8.** Preparation for detecting AI usage

| Level of preparedness | Women | Men | Total |
|---|---|---|---|
| 1. Not prepared at all | 27.87% | 16.00% | 21.32% |
| 2. Slightly prepared | 31.15% | 33.33% | 32.35% |
| 3. Partially prepared | 22.95% | 36.00% | 30.15% |
| 4. Prepared | 16.39% | 10.67% | 13.24% |
| 5. Fully prepared | 1.64% | 4.00% | 2.94% |

Source: developed by authors.

In aggregate terms, an inclination towards moderate to low levels of preparation is evident, with the majority of participants classifying themselves in the areas of "slightly prepared" (32.35%) and "partially prepared" (30.15%). A noteworthy observation arises from the marked minority of respondents who classify themselves as "fully prepared" (2.94%), indicating a possible inadequacy of resources, knowledge or confidence in relation to competently identifying and managing applications of AI.

When disaggregating the data by gender, noticeable disparities emerged. Women tend to exhibit lower levels of preparedness compared to men: 27.87% identify as "not at all prepared," in contrast to 16.00% of men within the same category. On the contrary, men show a greater propensity to feel "partially prepared", representing 36.00% compared to 22.95% among women. These delin-

eations may connote different perceptions of personal competence or disparate levels of exposure to AI technologies between genders.

Furthermore, at the top of the preparedness continuum, the proportion of men who perceive themselves as "fully prepared" is almost triple that of women (4.00% versus 1.64%), suggesting a dichotomy based on gender in the perception of comprehensive competence regarding AI detection. However, it is worth noting that both genders present relatively modest percentages within this category, underscoring a widespread opportunity to increase educational and training efforts in the field of AI.

This analysis highlights the imperative requirement to strengthen teachers' competencies in relation to the expert use of advanced technological tools and pedagogical methodologies for the competent detection of plagiarism.

## 1.4. Conclusion

The study highlights the critical importance of developing specific training programs for educators. These programs should adequately prepare them to face the challenges associated with the use of AI and plagiarism prevention. Training should address not only the technical skills necessary to effectively use AI tools, but also foster a deep understanding of the ethical implications of their use in educational contexts. The approach must be holistic, considering the impact on the most vulnerable groups and the possibility that AI technology, especially generative AI, could undermine the authority of educators and promote greater automation of education, which could lead to scenarios in which personalized teaching and learning are compromised.

Stefania Giannini (2023) emphasizes the need to remain vigilant to these powerful technologies to avoid unintended consequences, such as the depersonalization of education and the exacerbation of inequalities. Teacher training is essential not only to equip them with the tools to detect and prevent plagiarism, but also to ensure that they can guide students towards the ethical and responsible use of AI, thus promoting academic integrity and originality in the academic work.

This position underscores the need for a collaborative effort among technologists, educators, and policymakers to create an

educational environment that respects and promotes academic integrity while harnessing the benefits of AI to enrich the learning experience.

### Study limitations

Methodologically, by employing an open invitation without stratified restrictions to select university faculty from different disciplines and universities in Spain, the study might face a bias in the representativeness of the sample. This means that the results obtained may not adequately reflect the diversity of opinions and perceptions among university faculty at a national level, limiting the generalization of the findings to the entire target population. However, we consider it can offer useful results to focus on the topic and guide future studies where more specific and controlled sampling methods are applied, which can ensure a more equitable and diverse representation of the faculty.

## Acknowledgement

This work is fully collaborative and is part of the research project "Vulnerabilidad, precariedad y brechas sociales. ¿Hacia una redefinición de los derechos fundamentales?", PID2020-114718RB-I00, funded by MICIU/AEI/10.13039/501100011033

## References

Chan, C. K. Y. (2023). *Is AI Changing the Rules of Academic Misconduct? An In-depth Look at Students' Perceptions of 'AI-giarism'*. arXiv.org. https://doi.org/10.48550/arXiv.2306.03358

Cotton, D., Cotton, P. A., & Shipway, J. (2023). Chatting and cheating: Ensuring academic integrity in the era of ChatGPT. *Innovations in Education and Teaching International*. https://doi.org/10.1080/14703297.2023.2190148

Dupps W. J. Jr. (2023). Artificial intelligence and academic publishing. *Journal of cataract and refractive surgery*, *49*(7), 655-656. https://doi.org/10.1097/j.jcrs.0000000000001223

Giannini, S. (2023). *La IA generativa y el futuro de la educación*. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000385877_spa

Liao, C., Palvia, P., & Lin, H.-N. (2021). The role of Artificial Intelligence in educational inclusion and equity. *AI & Society, 36*(3), 905-916.

Longoni, C., Tully, S., & Shariff, A. (2023). *Plagiarizing AI-generated Content Is Seen as Less Unethical and more Permissible*. https://doi.org/10.31234/osf.io/na3wb

Perkins, M. (2023). Academic integrity considerations of AI Large language models in the post-pandemic era: ChatGPT and beyond. *Journal of University Teaching and Learning Practice, 20*(2), 07.

Quidwai, A., Chunhui, L., & Dube, P. (2023). Beyond black box AI generated plagiarism detection: From sentence to document level. In *Proceedings of the 18th Workshop on Innovative Use of NLP for Building Educational Applications* (BEA 2023) (pp. 727-735). Association for Computational Linguistics.

Rodriguez, C. M. et al. (2023). Impact of Artificial Intelligence in Promoting Academic Integrity in Education: A Systematic review. *Journal of Namibian Studies: History Politics Culture, 33*, 71-85. 10.59670/jns.v33i.415

Santra, P. P. (2023). Scholarly communication and machine-generated text: Is it finally AI vs AI in plagiarism detection? *SRELS Journal of Information Management*. https://doi.org/10.17821/srels/2023/v60i3/171028

Sarkar, A. (2023). Exploring perspectives on the impact of artificial intelligence on the creativity of knowledge work: Beyond mechanized plagiarism and stochastic parrots. In *Proceedings of the 2nd Annual Meeting of the Symposium on Human-Computer Interaction for Work (CHIWORK '23)*. Association for Computing Machinery, 13. https://doi.org/10.1145/3596671.3597650

Sullivan, M., Kelly, A., & McLaughlan, P. (2023). ChatGPT in higher education: Considerations for academic integrity and student learning. *Journal of Applied Learning & Teaching, 6*(1). https://doi.org/10.37074/jalt.2023.6.1.17

UNESCO (2019a). *Artificial Intelligence in education: Challenges and opportunities for sustainable development*. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000366994?posInSet=1&queryId=3caae4dd-9ae6-4a04-9fe6-a7f3f0a7e725

UNESCO (2019b). *Beijing Consensus on Artificial Intelligence and Education*. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000368303

UNESCO (2021a). *Inteligencia artificial y educación. Guía para las personas a cargo de formular políticas*. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000379376

UNESCO (2021b). *Recomendación sobre la ética de la inteligencia artificial*. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000381137_spa

Waltzer, T., Cox, R.L., & Heyman, G. D. (2023). Testing the ability of teachers and students to differentiate between essays generated by ChatGPT and high school students. *Human Behavior and Emerging Technologies*, Article ID 1923981 https://doi.org/10.1155/2023/1923981

Yeo, M. (2023). Academic integrity in the age of Artificial Intelligence (AI) authoring apps. *TESOL Journal, 14*(3), 1-12. https://doi.org/10.1002/tesj.716

# 2

# Analysis of an Artificial Intelligence Training Program in University Students: Perspectives and Horizons[1]

PhD Alejandro López-García
Universidad de Murcia, Spain
aloga@um.es
https://orcid.org/0000-0002-7665-57890

PhD José María Campillo-Ferrer
jmcf2@um.es
https://orcid.org/0000-0001-8570-3749

PhD María Victoria Zaragoza-Vidal
Universidad de Murcia, Spain
mariavictoria.zaragoza@um.es
https://orcid.org/0000-0002-6175-3239

PhD Pedro Miralles-Sánchez
Universidad de Murcia, Spain
pedro.miralless@um.es
https://orcid.org/0000-0002-2436-3012

**Abstract**
Artificial intelligence (AI) is an emerging technology that is playing a decisive role in education, transforming the way teaching and learning takes place. Personalization of learning, virtual assistance systems, task automation, skills

1. This work has been carried out within the period of the research projects "History Lab for European Civic Engagement" (2020-1-ES01-KA226-HE-095430), funded by the ERASMUS+ KA226 programme, and "La enseñanza y el aprendizaje de competencias históricas en Bachillerato: un reto para lograr una ciudadanía crítica y democrática" (PID2020-113453RB-100), funded by the Agencia Estatal de Investigación de España, to be developed by the DICSO research group of the University of Murcia. These organisations are thanked for their financial contribution to this study.

development and content creation are some of the numerous possibilities. However, they should be supported by innovative approaches that give an active role to e-learners. The general objective of this study was to analyze the effectiveness of a teacher training program at the university level that implements AI technologies to teach social sciences content in early childhood and primary education. To this end, a quantitative method was used, specifically a descriptive pre-experimental one-group pretest-posttest design. The research was carried out with 187 students from two Spanish universities in the Bachelor's Degree in Early Childhood and Primary Education. The training program consisted in the development and planning of 18 pedagogical situations in the field of social sciences, mediated by numerous AI tools. The results show a significant improvement in the learners' perceptions after the training program was implemented, highlighting its usefulness in improving teaching and learning processes, particularly the creation of more effective and personalized teaching plans.

**Keywords:** Artificial Intelligence, computer science, perception, social sciences, training methods.

## 2.1. Introduction

The emerging advancement of technology has found its zenith in artificial intelligence (AI) systems. AI is changing the way we live, work, interact and, inevitably, the way we educate and study (Norman-Acevedo, 2023). Thus, faced with the obvious need arising from the current technological evolution, official bodies such as UNESCO (2023) point to the challenge of developing innovative educational practices that are able to meet the challenge posed by education today, and consequently achieve the goals proposed in the 2030 Agenda. The Beijing Consensus (2019) already pointed out the need to introduce new teaching models by bringing together AI and education, as this symbiosis can be beneficial for both students and teachers. It was also pointed out that AI can help education to be more inclusive, equitable, personalized and open, which is why these official documents underline the need to update education systems, so that value is placed, for example, on the achievement of Sustainable Development Goal (SDG) 4 - aimed at education, which refers to ensuring inclusive, equitable and quality education, in addition to promoting lifelong learning opportunities for people.

Some authors have highlighted the need to explore the current university model due to the high degree of digitalization of society, as well as the constant improvement and updating of infrastructures, and the emergence of new technological tools (Tapalova & Zhiyenbayeva, 2022). A critical reconceptualization would contribute to improving the quality of the educational process, as it would allow for a better personalization of learning, enabling the content and pace of the process to be adapted to the needs and preferences of learners (Wild & Schulze, 2021; Mir et al., 2022).

In the context of higher education, some universities are offering training to implement AI with their students, even if it is complementary to other subjects. Some researchers such as Lee (2021) state the need for an educational program for students who are not specialized in the subject to train students in the appropriate use of this new technology. This AI literacy, in turn, has favored a positive ethical perception of AI, showing that its use in the classroom has obtained satisfactory results, which points to the need to implement an education that goes beyond theoretical classes limited to the transmission of theoretical knowledge. Likewise, Xiao & Yi (2020) agree on the need for an educational reform that develops new methodologies based on personalized training, highlighting those based on AI, and proposing a design for this type of training.

In this sense, the effects of AI and inclusive online practices on crucial factors such as student performance, motivation, satisfaction, and engagement are complex issues that require further study for the development of AI-driven systems. In relation to these issues, Ouyang et al. (2022) examined the effects and implications of AI-based approaches described in previous research between 2011 and 2020, and concluded that AI-enabled learning boosted student engagement and attention and improved academic performance. However, further research is needed on how AI resources influence student satisfaction, since, as suggested by Rodway and Schepman (2023), higher education institutions need to consider the effects of these technologies on student comfort, course satisfaction and support to minimize a hypothetical decrease in course satisfaction due to their possible adoption. For example, the correlation between student satisfaction and the level of progression in a given module, unit or

course, or the effectiveness of AI tools such as intelligent tutoring systems in web-based approaches deserve to be further examined in future studies. Indeed, in the United States, intelligent tutoring systems using AI are being included to assist in problem solving and provide more personalized education. It has also been used by faculty members to improve the governance of academic affairs (Wang et al. 2021).

The enormous applicability that is beginning to be elucidated around AI systems is thus appreciable. In addition to the possibilities of AI in education, some studies have also focused on analyzing university students' ethical awareness of these tools. In fact, the demand for AI ethics education is defined as a need not only for university education, but also for the other stages of the education system, since, as the coexistence with new AI techniques increases, the urgency of establishing AI ethics education becomes more and more apparent (Hong, 2021).

This chapter shows an approach to the knowledge of AI systems through the implementation and evaluation of a training program that is analyzed from the point of view of future teachers. Perspectives and horizons merge to further shed light on the usefulness of this emerging and promising line of work.

## 2.2. Objectives

The general objective of this study was to analyse the perception of the effectiveness of an AI program for teaching social science content at the university level. In order to provide an adequate response, the following specific objectives were set:

- To compare the degree of perception about learning, satisfaction, applicability of AI and its limitations, globally and according to gender.
- To analyze the degree of consistency between the previous perception of learning, satisfaction, applicability of resources and their limitations, globally and according to gender.
- To analyze the degree of consistency between subsequent perceptions of learning, satisfaction, applicability of resources and the difficulties in the application of AI, globally and according to gender.

## 2.3. Method

### Design and participants of the research

This research was based on a quantitative method, specifically on a pre-experimental design of one group with a pretest-posttest (McMillan & Schumacher, 2005). The total number of participants in this research was 187 university students of the Degree in Early Childhood Education and Degree in Primary Education from two Spanish universities located in the Region of Murcia, one public and one private. To constitute the sample, a non-probabilistic, accidental or chance sampling procedure was used, thus six groups of intact students were selected, of whom 145 were female and 42 were male.

### Description of the teacher training program

This study was implemented during the first term of the 2023/2024 academic year (September-December). The contents of the subjects where the program was carried out were based on the reflective analysis of the cultural and evolutionary phenomena that characterize the current development of contemporary societies. Specifically, the training program was based on 18 curricular learning situations in which students had to respond critically to relevant social problems by analysing primary sources (readings, photographs, interviews, institutional documents) and secondary sources (articles, biographies, documentaries), as well as using different AI tools to carry out activities based on chatbots, avatar design, generation of presentations, posters and infographics, and the creation of online courses, videos and web pages (Figure 2.1). Likewise, with the help of AI, the students designed online questionnaires to check the extent to which they had assimilated the contents previously worked on in the program, which took the form of gamified tasks such as Kahoot, Educaplay and Plickers. All activities were implemented in small groups, presented in the classroom and defended in a shared discussion.

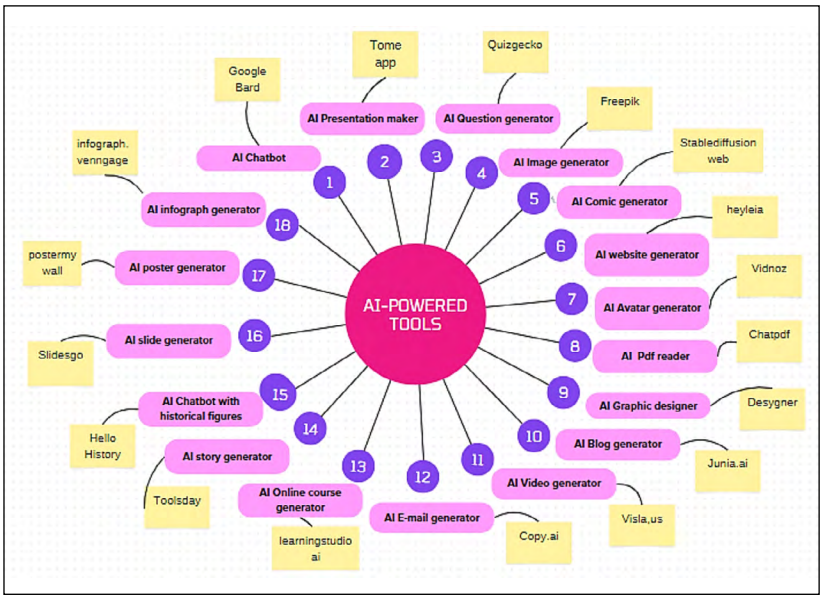



**Figure 2.1.** List of AI-based resources that were used during the study. Source: developed by author

## Data collection tool

An appropriate instrument should record observable data that truly represent the concepts or variables that the researcher has in mind (Hernández et al., 2006). For this research, the instrument "Effectiveness of Artificial Intelligence in a Teacher Training Program" was used. It is an adaptation of the questionnaire designed by Ayuso-del Puerto and Gutiérrez-Esteban (2022). From there, a focus group was held to restructure the blocks and validate the content of the instrument. On this version, the reliability index was calculated, obtaining an alpha value of .929, which left a good degree of internal consistency, with values practically similar to those of its initial version ($\alpha = .930$).

This version of the instrument begins with an instruction section, followed by a section with identification questions. In its central part, the questionnaire is made up of four blocks or groups of questions, presented on a five-point Likert scale, ranging from 1, indicating total disagreement, to 5, indicating total agreement. As for the specific description of the blocks, the first

one contains ten items and aims to determine what students think about the learning process with AI tools. The second block consists of five statements and aims to analyze their overall level of satisfaction. The third block, consisting of five statements, investigates the applicability of the technology. The last block is related to possible difficulties or deficits in working with AI.

## 2.4. Results

**About the Objective 1: To compare the degree of perception about learning, satisfaction, the applicability of AI and its limitations, globally and according to gender**: Tables 2.1 and 2.2 present the descriptive results of this first objective, based on an analysis of the indices of central tendency of the blocks of the instrument, so that the self-perceived e-competence in this approach is collected, i.e., the perception of their learning, the satisfaction achieved, the degree of applicability that AI deserves, and the limitations derived from its practice. Only in this way can it be observed whether the applied program had an effect on computational thinking about the mastery of these AI systems.

**Table 2.1.** Descriptive statistics for the variables referring to self-perceived e-competence in this approach

| Blocks of variables | Tests | Participants (n = 187) | | |
|---|---|---|---|---|
| | | M | Sd | Md |
| Learning | Pretest | 3.67 | .63 | 3.7 |
| | Posttest | 3.94 | .80 | 4 |
| Satisfaction | Pretest | 3.48 | .61 | 3.4 |
| | Posttest | 3.91 | .79 | 4 |
| Applicability | Pretest | 3.15 | .67 | 3.2 |
| | Posttest | 3.81 | .72 | 3.8 |
| Limitations | Pretest | 3.10 | .57 | 3 |
| | Posttest | 3.18 | .63 | 3.2 |

Source: developed by autor.

The results show that the block of variables in which the difference before and after the application of the program is most evident is the one related to applicability, with the highest grouped median appearing in the posttests (3.8). Moreover, the best rated block is the one related to learning, with grouped medians being close to 4 points. According to the gender of the participants, the results improve in posttests in all blocks and for both male and female participants, as can be observed in Table 2.2.

**Table 2.2.** Descriptive statistics for the variables referring to self-perceived e-competence in this approach according to the gender of the participants

| Blocks of variables | Tests | Participants (n=187) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Men n = 42 | | | Women n = 145 | | |
| | | M | Sd | Md | M | Sd | Md |
| Learning | Pretest | 3.74 | .23 | 4 | 3.64 | .93 | 4 |
| | Posttest | 3.89 | 1.05 | 4 | 3.97 | 1.01 | 4 |
| Satisfaction | Pretest | 3.61 | .17 | 4 | 3.44 | .92 | 4 |
| | Posttest | 3.89 | 1.02 | 4 | 3.92 | .99 | 4 |
| Applicability | Pretest | 3.33 | .85 | 4 | 3.10 | .98 | 3 |
| | Posttest | 3.76 | .94 | 4 | 3.83 | 1.02 | 4 |
| Limitations | Pretest | 3.14 | .61 | 3 | 3.13 | .98 | 3 |
| | Posttest | 3.23 | 1.19 | 3 | 3.16 | 1.10 | 3 |

Source: developed by author

The block of variables in which the best results are obtained in both subgroups is the one linked to learning through AI, since the grouped mean of the responses in the posttest are closer to 4 (agree) in the subgroup of female participants, followed by the block related to satisfaction, also with grouped means close to 4 in both subgroups.

The higher rated results for male participants shown in the table above are reinforced by similar findings from the non-parametric Mann-Whitney tests on applicability, as they indicate that male students consider AI resources to be significantly more effec-

tive in their studies, as well as in the development of e-projects (U = 2083.5; p < .001; U = 2375; p < .029). In addition, the participants' ratings were significantly higher regarding the satisfaction obtained by using these tools, particularly when designing new online projects or searching for more information on AI. Specifically, there is a significant difference in these two variables between the mean scores of male and female students (U = 2395.5; p < .023; U = 2403.5; p < .028), which shows that the use of AI resources promoted a change in attitude, especially among male students.

**About the Objective 2: To analyze the degree of consistency between the previous perception of learning, satisfaction, applicability of resources and their limitations, globally and according to gender**: In order to meet this objective, Spearman's rho correlation coefficient was calculated, which is used to analyze ordinal variables. During the process, the mean values of each item were obtained, and then a categorized grouping was established, by blocks, in order to be able to carry out a transformation into discrete variables that would allow us to analyze the degree of consistency between the variables of each construct of the questionnaire. At this point, it is necessary to highlight the contribution of several authors (Monroy & Maquilón, 2015), who estimate that this coefficient can range between -1 (negative perfect relationship) and 1 (positive perfect relationship), with a value close to 0 meaning an absence of relationship. Table 2.3 presents the index of relationships found between the variables Learning, Satisfaction, Applicability and Limitations, before the implementation of the AI program.

**Table 2.3.** Relationship between pre-program learning, satisfaction, applicability and limitations, at a global level

| Correlations at a global level Spearman's Rho | | Learning | Satisfaction | Applicability | Limitations |
|---|---|---|---|---|---|
| Learning | C. correlation | 1.000 | .703** | .531** | .226** |
| | Sig. (bilateral) | . | <.001 | <.001 | .002 |
| | N | 186 | 186 | 184 | 185 |

| | | | | | |
|---|---|---|---|---|---|
| Satisfaction | C. correlation | .703** | 1.000 | .641** | .128 |
| | Sig. (bilateral) | <.001 | . | <.001 | .082 |
| | N | 186 | 187 | 185 | 186 |
| Applicability | C. correlation | .531** | .641** | 1.000 | .142 |
| | Sig. (bilateral) | <.001 | <.001 | . | .055 |
| | N | 184 | 185 | 185 | 184 |
| Limitations | C. correlation | .226** | .128 | .142 | 1,000 |
| | Sig. (bilateral) | .002 | .082 | .055 | . |
| | N | 185 | 186 | 184 | 186 |

**. The correlation is significant at 0.01 (bilateral).
Source: developed by autor.

As is shown in Table 2.3, there is a positive and significant relationship between the mean perception on Block I, which deals with perceived learning with AI, and Block II, related to students' satisfaction with their previous experience with this technology ($r = .70$; $p < .001$). Although less strongly, the learning variable also correlates with the block III variable, related to the applicability of AI, in this global analysis ($r = .53$; $p < .001$). There is also a statistically significant positive relationship between Block II (satisfaction) and Block III (applicability) ($r = .64$; $p < .001$). These findings are justified by the contribution of some authors, who indicate that a positive correlation higher than .50 (Cohen, 1988) and .70 (Mateo, 2009) is considered strong. Therefore, there is strong consistency between three of the four variables in which the previous perception of the research participants was analysed, with no relationship with Block IV, related to the limitations of AI. Table 2.4 shows the relationships found between the average degree of perception of these four variables according to gender, in order to contrast their degree of consistency before the implementation of the AI training program.

**Table 2.4.** Relationship between pre-program learning, satisfaction, applicability and limitations, according to sex

| Correlations according to sex Spearman's Rho | | | Learning | Satisfaction | Applicability | Limitations |
|---|---|---|---|---|---|---|
| Male | Learning | C. correlation | 1.000 | .574** | .462** | .411** |
| | | Sig. (bilateral) | . | <.001 | .002 | .007 |
| | | N | 42 | 42 | 42 | 42 |
| | Satisfaction | C. correlation | .574** | 1.000 | .564** | .127 |
| | | Sig. (bilateral) | <.001 | . | <.001 | .424 |
| | | N | 42 | 42 | 42 | 42 |
| | Applicability | C. correlation | .462** | .564** | 1.000 | -.022 |
| | | Sig. (bilateral) | .002 | <.001 | . | .890 |
| | | N | 42 | 42 | 42 | 42 |
| | Limitations | C. correlation | .411** | .127 | -.022 | 1.000 |
| | | Sig. (bilateral) | .007 | .424 | .890 | . |
| | | N | 42 | 42 | 42 | 42 |
| Female | Learning | C. correlation | 1.000 | .727** | .545** | .179* |
| | | Sig. (bilateral) | . | <.001 | <.001 | .032 |
| | | N | 144 | 144 | 142 | 143 |
| | Satisfaction | C. correlation | .727** | 1.000 | .647** | .139 |
| | | Sig. (bilateral) | <.001 | . | <.001 | .096 |
| | | N | 144 | 145 | 143 | 144 |
| | Applicability | C. correlation | .545** | .647** | 1.000 | .199* |
| | | Sig. (bilateral) | <.001 | <.001 | . | .018 |
| | | N | 142 | 143 | 143 | 142 |
| | Limitations | C. correlation | .179* | .139 | .199* | 1.000 |
| | | Sig. (bilateral) | .032 | .096 | .018 | . |
| | | N | 143 | 144 | 142 | 144 |

* The correlation is significant at 0.05 (bilateral).
** The correlation is significant at 0.01 (bilateral).
Source: developed by author.

The results corroborate the existence of differences in the degree of consistency between men and women. For the variable related to the limitations derived from the use of AI, no relationship was found. However, this was not the case for the other variables. In the male group, the learning variable correlated positively and significantly with the satisfaction variable (r=.57; p<.001). The latter, in turn, did the same with the applicability variable (r=.56; p<.001). With regard to the analysis of the average perception of women, there was a higher degree of consistency, with a positive and significant correlation between the variables learning and satisfaction (r=.73; p<.001), learning and applicability (r=.54; p<.001), and satisfaction and applicability (r=.65; p<.001). These results allow us to assert that, in the female group, the number of significant correlations is somewhat higher (three) than in the case of boys (two), and these relationships have a higher degree of consistency according to the aforementioned authors (Cohen, 1988; Mateo, 2009).

**About the Objective 3: To analyze the degree of consistency between subsequent perceptions of learning, satisfaction, applicability of resources and the difficulties in the application of AI, globally and according to gender**: To answer this objective, Spearman's rho correlation coefficient, derived from the grouped mean values of each construct, was recalculated. Table 2.5 shows the relationships found between blocks after the implementation of the AI training program.

**Table 2.5.** Relationship between post-program learning, satisfaction, applicability and limitations, at a global level

| Correlations at a global level Spearman's Rho | | Learning | Satisfaction | Applicability | Limitations |
|---|---|---|---|---|---|
| Learning | C. correlation | 1.000 | .778** | .697** | .178* |
| | Sig. (bilateral) | . | <.001 | <.001 | .018 |
| | N | 180 | 178 | 178 | 177 |
| Satisfaction | C. correlation | .778** | 1.000 | .752** | .206** |
| | Sig. (bilateral) | <.001 | . | <.001 | .006 |
| | N | 178 | 183 | 181 | 180 |

| | | | | | |
|---|---|---|---|---|---|
| Applicability | C. correlation | .697** | .752** | 1.000 | .261** |
| | Sig. (bilateral) | <.001 | <.001 | . | <.001 |
| | N | 178 | 181 | 185 | 182 |
| Limitations | C. correlation | .178* | .206** | .261** | 1.000 |
| | Sig. (bilateral) | .018 | .006 | <.001 | . |
| | N | 177 | 180 | 182 | 184 |

* The correlation is significant at 0.05 (bilateral).
** The correlation is significant at 0.01 (bilateral).
Source: developed by autor

Finally, Table 2.6 shows the relationships found according to sex in the average degree of perception of each of the blocks, after the application of the AI training program.

**Table 2.6.** Relationship between post-programme learning, satisfaction, applicability and limitations, according to sex

| Correlations according to sex Spearman's Rho | | | Learning | Satisfaction | Applicability | Limitations |
|---|---|---|---|---|---|---|
| Male | Learning | C. correlation | 1.000 | .819** | .800** | .225 |
| | | Sig. (bilateral) | . | <.001 | <.001 | .157 |
| | | N | 41 | 41 | 40 | 41 |
| | Satisfaction | C. correlation | .819** | 1.000 | .774** | .123 |
| | | Sig. (bilateral) | <.001 | . | <.001 | .438 |
| | | N | 41 | 42 | 41 | 42 |
| | Applicability | C. correlation | .800** | .774** | 1.000 | .253 |
| | | Sig. (bilateral) | <.001 | <.001 | . | .111 |
| | | N | 40 | 41 | 41 | 41 |
| | Limitations | C. correlation | .225 | .123 | .253 | 1.000 |
| | | Sig. (bilateral) | .157 | .438 | .111 | . |
| | | N | 41 | 42 | 41 | 42 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Female | Learning | C. correlation | 1.000 | .766** | .663** | .168* |
| | | Sig. (bilateral) | . | <.001 | <.001 | .050 |
| | | N | 139 | 137 | 138 | 136 |
| | Satisfaction | C. correlation | .766** | 1.000 | .748** | .225** |
| | | Sig. (bilateral) | <.001 | . | <.001 | .008 |
| | | N | 137 | 141 | 140 | 138 |
| | Applicability | C. correlation | .663** | .748** | 1.000 | .269** |
| | | Sig. (bilateral) | <.001 | <.001 | . | .001 |
| | | N | 138 | 140 | 144 | 141 |
| | Limitations | C. correlation | .168* | .225** | .269** | 1.000 |
| | | Sig. (bilateral) | .050 | .008 | .001 | . |
| | | N | 136 | 138 | 141 | 142 |

* The correlation is significant at 0.05 (bilateral).
** The correlation is significant at 0.01 (bilateral).
Source: developed by author.

As is shown in Table 2.5, the overall results obtained show the existence of a statistically significant positive relationship between the learning variable and the variables satisfaction ($r = .78$; $p<.001$) and applicability ($r = .70$; $p < .001$). Similarly, the variable related to student satisfaction also presents a relationship of this level with the applicability variable ($r = .75$; $p < .001$), taking into account for all three cases the condition of exceeding .70 proposed by Mateo (2009) for a relationship to be considered statistically strong. In turn, according to the rho coefficient derived from Table 2.6, in the male sex there is a very positive and significant association between the block related to learning and the block that shows student satisfaction ($r = .82$, $p < .001$), as well as between learning and the AI applicability block ($r = .80$; $p < .001$). Similarly, there is also a statistically significant positive interdependence relationship between satisfaction with AI and its applicability ($r = .77$; $p < .001$), and all these relationships can be considered strong (Mateo, 2009). Despite remaining strong, these consistency relationships are slightly weaker in the female group, where the learning variable correlates positively with the satisfaction variable ($r = .77$; $p < .001$)

and with the applicability variable ($r = .66$; $p < .001$), while the satisfaction and applicability variables also have a high interdependence relationship with each other ($r = .75$; $p < .001$), in a statistically significant way in all these cases.

## 2.5. Discussion and Conclusions

AI is being implemented in new learning scenarios, adding value to complex issues in higher education and also introducing new challenges and demands for better, more advanced and motivating educational systems.

One of the main benefits that participants highlighted in this study was the driving force of AI for the development of e-projects. In this regard, some authors, such as Klašnja-Milićević & Ivanović (2021), highlight the relevance of AI-based resources for building personalised learning systems that adapt to learners' needs and preferences in digital tasks. In this sense, the creation of inclusive learning pathways through AI training on online platforms, virtual spaces, digital feedback and generative pedagogical content can pave the road to an effective shift towards a more innovative, learner-friendly and web-based education system.

Another advantage reported by the participants was the growth of interest in knowing more about these AI-powered resources. The great attention paid by participants to these online tools in terms of engagement has been examined in previous studies, such as that of Wang et al. (2023), who analyzed how students engage in smart learning and concluded that enhancing students' engagement experiences through AI, as well as implementing learner-oriented approaches, could be successful in terms of participation and interest.

In global terms, this chapter elucidates some parameters that point to the potential that AI seems to have as an influential factor in the self-perception of learning, in satisfaction, and in the applicability of the use of AI tools for teaching social sciences. Likewise, the results also highlight the impact of the teacher training program, demonstrating that, after its application, the parameters analyzed increased notably and the impact on the consistency between variables increased, particularly in the case of the male sex. However, it is striking that the only

variable where there is no relationship of dependence with the perception of learning, with reported satisfaction or with the applicability of AI tools, is in the block derived from the items that address the limitations generated with this technology. This coincides with the fact that this is the variable with the lowest grouped means of the whole instrument, thus it is not surprising that those students who do not feel insecure or intimidated with AI, do not consider the projects addressed in the program to have been difficult, and have not had difficulties remembering the important points, are exactly the same who report learning more, feeling more satisfied, valuing more the applicability of the activities and resources used and, in general, having better results in e-competence and perceived usefulness with AI systems, showing strong consistency between these parameters.

Based on the above, we believe that a clear answer has been given to the stated objectives and that, in the absence of a controlled evaluation, in terms of actual learning, to confirm these findings, the self-perception of performance generation, ease of use, motivation and satisfaction generated engagement or efficiency in the perception of success, point in the right direction. These results are in line with those reported in other studies (Ouyang et al., 2022; Rodway & Schepman, 2023), which, over several years, are examining the effects and implications for learners, concluding an improvement in engagement, attention and perception of learning, although the utmost caution is needed, as AI can have very marked effects on student comfort, satisfaction with the course or bias in terms of perceived interest in the academic course.

In summary, this current e-paradigm should be used as an innovative framework for many educational institutions wishing to explore the capabilities of AI in an attempt to improve higher education in terms of quality (Hooda et al., 2022). There are qualities that AI will never be able to develop to replace a teacher, as the warmth of the relationship with students, empathy towards them, personalized assessments adapted to each student, and the creativity of teachers to create material are and will always be irreplaceable. In this sense, universities must continue to take firm steps towards the formative consolidation of a series of human competences that cannot be developed by AI

systems, such as creativity, the emotional approach or the casuistry that implies adaptability to each person, with their personal circumstances. It would be unreasonable if we were to consider that our students do not use AI to study or carry out academic work, just as it would be illogical for any teacher to forbid these tools. Therefore, teachers must take a critical look at the advantages and disadvantages that underlie these resources and make use of the enormous possibilities that AI certainly seems to offer.

## References


Ayuso-del Puerto, D., & Gutiérrez-Esteban, P. (2022). La inteligencia artificial como recurso educativo durante la formación inicial del profesorado. *RIED. Revista Iberoamericana de Educación a Distancia*, *25*(2), 347-358. https://doi.org/10.5944/ried.25.2.32332

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd edition). Lawrence Erlbaum Associates.

Hernández, R., Fernández-Collado, C., & Baptista, P. (2006). *Metodología de la investigación* (4rt ed.). McGraw-Hill.

Hooda, M., Rana, C., Dahiya, O., Rizwan, A., & Hossain, M. S. (2022). Artificial Intelligence for assessment and feedback to enhance student success in higher education. *Mathematical Problems in Engineering*, 1-19. https://doi.org/10.1155/2022/5215722

Hong, H.J. (2021). A plan to apply Artificial Intelligence ethics education into the elementary moral curriculum. *Korean Elementary Moral Education Society*, *75*, 183-206. https://n9.cl/39wa7

Klašnja-Milićević, A., & Ivanović, M. (2021). E-learning personalization systems and sustainable education. *Sustainability*, *13*(12), 6713. https://doi.org/10.3390/su13126713

Lee, A. (2021). The effect of Artificial Intelligence literacy education on university studens' ethical consciousness of Artificial Intelligence. *Robotics & AI Ethics*, *6*(3), 52-61. https://doi.org/10.22471/ai.2021.6.3.52

Mateo, J. (2009). La investigación ex post facto. In R. Bisquerra (Coord.). *Metodología de la investigación educativa* (pp. 195-230). La Muralla.

McMillan, J. H., & Schumacher, S. (2005). *Investigación educativa* (trad. J. Sánchez) (5ª ed.). Pearson Educación.

Mir, U., Kar, A. K., & Gupta, M. P. (2022). AI-enabled digital identity-inputs for stakeholders and policymakers. *Journal of Science and Technology Policy Management, 13*(3), 514-541. https://doi.org/10.1108/JSTPM-09-2020-0134

Monroy, F., & Maquilón, J. J. (2015). Correlación y regresión. In F. Hernández Pina, J. J. Maquilón, J. D. Cuesta, & T. Izquierdo (Eds.). *Investigación y análisis de datos para la realización de TFG, TFM y tesis doctoral* (pp. 131-156). Compobell.

Norman-Acevedo, E. (2023). La inteligencia artificial en la educación: una herramienta valiosa para los tutores virtuales universitarios y profesores universitarios. *Panorama, 17*(1). https://doi.org/10.15765/pnrm.v17i32.3681

Ouyang, F., Zheng, L., & Jiao, P. (2022). Artificial Intelligence in online higher education: A systematic review of empirical research from 2011 to 2020. *Education and Information Technologies, 27*(6), 7893-7925. https://doi.org/10.1007/s10639-022-10925-9

Rodway, P., & Schepman, A. (2023). The impact of adopting AI educational technologies on projected course satisfaction in university students. *Computers and Education: Artificial Intelligence, 5*, 100150. https://doi.org/10.1016/j.caeai.2023.100150

Tapalova, O., & Zhiyenbayeva, N. (2022). Artificial Intelligence in education: AIEd for personalised learning pathways. *Electronic Journal of e-Learning, 20*(5), 639-653. https://doi.org/10.34190/ejel.20.5.2597

UNESCO (2023). *La inteligencia artificial en la educación*. https://www.unesco.org/es/digital-education/artificial-intelligence

UNESCO (2019). *International Conference on Artificial Intelligence and Education, Planning Education in the AI Era: Lead the Leap*. Beijing, China. https://unesdoc.unesco.org/ark:/48223/pf0000368303

Wang, R., Li, J., Shi, W., & Li, X. (2021). Application of Artificial Intelligence techniques in operating mode of professors' academic governance in American research universities. Hindawi. *Wirelesss Communications and Mobile Computing*, 1-7. https://doi.org/10.1155/2021/3415125

Wang, S., Wang, H., Jiang, Y., Li, P., & Yang, W. (2023). Understanding students' participation of intelligent teaching: an empirical study considering artificial intelligence usefulness, interactive reward, satisfaction, university support and enjoyment. *Interactive Learning Environments, 31*(9), 5633-5649. https://doi.org/10.1080/10494820.2021.2012813

Wild, S., & Schulze, L. (2021). Re-evaluation of the D21-digital-index assessment instrument for measuring higher-level digital competences. *Studies in Educational Evaluation, 68*(1), 100981. https://doi.org/10.1016/j.stueduc.2021.100981

Xiao, M., & Yi, H. B. (2020). Building an efficient artificial intelligence model for personalized training in colleges and universities. *Computer application in Engineering Education, 29*(2), 350-358. https://doi.org/10.1002/cae.22235

3

# Validation of the Attitude Scale on the Perceptions of Future Teachers about Artificial Intelligence and its Consequences on their Motivation, Critical Thinking and Improvement of their Learning

PhD María Dolores Díaz-Noguera
Universidad de Sevilla, Spain
noguera@us.es
https://orcid.org/0000-0002-0624-4079

PhD Carlos Hervás-Gómez
Universidad de Sevilla, Spain
hervas@us.es
https://orcid.org/0000-0002-0904-9041

Eduardo Puraivan
Universidad de Viña del Mar, Chile
Universidad de Playa Ancha, Chile
epuraivan@uvm.cl
https://orcid.org/0000-0003-2134-8922

Mg. Macarena Gema Astudillo-Vásquez
Universidad de Viña el Mar, Chile
mastudillo@uvm.cl
https://orcid.org/0000-0001-5840-0865

Mg. Connie Cofré-Morales
Universidad de Viña del Mar, Chile
connie.cofre@docente.uvm.cl
https://orcid.org/0009-0000-1442-1218

https://doi.org/10.36006/09643-1-03 

**Abstract**
The aim of this study was to analyze the validated psychometric characteristics of the 'Scale of Attitudes towards the inclusion of Artificial Intelligence, called Pretest_Perception and Attitude towards Artificial Intelligence in the Educational Environment' (EIPAA-IAE)' using a short version for future teachers, in the integration of AI as a learning tool. The study describes future teachers' attitudes towards critical thinking, emotional competencies and creativity, determining the internal consistency and reliability of the designed tool. The design structure of the instrument consists of the following three latent factors, which were obtained through an exploratory factor analysis (EFA): AI/critical thinking, AI/emotional competencies, and AI/creativity. The questionnaire was applied to a sample of 205 participants. With confirmatory factor analyses (CFA), a prior hypothesis was established regarding the relationship of the factors and their number and nature, specifying the number of factors and the way in which the variables relate to each other. According to the analyses, 66.53% of the total variance was explained. Reliability, calculated with Cronbach's alpha, reached an overall value greater than 0.90 ($\alpha$ = 0.94). This valid and reliable questionnaire, which incorporates a dimension that measures the transfer of learning in hybrid and multimodal models of digital ecosystems in higher education with AI, can be applied in the evaluation of online education processes.

**Keywords:** educational environment, emotional competencies, creativity, Artificial Intelligence, motivation and critical thinking.

## 3.1. Introduction

Transformation of training institutions in this digital era is a crucial issue, especially when considering the growing role of Artificial Intelligence (AI). The integration of AI in educational environments not only optimizes teaching and learning processes, but also prepares students for a future where technology is ubiquitous. Recent discourse on ChatGPT (e.g., Bai et al., 2022; Kasneci et al., 2023; Rudolph et al., 2023) and a growing rate of research on artificial intelligence in education (AIED; see Zawacki -Richter et al., 2019) demonstrate a growing interest in the potential of AI to transform teaching and learning (Tuomi, 2018). However, the prohibitive costs of developing cutting-edge AI tools, combined with resource disparities among stakeholders, can result in AI applications that further encroach existing inequalities. In response, efforts to develop policies for ethical AI

have identified multi-stakeholder dialogue as a method to mitigate the risk of exacerbating social inequalities (e.g., IEEE, 2018; OECD, 2022; UNESCO, 2021).

Firstly, AI allows personalizing education, which, by implication, places us in the unstoppable advance of educational inclusion. AI-based systems can analyze the learning style and performance of each student, offering materials and resources adapted to their specific needs, surely advancing in equality and equity. By offering access to quality educational resources through online platforms and other technological tools, AI has the potential to reduce education gaps and provide opportunities to a broader audience. This personalization contributes to a more effective and motivating learning experience.

In addition, AI will help educational organizations to improve their quality. Since the last century, the scientific community has sought efficiency in educational administration. In the management of teaching-learning processes, it is essential in these years, where the Educational Administration is precipitating the bureaucratization of teachers. It can be a great support for the automation of administrative tasks, provide evidence to improve evaluation processes, and help in research with advanced data management. AI can free up time and resources, allowing educators to focus on the teaching and development of their students.

AI also fosters innovative teaching methods. For example, intelligent tutoring systems and virtual reality environments provide immersive learning experiences that were previously unimaginable. These tools not only enrich the educational process but also prepare students to work with advanced technologies in their future careers. Ultimately, AI will support a large part of the transformations that will occur in training institutions. This integration not only improves the quality of education but also equips students with the necessary skills to thrive in the future.

## Artificial Intelligence and critical thinking

The field of AI in education (AIED) uses techniques from AI and cognitive science to better understand the nature of learning and teaching and to build systems that help students acquire new skills or understand new concepts. There are meta-reviews and

meta-analyses to advocate for blended learning, in which teachers can offload part of the work to AIED systems (Boulay, 2016). Videoconferencing, for example, has allowed synchronous communication in the classroom and created multisensory content to stimulate students. AI involves complex equations that are best when teaching processes are using constructive pedagogy, where students experiment with alternative ways of solving the same problem. Multiple-choice questions have high reliability and can easily reveal students' skill levels quickly. Managing software projects is a challenge for students with visual or attention-related disorders. Therefore, it is fundamental to know how to use graphs to visually observe variables and narrow down possible relationships before performing an in-depth analysis. One of the main purposes of education is employability. Therefore, if a greater context of real-world industry examples is introduced into the conferences, we will achieve the transfer we are looking for (Chaturvedi, Cambria & Welsch, 2023). Other research has focused on the effects of AI on administration, instruction, and learning. Teachers can perform different administrative functions, such as reviewing and grading student assignments, more efficiently and effectively, and therefore achieve higher quality in teaching tasks. This educational quality can be reflected in the adaptability, as the curriculum and content have been customized according to the needs of the students, which has encouraged acceptance and retention, thus improving the student experience and the overall quality of learning (Chen, Chen & Lin, 2020).

AI has impacted the transformation of teaching methods in the university environment, this also influences critical thinking, leaving the traditional classroom, removing limitations of teaching resources, enabling the transformation of educational times, and promoting the advancement of new hybrid spaces. Modern distance education uses advanced technology such as computer networks, multimedia, and artificial intelligence to build a network-based virtual teaching environment, eliminating the limitations of teachers, teaching materials, experimental equipment, and other resources that exist under the traditional teaching model. Using educational resources of the same scale can exponentially expand educational capabilities and, at the same time, overcome the unified progress of traditional teaching methods, one-size-fits-all teaching methods, and student dissatisfaction. The

deficiencies of differences and personalities that are not reflected favor the improvement of the quality of education. The original intention of education is to provide students with special study resources and stimulate their enthusiasm for learning. These new learning systems can also provide personalized and intelligent recommendations to female students based on their learning habits. The system should be developed on the basis of an intelligent multimedia method, possesses the characteristics of security and stability, and has helped develop the network teaching of educational institutions to a certain extent (Zhang, 2022). It is possible to make students understand the course content before starting the course by simulating the real class and choosing the style and form of the course according to the students' ability and interest in the learning process. In the era of vigorous development of artificial intelligence, the development of smart classrooms will not be underestimated, which will also play an important role in the development of life in the future (Qi, 2019).

## Artificial Intelligence and emotional competencies

In the review of the scientific literature on trends in emotional intelligence research, verified from different disciplines such as neuroscience, psychology, and education, different authors have highlighted the importance of research in the evaluation and training of emotional intelligence in the field of education and how AI can play a role in this process. In the case of teachers, emotional intelligence is a protective factor against teacher burnout (Fernández-Berrocal et al., 2022). In this sense, motivation is intrinsically linked to the study of emotions. If we combine AI, the state of the art on this topic shows numerous findings on education and the process of sentiment analysis when these tools are used. In the research carried out, the Analyze Sentiment methodology (Google, 2022) has been used, with conclusions such as the following: the combination of artificial intelligence methods for natural language analysis, together with descriptive statistics and discourse analysis techniques, constitutes a viable approach for data and sentiment analysis to improve the transmission of messages used in the classroom (Meléndez-Gómez et al., 2022). However, it is also important to consider the possible psychological consequences of using AI.

### Artificial Intelligence and creativity

AI has the potential to enhance creativity by providing diverse perspectives and resources. In this sense, research indicates that, as AI is used by students to increase their work, their production is greater. From an artistic point of view, the Institute of Human Artificial Intelligence's spring conference finds that the symbiosis between AI and art is beneficial. Now, that does not mean it can replace human skills like judgment, empathy, and contextual understanding. Significantly, it can generate a wealth of ideas based on existing data and patterns, which helps unlock creative thinking. On the other side of the scale, we find research on the impact that AI generates on the personal learning environments of university centennials through unethical practices in the classroom. Consequently, it is found that critical and creative thinking, and linguistic and logical-mathematical intelligence are affected (Castillejos-López, 2022). In this sense, we find the dilemma between AI and the ability that human beings develop from their experiences and their level of cognitive evaluation and assessment (Oviedo Guevara, 2023). Other research focuses on the use of AI-supported systems and the tension that occurs between the potential for problem solving and the risks related to the violation of human rights, access to education, and educational inclusion (Dellepiane & Guidi, 2023).

## 3.2. Methodology

The research design used is descriptive; this means that it is an approach in which the main objective was to describe and understand the attitudes of future teachers regarding the incorporation of AI in their teaching and learning processes. This type of design was used to collect information about the current situation, characteristics or behaviors of a group of future teachers, without manipulating variables or establishing causal relationships. This methodological section contains the objectives, the sample (participants, procedure) and the collection and analysis of the data.

## Goals

The objective of this study was to validate the 'Attitude scale towards the inclusion of Artificial Intelligence, called 'Pretest_Perception and Attitude towards Artificial Intelligence in the Educational Environment' (EIPAA-IAE)'. The tool was designed by researchers from a Spanish university with the aim of diagnosing the new scenarios that have arisen after the arrival of artificial intelligence, such as the emergence of ChatGPT in November 2023. The study focused on describing the attitudes of future teachers towards critical thinking, emotional competencies, and creativity, as well as determining the internal consistency and reliability of the aforementioned tool. In this sense, the design structure of the instrument consists of three latent factors: AI/critical thinking, AI/emotional competencies, and AI/creativity. The innovation experience was carried out during the 2023/24 academic year.

## The sample

The sample was randomly selected by simple random sampling, in which each member of the population has the same probability of being selected to be part of the sample. Therefore, it was done for the convenience of the students. The total number of participating students was 205 (Female = 88%; men = 13%). The students belonged to the Degree of Early Childhood Education (96) the Double Degree of Early Childhood and Primary Education (108) and the Degree of Pedagogy (1). Bartlett's sphericity test and Kaiser-Meyer- Olkin (KMO) test were also performed for sample adequacy.

## The instrument

An instrument was developed that would allow evaluating the training experience carried out, aimed at future education professionals, as well as AI/critical thinking, AI/Emotional Competencies and AI/Creativity.

Starting from this objective, a first questionnaire of eight sociodemographic questions was designed that would allow us to know the characteristics of the population evaluated: they were

asked for their name and surname to prevent duplicate records, their e-mail, in case they wanted to receive additional information about the study, academic year in which they were enrolled (all participants belonged to the 2023-2024 academic year), gender (open question: female, male and other), age (multiple-choice question: 18-20 years, 21-24 years, and >25 years), academic year of the subject and degree (multiple-choice questions: pedagogy, primary education and early childhood education), and course (multiple-choice question: 1, 2, 3, and 4).

On the other hand, a block of 32 questions was developed, with the questions being responded in a 5-point Likert scale (1 = totally agree, 5 = totally disagree). These questions were based on 3 dimensions: AI/critical thinking, AI/Emotional Competencies and AI/Creativity.

## Procedure

This work was carried out in three phases: (1) validation of the instrument by experts in the subject and in research methods; (2) determination of the validity of the construct after passing the version of the questionnaire developed in the previous phase; (3) calculation of instrument reliability; and (4) validation of the proposed model, specifying the number of factors and the way in which the variables were related. After these phases, the questionnaire was designed and validated for its final version.

After this first work, the group of experts was selected to validate the questionnaire, with the 30 professionals mentioned in the participants section. They were given the guide for validating the content of the instrument, which they completed, taking into account its relevance, clarity, and adequacy. Kendall's test was applied to evaluate agreement between evaluators.

Once this phase of the procedure was completed, the questionnaire was reviewed, designing a new version for its final validation. The instrument was analyzed, studying its structure through an exploratory factor analysis using the factor extraction method of the principal components and promax rotation, since there was a correlation between the dimensions, which is why the extraction of factors is detailed in later sections. To this end, the Kaiser-Meyer-Olkin (KMO) test for sampling adequacy and

Bartlett's sphericity test were applied. The sample of this study was made up of a total of 205 students from a Spanish University (mentioned in the participants section). An online questionnaire was administered to this sample using the Microsoft Forms platform. This procedure provides simple, fast and economical access to a large number of participants, allowing them to complete the questionnaire in a flexible manner. In addition, this online tool has numerous advantages, such as the direct exploitation of responses in different formats for analysis.

The obtained factors and the complete scale were subjected to a reliability analysis procedure using Cronbach's alpha and McDonald's Omega to evaluate the internal consistency of the scale.

Finally, the validity of the construct was analyzed using confirmatory factor analysis (CFA) to validate the instrument that aims to measure the attitudes of future teachers and which is defined in the set of attitudes and predispositions of future teachers towards teaching-learning processes mediated by AI.

### Analysis of data

For these statistical analyses, the SPSS v.26 program was used.

## 3.3. Results

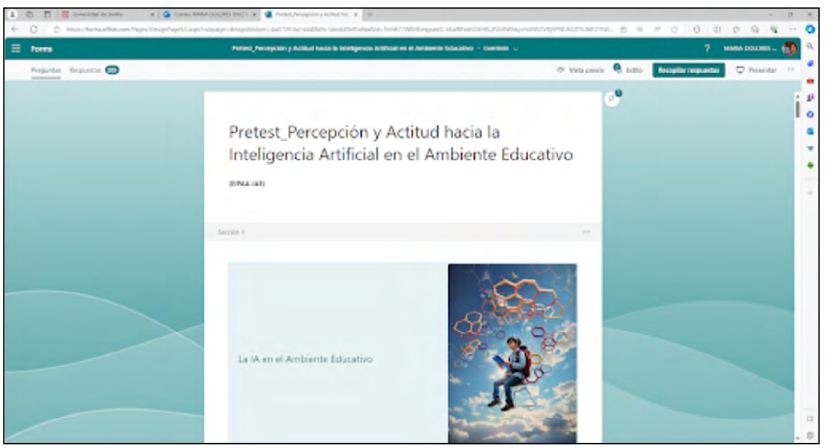



**Figure 3.1.** Título Pretest_Percepción y Actitud hacia la Inteligencia Artificial en el Ambiente Educativo

**Table 3.1.** Dimensions and items of the questionnaire.

| DIMENSION | ITEMS |
|---|---|
| AI/CRITICAL THINKING (AI/PC) | AI/PCI. AI encourages critical thinking in students.<br>AI/PC2. AI can stimulate discussion and critical analysis of complex topics.<br>AI/PC3. AI has helped expand my critical thinking in the classroom.<br>AI/PC4. I have found that AI offers tools that promote creativity in projects.<br>AI/PC5. AI has enriched class discussions, promoting deeper critical analysis.<br>IA/PC6. AI has helped me explore new ideas and approaches in my learning.<br>AI/PC7. I find that AI supports the exploration and development of creative ideas in the classroom. |
| AI/EMOTIONAL COMPETENCES (AI/CE) | IA/CIS. I am excited by the possibilities that AI can offer to education.<br>AI/CE2. I am willing to learn new tools related to AI.<br>IA/CE3. I believe AI is a valuable tool for learning.<br>IA/CE4. I feel intimidated by the use of AI in the classroom.<br>IA/CE5. I think AI could reduce human interaction in the classroom.<br>IA/CE6. AI increases my motivation to learn.<br>IA/CE7. I am more motivated to participate in classes that integrate AI. |
| AI/CREATIVITY (AI/C) | AI/CI. AI can be a valuable tool to promote creativity in the classroom.<br>AI/C2 AI can provide different perspectives and resources that foster creativity.<br>AI/C3 AI can help students develop problem-solving skills.<br>IA/C4. Personalization of learning through AI motivates me to achieve my academic goals.<br>AI/C5 AI can provide additional learning resources that increase my creativity.<br>IA/C6. I find that AI supports the exploration and development of creative ideas in the classroom.<br>IA/C7. AI has helped expand my critical thinking in the classroom. |

Source: developed by author.

In the latent factor "AI/Critical Thinking", 100% of the respondents responded to all items. In relation to the AI/PC1 item, 41.27% agreed and 58.73% totally agreed. Regarding item IA/PC2, 53.97% agreed and 46.03% totally agreed. Regarding item IA/PC3, 6.35% somewhat disagreed, 55. 56% agreed and 38.1% totally agreed. In item IA/PC4, 3.17% disagreed, 6.35% somewhat disagreed, 52.38% agreed, and 38.1% totally agreed. Regarding item IA/PC5, 1.59% somewhat disagreed, 55.56% agreed, and 42.86% totally agreed. Regarding item IA/PC6, 12.7% somewhat disagreed, 47.62% agreed, and 39.68% totally agreed. Finally, in item IAPC7, 3.17% somewhat disagreed, 50.79% agreed, and 46.03% totally agreed.

In the latent factor "AI/Emotional Competencies", 100% of the participants responded to all items. Regarding item IA/CE1, 33.33% agreed and 66.67% totally agreed. In item IA/CE2,

39.68% agreed and 60.32% totally agreed. Regarding item IA/CE3, 22.22% somewhat disagreed, 39.68% agreed, and 38.10% totally agreed. In item IA/CE4, 41.27% agreed and 58.73% totally agreed. Regarding item IA/CE5, 22.22% somewhat disagreed, 42.86% agreed, and 34.92% totally agreed. Regarding item IA/CE6, 3.17% totally disagreed, 20.63% somewhat disagreed, 39.68% agreed, and 36.51% totally agreed. Finally, item IA/CE7 shows that 9.52% somewhat disagreed, 44.44% agreed, and 46.03% totally agreed.

In the latent factor "AI/Creativity", 100% of the participants responded to all items. Regarding item IA/C1, 7.94% somewhat disagreed, 61.90% agreed and 30.16% totally agreed. Regarding item IA/C2, 6.35% somewhat disagreed, 46.03% agreed and 47.62% totally agreed. In relation to item IA/C3, 4.76% somewhat disagreed, 50.79% agreed and 44.44% totally agreed. In item IA/C4, 6.35% somewhat disagreed, 49.21% agreed and 44.44% totally agreed. Regarding item IA/C5, 1.59% totally disagreed, 20.63% somewhat disagreed, 47.62% agreed and 30.16% totally agreed. Regarding item IA/C6, 7.94% somewhat disagreed, 53.97% agreed and 38.10% totally agreed. Finally, regarding item IA/C7, 1.59% totally disagreed, 20.63% somewhat disagreed, 47.62% agreed and 30.16% totally agreed.

## 3.4. Conclusions and Implications

The results of the study led to the following conclusions. We can indicate that our instrument 'Pretest_Perception and Attitude towards Artificial Intelligence in the Educational Environment' (EIPAA-IAE)' has brought us closer to the field of Artificial Intelligence in Education (AIED). We identified the implications of the use of educational techniques with AI and agree with authors who have reported similar results (Chaturvedi, Cambria & Welsch, 2023), including the idea that metacognition processes are essential in the deep learning. Another implication found is the impact on education quality, which can be reflected in creativity and the use of emotional intelligence in the adaptability of study plans (Chen, Chen & Lin, 2020).

We agree that critical thinking is essential, moving beyond the traditional classroom and eliminating didactic resource limi-

tations. This approach transforms educational time and advances new hybrid spaces that favor the development of autonomy among university students. As we have confirmed through their responses, AI facilitates this type of environment (Zhang, 2022). In the era of vigorous artificial intelligence development, the importance of smart classroom development in shaping the future should not be underestimated (Qi, 2019).

Artificial Intelligence undoubtedly provides us with many benefits in managing teaching and learning processes in Higher Education. However, as recommended by guidelines on ethics in its use and the humanistic approach that the concept of education itself should have, we must not forget the human aspect. Therefore, continuing to investigate emotional intelligence and neuroscience is of vital importance. In the responses obtained from the surveyed students, we have identified similarities with the results obtained by Fernández-Berrocal et al. (2022). AI has the potential to enhance creativity by providing diverse perspectives and resources. Creativity, emotional competencies, and personal learning environments are fundamental principles for advancing ethical experiences. As confirmed in other studies, the development of ethical practices is closely linked to the assessment processes in higher education and the types of learning that students can achieve. In this regard, metacognition and deep learning are essential for obtaining significant cognitive evaluation (Castillejos-López, 2022; Oviedo-Guevara, 2023). On the other hand, research findings on AI and its contributions to educational processes reveal a tension between two perspectives: 1) the idea that AI enhances and enriches these formative processes by addressing numerous learning problems; and 2) the concern that this tool could become a privilege accessible only to a few students. This would imply a lack of equality and inclusion in educational processes (Delphine & Guidi, 2023). This issue is one of the central points in the report by the International Commission on the Future of Education, which aims to reimagine our future together.

In conclusion, the proposed instrument we present is useful for identifying teaching and learning processes in higher education with AI. It is a valid and reliable questionnaire, with a Cronbach's alpha of 0.94 and a variance of 66.53%. Therefore, this tool can help measure whether learning transfer occurs when using hybrid and multimodal ecosystems in higher education.

## Acknowledgments

This study was funded by the VI Research and Transfer Plan of the University of Seville (VI PPIT-US), as part of the project entitled "Development of Skills in the Production of Educational Videos with Artificial Intelligence for Teaching: An Initiative for Initial Teacher Training (VIDIA-EDU)", within the 4th Teaching Plan of the University of Seville (Spain), call for Support for Teaching Coordination and Innovation (ref. 221). Call 2023/2024.

## References

Bai, J.Y.H., Zawacki -Richter, O., & Müskens , W. (2022). Developing strategic scenarios for artificial intelligence applications in higher education. In *5th International Open and Distance Learning Conference Proceedings Book* (pp. 47-70). Eskişehir, Turkey. https://iodl.anadolu.edu.tr/proceedings-iodl-2022

Bai, J. Y. H., Zawacki -Richter, O., & Müskens, W. (in press). Re-examining the future prospects of artificial intelligence in education (AIEd) in light of the GDPR and ChatGPT . *Turkish Online Journal of Distance Education*

Boulay, J. (2016). Artificial Intelligence as an effective classroom assistant. *IEEE Intelligent Systems*, *31*, 76-81. https://doi.org/10.1109/mis.2016.93

Castillejos López, B. (2022). Artificial Intelligence and personal learning environments: Attentive to the appropriate use of technological resources by university students. *Education*, *31*(60), 9-24.

Chaturvedi, I., Cambria, E., & Welsch, R. (2023). Teaching simulations supported by Artificial Intelligence in the real world. *Education Sciences*. https://doi.org/10.3390/educsci13020187

Chen, L., Chen, P., & Lin, Z. (2020). Artificial Intelligence in education: A review . *IEEE Access*, *8*, 75264-75278. https://doi.org/10.1109/ACCESS.2020.2988510

Dellepiane, P., & Guidi , P. (2023). Artificial Intelligence and education: Challenges and opportunities from an ethical perspective. *Question /Cuestión*, *3*(76), e859-e859.

Google. (2022). *Google Cloud*. https://cloud.google.com/natural

IEEE (2019). Ethically aligned design: A vision for prioritizing human well-being with autonomous and intelligent systems. In *The IEEE*

*Global Initiative on Ethics of Autonomous and Intelligent Systems*. https://standards.ieee.org/content/ieeestandards/en/industry-connections/ec/autonomous-systems.html

Kasneci, E., Sessler, K., Kuchemann, S., Bannert, M., Dementieva, D., Fishcher, F., ... & Kasneci, G. (2023). *ChatGPT for Good? On opportunities and challenges of large language models for education*. edArXiv preprint. https://doi.org/10.35542/osf.io/5er8f

Meléndez, N., Briceño, M., Gibertoni , J., & Lucente , R. (2023). Text mining applied to sentiment analysis to search for motivation patterns in teacher updating programs. *CIE Academic Journal, 2*(1), 32-40.

OECD (2022). *Recommendation of the Council on Artificial Intelligence*. OECD/LEGAL/0449. https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0449

Oviedo Guevara, L. G. (2023). Dilemma of Artificial Intelligence: critical thinking and digital generations. *Reality and Reflection, 58*, 69-83.

Qi, B. (2019). Analysis on the application of Artificial Intelligence in classroom. *Journal of Physics: Conference Series, 1345*. https://doi.org/10.1088/1742-6596/1345/4/042075

Tuomi, I. (2018). *The impact of Artificial Intelligence on learning, teaching, and education*. European Commission, Joint Research Centre. https://doi.org/10.2760/12297

UNESCO (2021). *Recommendation on the ethics of Artificial Intelligence*. United Nations Educational, Scientific and Cultural Organization. https://unesdoc.unesco.org/ark:/48223/pf0000381137

Zawacki -Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on Artificial Intelligence applications in higher education. Where are the educators? *International Journal of Educational Technology in Higher Education Education, 16*, 1-27. https://doi.org/10.1186/s41239-019-0171-0

Zhang, Y. (2022). Development and application of Artificial Intelligence multimedia technology based on Big Data. *Mob. Info. Syst.*, 2073091. https://doi.org/10.1155/2022/2073091

4

# Artificial Intelligence as a Teaching Tool to Promote the Development of Critical Thinking in Primary Education Students

PhD Gloria Morales-Pérez
Escuela Universitaria de Osuna, Spain
glorialuisamp@euosuna.org

PhD Pedro Román-Graván
Universidad de Sevilla, Spain
proman@us.es
https://orcid.org/0000-0002-1646-9247

María de los Ángeles Domínguez-González
Universidad de Sevilla, Spain
mariandg@us.es
https://orcid.org/0000-0002-9687-9325

Manuel Reina-Parrado
Universidad de Sevilla, Spain
mreinap@us.es
https://orcid.org/0000-0002-0801-0938

**Abstract**
The use of Artificial Intelligence (AI) as a teaching tool to promote the development of critical thinking in primary education students, and its integration into the teaching-learning process, represents an important step in its use as a potentially transformative resource, allowing pedagogical challenges to be addressed through innovative and personalized approaches, focused on active learning and the different teaching strategies that can be implemented in the service of education. AI, understood as the ability of machines to simulate human cognitive processes, offers significant opportunities to enrich teaching-learning processes. By leveraging machine learning algorithms and data ana-

lytics, educators can design adaptive educational experiences that fit the individual needs of students, thereby encouraging their engagement and active participation in the learning process. Through the development of critical thinking, which is considered a fundamental skill that integrates the key competencies of the current educational system, students are encouraged to acquire the necessary skills to face the challenges of a society that needs people who are capable of handling large amounts of information. A pedagogical approach focused on students and a careful selection of active methodologies is necessary to ensure that the use of AI as a teaching tool encourages critical thinking and contributes significantly to the comprehensive development of students and the achievement of educational objectives in the digital age.

**Keywords:** Artificial Intelligence, critical thinking, active learning, teaching strategies, active learning methodologies.

## 4.1. Theoretical Foundation

Currently, the latest advances in the field of AI are representing a very notable change in many sectors of society in every sense. In the field of education, the emergence of AI entails a paradigm shift that will undoubtedly disrupt many of the concepts that, to date, we have taken for granted, including what is currently understood as intelligence, the methodologies of teaching-learning, and the objectives of education (Peña et al., 2020). In this context, there are those who express their fears about this revolution with a resistance to change, revealing uncertainties and a process of adaptation that will not be easy. However, other authors, such as Peña et al. (2020), have a less catastrophic view and consider that AI, although it will disrupt a good part of our current conception of the teaching-learning process, is an excellent tool at the service of education. However, it is paradoxical that one of the fears that society faces with the arrival of AI is the fear that it will reduce our ability to think like humans, that it will significantly worsen our cognitive abilities in the long term, or that even decision-making will become worse (Aparicio Gómez, 2023).

There is no doubt that, given the growing proliferation of AI and the multitude of tools and applications that emerge every day, it is essential to address these concerns in a thoughtful and proactive manner. It is necessary to develop an ethical and regulatory framework that guides the responsible use of AI in the ed-

ucational field and in society in general. All of this involves the crucial need to promote digital literacy for the proper use of AI, and to encourage users, whether teachers or students, the necessary skills that allow them to understand and critically evaluate not only the enormous amount of information at their fingertips, but also the role of AI in their lives and in the educational process. The integration of AI as a teaching tool in the teaching-learning process can play an important role in the development of higher cognitive skills, such as critical thinking, problem solving and creativity (Parra & Lago de Vergara, 2003). In the framework of current regulated training, in which competencies are the key to the teaching-learning process, the development of these skills that allow students to fully grow as a person is more necessary than ever (Aguila, 2014). To achieve this, it is essential to adopt a student-centered pedagogical approach and a careful selection of active methodologies that maximize the benefits of AI while mitigating its potential risks (Benzanilla et al., 2019). In this way, AI can become a powerful ally in the search for a more inclusive, personalized education aimed at the comprehensive development of students in the digital age.

The development of critical thinking has become a fundamental objective in current education, since it enables students to analyze, evaluate and synthesize information in a reflective and informed manner, which allows students to not only understand complex concepts, but also apply them in various situations. Developing critical thinking allows students to be more autonomous in their learning process, being able to ask meaningful questions, solve problems and make informed decisions (Gautreaux & Ross, 2018). These skills are essential for their personal and professional development, preparing them to face a constantly changing world and adapt to new circumstances with resilience and creativity.

Some studies such as the one prepared by Vergel Ortega, Rincón Leal and Paz Montes (2019) mention that the educational practice in which students create, discover, imagine and assume information by interacting with other classmates using certain mobile applications, allows autonomous learning that favors the development of critical thinking (Vergel Ortega et al., 2019). Beyond the competencies, it is important to point out that critical thinking does not generate new ideas but rather re-

views, evaluates, values and analyzes the ideas that come to the students, reviewing what is understood and processed, which is why it requires a training process (Nieto & Saiz, 2011).

The development of critical thinking transcends what is done in the classroom, and some authors already point out that many of the repetitive tasks to which students are subjected harm or go against what they need to be able to develop it (López, 2012), also stating that the very tools that allow for a more conducive learning towards its promotion involves training in reading comprehension, problem solving, and language management.

## 4.2. AI as a Tool to Develop Critical Thinking

AI offers various tools and applications that can enhance the development of critical thinking in primary education students. A good example of this is intelligent tutoring systems, which can be adapted to the level of each student, providing personalized feedback that encourages reflection and analysis. On the other hand, it is important to note that AI-based learning platforms can offer interactive activities that challenge students to solve problems and make decisions, thus promoting the ability to think critically.

In a class context in which active participation is encouraged and contributions are valued, students develop higher motivation, and their level of participation increases. This undoubtedly affects the development of critical thinking, since inquiry strategies, problem solving and a climate of collaborative reflection, which encourages the full development of the necessary skills, is part of the strategies and tools that teachers must provide to establish the appropriate environment and methodological conditions (López, 2012).

In this environment of empowerment through participation, it is important to value not only the types of questions that are asked, as well as the way in which they are formulated, but also the tools and strategies that are put into operation (López, 2012).

One of the highlights is the potential of AI to cultivate critical thinking in primary school students. Through access to AI-enabled digital tools and resources, students can explore complex problems, critically analyze information, and reach informed

conclusions. This approach not only strengthens students' cognitive skills but also enables them to face real-world challenges with an analytical and reflective mindset. To this end, it is necessary to know the elements required to ask good questions, and recognize the different types of questions that can be asked (Hervás-Gómez et al., 2023). However, it is crucial to address the ethical and social implications associated with using AI in the classroom. Educators must promote the responsible and ethical use of technology, encouraging digital literacy and critical consciousness among students.

## 4.3. Objectives

The use of AI as a teaching tool in primary education presents promising opportunities to enrich the educational process and cultivate critical thinking in students. However, its effective implementation requires a thoughtful and careful approach that considers both the benefits and challenges associated with this emerging technology.

The main objective of this work was to analyze how AI can be used as a tool for the development of critical thinking in primary education classrooms, through its integration as a teaching tool in the classroom.

With the secondary aim of challenging and stimulating the cognitive and metacognitive skills of students, the use of intelligent algorithms and data analysis provided by AI systems was proposed through activities and exercises specifically designed to this end, thus providing immediate and personalized feedback on student performance, to encourage reflection and self-learning, and identify areas for improvement in the development of critical thinking. It will be necessary for AI to adapt to each context and the needs of the students, taking into account inclusive principles, and ensuring the active participation of all students in the educational process.

We trust that this proposal will help teachers understand the implications of the effective use of AI as a teaching tool for the development of critical thinking in the school context. Finally, it is considered that this work is a starting point for collaboration between education professionals who seek innovation and

continuous improvement of educational practice through the use of emerging tools such as AI and stop seeing it as a threat to teaching.

## 4.4. Methodology

Today's school faces the constant challenge of not only training in knowledge but also in skills that respond to the problems of today's society. The role of AI in the educational context is nothing more than a necessary view of symbiosis that must be contemplated by both areas. This inclusion of AI in the field of education is not only restricted to facilitating the acquisition of knowledge but has promoted a more complete educational approach adapted to the individual needs of students. The ability to adjust the educational experience according to the abilities, interests and learning pace of each student has materialized thanks to this technology, whose presence in education is increasingly solid and constantly evolving. In addition to the personalization of learning, AI has been positioned as a valuable tool for the development of skills linked to problem solving and critical thinking. By creating simulations and virtual scenarios, students face complex situations that require the application of knowledge and skills to make informed decisions, ask relevant questions, and evaluate responses through critical analysis to ensure their validity. Different research on the use of AI to promote Critical Thinking demonstrates how this technology can strengthen the analytical and evaluation capacity of students, preparing them to address the challenges of tomorrow (Palau, 2023).

It is not a simple challenge, since this commitment involves considering, in a slow and analytical way, the problems and difficulties faced by its use in the classroom. This is why the first barrier detected is undoubtedly related to the appropriate use of AI and knowledge of the possibilities it offers in an educational context. It is therefore necessary to take into account the adequate training of teachers to implement the use of AI as a teaching tool, not only in terms of active learning methodologies, but also in the use of AI itself, as well as the tools that will be used, intentionally selecting those that best adapt to the objectives and needs of the students, such as accessibility, attention to diversity

and the possibilities of the classroom in question. The training of these teachers in the use of AI and its integration into a learning process to obtain the best performance is no less necessary. The training of teachers in the numerous tools and skills that open up for the new teaching model that society demands is not something new and is present every time this role modifies either its functions or its role in the teaching-learning process.

The creation of activities that are effective in promoting the development of critical thinking implies being able to create simulation games, debates moderated by chatbots, and research projects guided by intelligent recommendation systems through the appropriate use of the well-known prompts, which involves language development and understanding how different AI-based tools work. Educators must create activities that make use of all the capabilities that AI has for the benefit of the teaching process, establishing an evaluation process and the necessary mechanisms to assess the progress of students in the development of critical thinking, as well as the effective use of language, the feedback that they use to give orders to the AI tools, the strategies they put into operation, etc. (Díaz & Montenegro, 2010).

Continuing with the challenges that this technology presents, it is essential to highlight that the incorporation of AI in education also entails a series of challenges and ethical considerations. One of the recurring topics of debate focuses on the impact that AI can have on the teacher's functions and the role that he or she plays in the training process. While AI has the potential to improve the efficiency and quality of education, it raises questions about the role of humans in the educational process. Related to the ethical issue, and without diminishing its relevance, it is important to point out that, like any emerging technology, preventing the widening of the so-called digital divide poses a challenge, since the availability and adequate training to manage it effectively are not guaranteed for all users on equal terms, which can contribute to the widening of said gap and accentuate existing educational inequalities. It is crucial to rigorously address these challenges to ensure that the integration of AI in education promotes the inclusion and equality principles of today's school.

In recent decades, artificial intelligence has experienced rapid advancement, generating extensive discussions and debates about its integration in the field of education. To understand the

implications of AI in education and its responsible approach, numerous experts have contributed works that broaden the perspective on the role of artificial intelligence in education and its influence on the development of skills such as problem solving and critical thinking. Dillenbourg & Jermann (2007) discuss how to design integrative scripts for collaborative learning supported by technology. Artificial intelligence can play a crucial role in designing and adapting these scripts to facilitate problem solving and critical thinking among students.

On the other hand, Liu & Wang (2020) explore how artificial intelligence can be applied in teaching thinking skills, such as critical and analytical thinking in the field of higher education. Different approaches and technological tools that can foster the development of these competencies among students are discussed. Ayuso indicates in his study that teachers in initial training appreciate the benefits associated with the incorporation of technology, specifically AI, in the teaching-learning process, such as increased motivation, the development of skills linked to problem solving, and the promotion of creativity, which would contribute to the achievement of meaningful and enriching learning (Ayuso del Puerto & Gutiérrez Esteban, 2022).

Authors such as Bautista-Castaño et al. (2019) examine how artificial intelligence has influenced higher education by highlighting the opportunities and challenges that this technology presents to foster critical thinking and problem solving among students (Deroncele-Acosta et al., 2020). For their part, Pérez-Ortiz et al. (2018) analyzed various artificial intelligence techniques used in education and carried out an analysis in which they attempted to explain how these techniques can be applied to promote the development of critical-thinking and problem-solving skills in educational environments. Responsible approaches to AI, as mentioned by Terrones Rodríguez (2021), are essential to ensure that this technology is used ethically and benefits the student learning process.

According to Aparicio Gómez (2023), AI in education has the potential to empower students, encourage creativity and critical thinking, and prepare them to face the challenges of the 21st century. With careful and thoughtful implementation, we can make the most of the transformative power of AI in education (Aparicio Gómez, 2023).

In short, this work aims to establish an active methodology that allows using Artificial Intelligence as an element that favors the development of critical thinking. Therefore, it is based on a participatory and collaborative approach that involves primary education students as main actors in the exploration and use of AI in the field of education.

This active role is considered one of the key aspects of the research and experimentation process of the use of AI in the aforementioned context. In this way, the methodology used was established in different phases, with the aim of promoting the development of critical thinking through the use of AI as a teaching tool.

It began with a first phase that consisted in the identification and compilation of Artificial Intelligence tools that could serve the objective of the project.

In an attempt to know the current panorama of AI tools available to work on the development of critical thinking, it was proposed that students actively get involved in said search, selection and analysis of the various AI tools.

The necessary bibliographic review that was carried out involved an extensive search for information in academic sources, books, magazines and reliable online sources that shed light on the latest advances and research on this topic, and allowed exploring different applications from different points of view. By becoming familiar with the different existing possibilities and the different applications that currently exist of AI to implement in the educational context, an unexplored field of knowledge was opened with multiple possibilities that were evaluated for use. At the same time, they were introduced to the different skills of information search and critical analysis, which provided them with a solid foundation to continue with the rest of the project appropriately.

The work was organized both individually and in groups to compile and analyze the information collected. Classroom debates and discussions were held to share findings and perspectives, encouraging critical thinking and reflection on the potential impact of AI on education to emerge in the process. As this phase progressed, the students began to discern the different AI tools and approaches, as well as the potential advantages and challenges associated with their integration into the educational setting.

The next phase consisted in the implementation of the different activities that were previously designed, with the aim of finding skills related to critical thinking, such as the preparation of prompts and discussion groups moderated by an AI. To this end, the class group was divided into four smaller groups; each of these groups was in charge of designing an activity using AI tools, and was invited to apply their knowledge acquired in the first stage of the study to design practical activities using writing tools. These activities were presented as a challenge or problem resolution that the other groups had to complete. Collaboration between peers became a fundamental aspect, since the students had to put themselves in each other's shoes and think about activities with clear didactic objectives that addressed different learning areas in a cross-sectional manner. During this phase, the students were challenged to work collaboratively to develop activities that addressed specific teaching objectives and were appropriate for primary education. Likewise, the possibility of establishing levels of difficulty in the activities enriched the learning experience by adapting to the individual needs of the students and their different learning rates.

With the development of proposals for use and activities to promote skills related to the development of critical thinking, we started the third phase, which focused on applying the AI Apps and the activities prepared by the students. Each group had the responsibility of carrying out the others' proposals and providing a critical and constructive evaluation. This phase undoubtedly contributed significantly to the development of critical thinking and the ability to design and evaluate educational materials based on AI. The students had the opportunity to experience the practical use of AI tools in the educational process, allowing them to better understand their potential and applicability in the classroom. Additionally, the feedback received from peers drove continuous improvement of learning and valuing of teamwork, and promoted a culture of collaborative feedback.

## 4.5. Results

Through the different phases of the project, it was possible to understand the use that can be made of the different AI tools

currently available for the development of critical thinking and their application in the field of education. The identification and compilation of the different AI tools allowed for an analysis and exploration of the different resources that can be found and analyzed with a critical view, where the advantages and challenges associated with the integration of AI in the process of implementation could be discerned.

The applied work methodology enabled the development of key skills for the responsible and effective use of AI in education, and enabled the acquisition of skills related to the development of critical thinking, creativity, and teamwork.

## 4.6. Discussion and Conclusions

The implementation of AI in the field of education is presented as a challenge that requires a deep and detailed analysis of the problems and obstacles that arise in the school environment. One of the main obstacles identified is related to the appropriate use of AI and understanding the possibilities it offers in the educational context. It is essential to guarantee adequate teacher training to make the most of the potential of AI as a teaching tool, both in terms of active teaching-learning methodologies and in the management of the AI tools themselves and their selection to adapt to the objectives and student needs.

Creating effective activities to foster the development of critical thinking involves the ability to design simulation games, discussions moderated by chatbots, and research projects guided by intelligent recommendation systems. This requires a command of the language and an understanding of how different AI-based tools work. Likewise, it is necessary to establish evaluation processes and mechanisms to assess students' progress in the development of critical thinking and the effective use of language, as well as the strategies they use in their interactions with AI tools. Another important challenge posed by the integration of AI in education is the ethical considerations related to the role of the teacher and the impact on the educational process. While AI can improve the efficiency and quality of education, it also raises questions about the human role in the educational process and the possible widening of the digital divide. It is essential to rigor-

ously address these challenges and ensure that the integration of AI in education promotes inclusion and equity.

The results of this study suggest that AI can play a crucial role in fostering critical thinking among students. The literature review and empirical research conducted show that AI can be used effectively to design educational activities that promote critical thinking and problem solving. However, it is important to take a responsible approach to the use of AI in education, ensuring that it is used ethically and benefits the students' learning process.

This study highlights the importance of an active methodology that uses AI as a tool for the development of critical thinking in education. It was shown that actively engaging students in the exploration and use of AI in the classroom can significantly contribute to the development of cognitive skills and promote meaningful and enriching learning. It is essential to continue researching and exploring new ways to use AI in education responsibly and effectively to improve the quality of teaching and learning in the 21st century.

In conclusion, the use of AI as a teaching tool in primary education classrooms offers significant opportunities to promote the development of critical thinking in students. However, its successful implementation requires a comprehensive approach that includes teacher training, the appropriate selection of technological tools, the design of student-centered pedagogical activities and the use of active teaching methodologies that would undoubtedly complement this puzzle.

This work aims to provide a starting point with an argued theoretical basis and a practical intervention proposal that we hope will be the beginning of a productive line of work and a source of collaboration between professionals to guide the integration of AI as an educational resource that allows for the development of critical thinking as a fundamental tool that serves as a battering ram against fake news and the so-called post-truth that circulates so much in today's society.

## References

Águila, E. (2014). *Habilidades y estrategias para el desarrollo del pensamiento crítico y creativo en alumnado de la Universidad de Sonora* (doctoral thesis). Universidad de Extremadura, Spain.

Aparicio Gómez, W. O. (2023). La inteligencia artificial y su incidencia en la educación: transformando el aprendizaje para el siglo XXI. *Revista Internacional de Pedagogía e Innovación Educativa*, *3*(2), 217-229. https://doi.org/10.51660/ripie.v3i2.133

Ayuso del Puerto, D., & Gutiérrez Esteban, P. (2022). La inteligencia artificial como recurso educativo durante la formación inicial del profesorado. *RIED-Revista Iberoamericana de Educación a Distancia*, *25*(2), 347-362. https://doi.org/10.5944/ried.25.2.32332

Bautista-Castaño, I., González-Torre, P. L., & Hinojo-Lucena, F. J. (2019). A systematic review of research on the influence of artificial intelligence on higher education. *Sustainability*, *11*(11), 3198.

Bezanilla, J., Fernández-Noriega, D., Poblete, M. y Galindo-Domínguez, H. (2019). *Metodologías para el pensamiento crítico de enseñanza-aprendizaje en la educación superior: La opinión del maestro*. https://doi.org/10.1016/j.tsc.2019.100584

Deroncele-Acosta, A., Nagamine-Miyashiro, M., & Medina-Coronado, D. (2020). Desarrollo del pensamiento crítico. *Revista Maestro y Sociedad*, *17*(3), 532-546.

Díaz, L., & Montenegro, M. (2010). *Las prácticas profesionales y el desarrollo del pensamiento crítico.* XXXII Simposio de Profesores de Práctica Profesional, Universidad Nacional de Rosario, Argentina. http://www.economicas.uba.ar/wpcontent/uploads/2016/05/ CECONTA_SIMPOSIOS_T_2010_06_Diaz_Montenegro.pdf

Dillenbourg, P., & Jermann, P. (2007). Designing integrative scripts. In F. Fischer, I. Kollar, H. Mandl, & J. M. Haake (Eds.). *Scripting Computer-Supported Collaborative learNing: Cognitive, computational, and educational perspectives* (pp. 275-301). Springer.

Gautreaux, M., & Ross, W. (2018). Pensando de manera crítica sobre el pensamiento crítico. *Aula Abierta*, *47*(4), 383-386.

Hervás-Gómez, C., Díaz-Noguera, M. D., Román-Graván, P., & Domínguez-González, M. Á. (2023). Educación inclusiva en la era de la inteligencia artificial: análisis de PROMPT para la atención a la diversidad. In C. Hervás-Gómez, P. Román Graván, J. García Jiménez, & C. Argüello Gutiérrez (Eds.). *Conexiones digitales: las tecnologías como puentes de aprendizaje* (pp. 529-549). Universidad de Sevilla.

Liu, D. Y., & Wang, Y. (2020). Application of Artificial Intelligence technology in the teaching of thinking skills in higher education. *Education and Modernization*, *1*(1), 29-33.

López, G. (2012). Pensamiento crítico en el aula. *Docencia e Investigación*, *22*, 41-60. Recuperado de https://bit.ly/30chE8K

Nieto, A. M., & Saiz, C. (2011). Skills and dispositions of critical thinking: are they sufficient? *Anales de Psicología, 27*(1), 202-209.

Palau, N. C. R. (2023). Inteligencias artificiales en la formación del pensamiento crítico en Ciencias Sociales. *Maestro y Sociedad, 20*(4), 1023-1029.

Parra, E., & Lago de Vergara, D. (2003). Didáctica para el desarrollo del pensamiento crítico en estudiantes universitarios. *Educación Médica Superior, 17*(2) https://bit.ly/3fsabch

Peña, V. R. G., Marcillo, A. B. M., & Ramírez, J. A. Á. (2020). La inteligencia artificial en la educación. *Dominio de las Ciencias, 6*(3), 28.

Terrones Rodríguez, A. L. (2021). *Inteligencia artificial responsable: humanismo tecnológico y ciencia cívica.* Trillas.

Vergel Ortega, M., Rincón Leal, O. L., & Paz Montes, L. S. (2019, November). Mobile devices for the development of critical thinking in the learning of differential equations. *Journal of Physics: Conference Series, 1408*(1), 1-6).

Pérez-Ortiz, M., Gómez-Pulido, J. A., & Rojas, I. (2018). Analysis of Artificial Intelligence techniques in education. *Applied Sciences, 8*(10), 1885.

5

# AI as a Tool for Educational Transformation: Keys for Responsible Implementation Fostering Digital Well-being

PhD Ortí Martínez
Universidad Católica de Murcia, Spain
jorti@ucam.edu
https://orcid.org/0000-0002-1761-3140

PhD Pardo Ríos
Universidad Católica de Murcia, Spain
mpardo@ucam.edu
https://orcid.org/0000-0001-7965-0134

Jorge Burgueño López
Universidad Pontificia Comillas, Spain
jburgueno@comillas.edu
https://orcid.org/0000-0001-6024-9500

Javier Plitt Stevens
Universidad Católica de Murcia, Spain
ejplitt@ucam.edu
https://orcid.org/0000-0002-8452-5386

**Abstract**
Artificial Intelligence has the necessary potential to transform education, but careful planning of its implementation is essential, knowing what we are doing and why we are doing it. The opportunities for AI to personalize learning, foster connections between subjects, deepen concepts and put learning into practice are enormous. However, as these technologies advance, it is important to rethink our relationship with them, i.e., to assess digital well-being. It

is essential to develop a formative, healthy and safe relationship with technology, with the main objective of finding a balance in digital life by developing skills and competences that allow minimizing the risks without losing the benefits. This chapter addresses some of the challenges that need to be considered when implementing AI in education, while respecting the digital well-being of teachers and students, and offers recommendations that may inspire those who wish to start working with this technology in the classroom.

**Keywords:** AI ethics; Artificial Intelligence in education; digital well-being; personalization of learning; teacher training.

## 5.1. AI in Education

The current society of knowledge and information has brought about changes in the nature and scope of education, leading educational systems worldwide to adopt strategies and policies to introduce and improve the use of digital tools (Timotheou et al., 2023). In this context, in recent years, international organizations have emphasized the importance of structuring digital literacy, which should be present at all levels of the educational sphere, with the primary goal of integrating technologies into teaching-learning environments. For example, UNESCO (2016) already stresses the need to use technologies effectively, promoting both the expansion of freely accessible resources and the implementation of distance learning with the aim of improving the quality of education.

To this reality of the integration of digital skills in education, which has been present for decades, has been added, with almost unexpected vehemence, the emergence of Generative Artificial Intelligence (GAI), especially after the boom caused by the release of the new version of OpenAI's ChatGPT-3 in 2022. This tool, capable of generating texts of high argumentative quality and with a great ability to maintain a coherent conversation, attracted one million users in the first five days after its launch, becoming the fastest growing application in history. Given the capabilities of GAI, this phenomenon has a particular impact in the field of education (García Peñalvo, 2023) and has become an emerging topic in research on digital literacy in educational settings (Ayuso del Puerto & Gutiérrez Esteban, 2022; Su et al., 2023).

Education plays an important role in promoting social justice (Atterberry-Ash, 2023), fostering equal opportunities and encouraging responsibility in building a fairer and freer society. In a world where digitalization has such a strong presence and influence on people's lives, it is essential that all students have the opportunity to learn and explore the use of digital tools and, in particular, artificial intelligence.

In this way, authors such as Baidoo and Owusu (2023) propose to explore the potential of ChatGPT to improve education and student learning. In a new scenario where there are tools with immense potential and opportunities (and also dangers, it must be said), it is essential to experiment with and understand them in order to promote the development of strategies and the creation of motivating activities that create a dynamic and engaging educational environment (Grané, 2024). Sabzalieva and Valentini (2023) propose several strategies for integrating and using the OpenAI application in the classroom, assigning it roles such as study companion, Socratic opponent, complementary guide, co-designer or dynamic evaluator, among others.

AI enables tasks that enhance the learning experience of students, such as creating summaries or extracting ideas from text, translating text into different languages and improving their writing, creating videos or images from text, overcoming writer's block when starting to write, acquiring vocabulary through conversation, or self-assessing knowledge by receiving instant feedback on performance in assignments or exams (Vicerrectorado de Innovación Educativa, 2023).

Beyond the mere integration in the classroom, the aforementioned digital tools are widely used by teachers in designing activities, formulating questions and planning lessons (Sánchez Vera, 2024). This highlights the close collaboration that can be established between these technologies and teaching.

Each of these ideas about the use of AI tools in education should include a natural discussion about their application, thus fostering debates inherent to the use of these applications, such as the limited ways in which educational processes can be modelled, the different ways in which AI technology risks perpetuating social harm for students at risk of exclusion, or the ecological and environmental costs of data-intensive AI forms and devices (Selwyn, 2024); as well as other ethical aspects such as the mis-

use of information (partial or biased), the creation of fake information (*deepfake*) or the sharing of personal data and the lack of legislation in this regard.

The absence of a regulatory framework for artificial intelligence is hampering progress in its research and development. The definition of parameters for action, limits, conditions and responsibilities is crucial for progress in this field. It is necessary to determine whether these technologies can be held legally responsible for their actions, either wholly or in part. The lack of clarity in this respect creates uncertainty and limits investment and the development of new AI applications, especially when these tools are used with minors.

Establishing clear and specific regulations for AI would promote responsible innovation, protect students, teachers and families, and ensure the ethical and safe development of this technology.

## AI and learning

The advent of AI could lead to a radical change in the way we value truth. In a future where artificial intelligence is ubiquitous, verisimilitude, or the appearance of truth, may be more important than truth itself (Casanovas, 2023). However, learning and truth are closely related. Learning is the process of acquiring new knowledge or skills, and truth is the correspondence between knowledge and reality. Therefore, learning should be a driving force that brings us closer to truth.

Learning aims to develop critical skills in students by promoting holistic thinking and reasoning. These skills allow evaluating information objectively and drawing one's own conclusions. It is this way of being and doing in the classroom that this chapter seeks to support.

From a pedagogical point of view, the emergence of AI may require a repositioning of the true role of the educational institution. Organic Law 3/2020, of December 29th, which amends Organic Law 2/2006, of May 3rd, on education (BOE number 340, Wednesday December 30th 2020), emphasizes the development of competences and personalized learning. The aim is that no student should leave compulsory education without the necessary skills to take on personal, academic, social and professional

projects. The competency-based approach goes beyond the mere acquisition of knowledge and focuses on the ability to apply it to real-world problem-solving situations.

According to Galán, Ruiz and Jiménez (2023), generative AI can play a relevant role in achieving these objectives, as it can promote the following:

- Personalized learning, adapting content and activities to the individual learning needs and styles of each student.
- Develop critical thinking by exposing students to different perspectives on a topic and helping them to critically analyze and evaluate information.
- Creative problem solving, encouraging students to explore different approaches to problems and find innovative solutions.
- Personalize content, using generative AI to create personalized learning materials tailored to each student's knowledge, skills and interests.
- Provide feedback, analyzing students' work and providing valuable information to help them progress.

In addition, AI can mimic and enhance certain human skills in various areas:

- **Listening**: automatic translation and speech recognition (Delić et al., 2019). AI can automatically translate text and audio from one language to another, facilitating communication between students and teachers from different cultures. Speech recognition allows AI to interact with students naturally through spoken commands.
- **Speech**: voice synthesis and human-machine dialog (Chiba et al., 2019). Speech synthesis allows AI to naturally generate spoken text, which can be useful for creating educational materials or assisting students with learning disabilities. Human-machine dialogue allows AI to interact with students in a conversational manner, answering their questions and providing them with information.
- **Observation**: computer vision, image recognition, and text recognition (Paglen, 2019). Image recognition allows AI to analyze images and videos to extract information, such as the

number of people in a classroom or the type of activities taking place. Text recognition allows AI to read and understand written text, which can be useful for correcting assignments or translating documents.

- **Thinking**: theorem proving (Sarma & Hay, 2017). AI can prove mathematical theorems, which can be useful for mathematics education and research.
- **Learning**: scientific learning and context adaptive learning (Colchester et al., 2017). Machine learning allows AI to learn autonomously from data, which can be useful for creating personalized tutoring systems. Intelligent adaptive learning allows AI to create learning plans for each student based on their needs and learning style.

Artificial Intelligence (AI) can not only transform education, but also free up teachers to spend more time with their students. Currently, much of a teacher's time is spent on repetitive tasks such as grading papers and exams, limiting the time available for teaching, research, and personal interaction with students. This is where AI plays a fundamental role. Systems such as Holstein, McLaren, and Aleven's intelligent tutoring system (2017) or Cui, Zhang, and Li's intelligent assessment system (2019) automate these repetitive tasks, freeing teachers from administrative burdens and allowing them to focus on what really matters: human interaction and each student's individual learning experience.

Finally, it is important to note that AI technology can also enhance teachers' skills, helping them to provide students with personalized and accurate pedagogical guidance that they could not provide before, and significantly improve the efficiency of knowledge transfer. In addition, AI allows teachers to devote more time and energy to communicating with students, allowing them to focus on developing other competencies in students.

## 5.2. Digital Well-being and AI

In the popular imagination, AI is seen as a possible threat, but it is important to recognize its potential as a catalyst for digital well-being when implemented ethically and responsibly. Digital well-being has become a relevant topic in the age of technology,

especially with the increasing integration of AI into various aspects of everyday life and education. Technological change is very fast and generates a lot of impact.

This phenomenon of immediacy and frugality also influences concepts and theories, so we have to consider digital well-being as a dynamic concept influenced by technological and social changes (Vanden, 2021). Digital well-being is often implicitly defined by juxtaposing it with undesirable habits (e.g., drawing a parallel between technology use and unhealthy eating habits) or with afflictions that represent digital discomfort, such as technology addiction. This is surprising, as well-being is usually understood not as the absence of an undesirable condition, but rather as "complete physical, mental, and social well-being and not merely the absence of disease or infirmity" (World Health Organization (WHO), 2020). At this point, we need to move towards a conceptual construction of well-being based on positive aspects and not on the absence of negatives.

The "quest for digital well-being" seems to be the challenge to be overcome (Quispe et al., 2020). AI can be the problem or the solution, as it can offer personalized solutions that promote healthy habits in the use of technology, thus improving the quality of life of users. At the same time, it is crucial to address the challenges it poses, such as privacy and the digital divide, to ensure that its integration in education effectively contributes to the well-being of students and educators. In this sense, the United Nations advocates for the responsible use of AI, highlighting its potential to contribute to the achievement of the Sustainable Development Goals (SDGs) (United Nations, 2023). AI is presented as a powerful tool to address the complex challenges of the present, allowing us to solve current problems with the technologies of the future.

This technological revolution has led professionals, researchers, scientific societies and institutions to open the debate on AI in education. UNESCO has developed a *Guidance on Generative AI in Education and Research*. This document explores some of the ways in which AI can contribute to digital well-being, such as: a) information management and privacy; b) emotional well-being and mental health; c) education and digital literacy; and d) prevention of cyberbullying and online violence.

## Conscious, balanced and safe use

Conscious and balanced use of AI is essential to maximize its benefits and mitigate potential risks in various fields, including education and research. Adopting a reflective and ethical perspective in the implementation of AI can help ensure its positive impact on society (Moya & Eaton, 2023).

Some key considerations to promote a conscious and balanced use of AI are:

- Awareness of AI capabilities and limitations: It is critical to consider the capabilities and limitations of AI when using it in educational and research contexts. Recognizing that AI is a powerful but not infallible tool can help avoid unrealistic expectations and poor decisions based on overestimating its capabilities.
- Impact assessment and ethics in AI implementation: Before integrating AI into educational or research processes, it is important to conduct a comprehensive assessment of its impact on users, society, and the environment. Consideration of ethical issues such as equity, transparency, and accountability can guide the ethical implementation of AI and ensure that it is used responsibly and fairly.
- Promoting digital literacy in AI: Promoting digital and AI literacy among users, including students, researchers, and professionals, is key to the conscious and balanced use of technology. Providing education on the basic principles of AI, its applications, and its ethical implications can empower individuals to make informed and ethical decisions about its use.
- Establish clear policies and guidelines: Developing clear policies and guidelines for the use of AI in educational and research environments can provide a regulatory framework that promotes conscious and balanced use. Establishing protocols for security, privacy and ethics can help mitigate risks and ensure the responsible use of AI in decision-making and knowledge generation. In this regard, the European strategy on AI aims to "build a resilient Europe for the Digital Decade", where people and businesses must be able to enjoy the benefits of AI while feeling safe and protected, and ensuring that AI is human-centered and trustworthy (An EU approach to artificial intelligence | Shaping Europe's digital future, 2024).

- Security, privacy, and separation are fundamental issues to consider in the development and application of artificial intelligence (AI). These elements are critical to ensure user trust, protect sensitive data, and mitigate potential risks associated with the use of AI in various contexts, including education and research. Ensuring compliance with data protection regulations, such as the European Union's General Data Protection Regulation (GDPR), is essential to protect user privacy (General Data Protection Regulation (GDPR), 2016).

## 5.3. Formative Use of Artificial Intelligence and Academic Integrity

The debate about the use of artificial intelligence (AI), especially large language models (LLMs), in academic education revolves around academic integrity. Perkins (2023) warns of the difficulty of determining the originality of content generated by students using LLMs, as the variability of text generation and the limitations of current plagiarism detection tools make it difficult to detect the use of these models.

The integration of AI in education therefore poses significant challenges to academic integrity, but also offers opportunities to enrich the educational process. It is imperative to adopt a balanced approach that promotes the ethical and responsible use of AI and ensures that assessments accurately reflect students' skills and knowledge.

### Evaluations and good practices

In the context of face-to-face instruction, traditional assessments -such as written and oral exams administered in person- are considered virtually risk-free in terms of academic integrity. These assessment methods allow instructors to directly observe students' thought processes, ability to reason, and depth of understanding. While valuable, these methods may not fully capture the abilities of all students, especially those who may not perform well under pressure or have different learning styles.

However, AI-powered assessments offer the opportunity to personalize and adapt tests to meet the individual needs of stu-

dents. Tools such as adaptive learning systems can adjust the difficulty of questions in real time based on students' responses, which could provide a more accurate measure of their understanding and skills. Yet, this approach presents challenges related to the authenticity of student responses and the potential for inappropriate use of AI to complete tasks (Ali et al., 2021).

Tasks could be designed to be more complex, mimicking real-world problems in business and academia, and requiring students to explain how, when, and with what data they used AI. This approach promotes not only the development of technical skills, but also the ability to argue and ethically justify the use of AI tools.

Some key points regarding the aforementioned balance are:

- Digital ethics education: It is important to educate students about digital ethics and academic integrity from the beginning of their education. This includes discussions about the appropriate use of AI and how to properly cite AI-generated content in their work (Yufei et al., 2020).
- Advanced anti-plagiarism tools: Develop and deploy anti-plagiarism tools that can detect not only traditional plagiarism, but also AI-generated content. This will require constantly updating the databases of these tools to include examples of AI-generated text.
- Authenticated assessments: Implementing assessments that require the application of knowledge in real-world scenarios, group projects, and oral presentations can help ensure that the work reflects students' true understanding and skills. In addition, the use of proctoring technology during online assessments can help verify students' identities and minimize academic fraud.
- Feedback and ongoing assessment: AI can be used positively to provide immediate and personalized feedback to students. This not only supports continuous learning, but also allows educators to identify areas where students may need additional support.

## References


Ali, S., DiPaola, D., Lee, I., Hong, J., & Breazeal, C. (2021). Exploring generative models with middle school students. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems* (pp. 1-13), Yokohama, Japan. https://doi.org/10.1145/3411764.3445226

Atterberry-Ash, B. (2023). Social work and social justice: A conceptual review. *Social Work, 68*(1), 38-46. https://doi.org/10.1093/sw/swac042

Ayuso del Puerto, D., & Gutiérrez Esteban, P. (2022). La inteligencia artificial como recurso educativo durante la formación inicial del profesorado. *RIED. Revista Iberoamericana de Educación a Distancia, 25*(2), 347-358. https://doi.org/10.5944/ried.25.2.32332

Baidoo-Anu, D., & Awusu-Ansah, L. (2023). Education in the era of generative Artificial Intelligence (AI): Understanding the potential benefits of ChatGPT in Promoting Teaching and Learning. *Journal of AI, 7*(1), 52-62. https://doi.org/10.61969/jai.1337500

Casanovas-Combalia, X. (2023). De la inteligencia artificial a la inmortalidad del alma. *Cristianismo y Justifica, 234*(2), 2-5. https://www.cristianismeijusticia.net/sites/default/files/pdf/papes269.pdf

Chiba, Y., Nose, T., Kase, T., Yamanaka, M., & Ito, A. (2018, July 12-14). An analysis of the effect of emotional speech synthesis on non-task-oriented dialogue system. In *19th Annual SIGdial Meeting on discourse and Dialogue* (pp. 371-375), Melbourne, Australia. https://doi.org/10.18653/v1/W18-5044

Colchester, K., Hagras, H., Alghazzawi, D., & Aldabbagh, G. (2017). A survey of Artificial Intelligence techniques employed for adaptive educational systems within e-learning platforms. *Journal of Artificial Intelligence and Soft Computing Research, 7*(1), 47-64. https://doi.org/10.1515/jaiscr-2017-0004

Comisión Europea. (2024). *Configurar el futuro digital de Europa. Un enfoque europeo de la inteligencia artificial.* https://digital-strategy.ec.europa.eu/es/policies/european-approach-artificial-intelligence

Cui, Y., Zhang, Y., & Li, X. (2022). *A student performance prediction method based on machine learning algorithms*. Wireless Communications and Mobile Computing.

Delić, V., Perić, Z., Sečujski, M., Jakovljević, N., Nikolić, J., Mišković, D., & Simić, N. (2019). Speech technology progress based on new machine learning paradigm. *Computational Intelligence and Neuroscience, 3*(19), 1-19. https://doi.org/10.1155/2019/4368036

Galán, I. A., Ruiz, J., & Jimenes, E. (2023, November 29-30). Buenas prácticas que integran la inteligencia artificial en el proceso de evaluación en la educación. In *8th Virtual International Conference on Education, Innovation and ICT* (pp. 184-185). https://doi.org/10.58909/adc24139168

García Peñalvo, F. J. (2023). The perception of Artificial Intelligence in educational contexts after the launch of ChatGPT: Disruption or panic? *Education in the Knowledge Society, 24*. https://doi.org/10.14201/eks.31279

Grané, M. (2024). Implementación de ChatGPT en el aula. In M. Ribera, & O. Díaz Montesdeoca (Coords.). *ChatGPT y educación universitaria. Posibilidades y límites de ChatGPT como herramienta docente* (pp. 97-122). Octaedro.

Holmes, W., & Miao, F. (2023). *Guidance for Generative AI in Education and Research*. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000386693

Holstein, K., McLaren, B. M., & Aleven, V. (2017, March 13-17). Intelligent tutors as teachers' aides: Exploring teacher needs for real-time analytics in blended classrooms. In *Seventh International Learning Analytics & Knowledge Conference* (pp. 257-266), Vancouver, Canada. https://doi.org/10.1145/3027385.3027451

Moya, B. A., & Eaton, S. E. (2023). Examinando recomendaciones para el uso de la inteligencia artificial generativa con integridad desde una lente de enseñanza y aprendizaje. *RELIEVE. Revista Electrónica de Investigación y Evaluación Educativa, 29*(2), 1-23.

Naciones Unidas (2024). *La inteligencia artificial como herramienta para acelerar el progreso de los ODS*. https://www.un.org/es/desa/preparing-for-future-of-everything

Paglen, T. (2019). Invisible images: Your pictures are looking at you. *Architectural Design, 89*(1), 22-27. https://doi.org/10.1002/ad.2383

Parlamento Europeo, & Consejo de la Unión Europea (2016). Reglamento (UE) 2016/679 del Parlamento Europeo y del Consejo, de 27 de abril de 2016, relativo a la protección de las personas físicas en lo que respecta al tratamiento de datos personales y a la libre circulación de estos datos y por el que se deroga la Directiva 95/46/CE (Reglamento general de protección de datos). https://eur-lex.europa.eu/legal-content/ES/TXT/?uri=CELEX:32016R0679

Perkins, M. (2023). Academic integrity considerations of AI large language models in the post-pandemic era: ChatGPT and beyond. *Jour-*

*nal of University Teaching & Learning Practice*, *20*(2). https://doi.org/10.53761/1.20.02.07

Quispe-Juli, C., Vela-Anton, P., Meza-Rodriguez, M., & Moquillaza-Alcántara, V. (2020). *COVID-19: A Pandemic in the Era of Digital Health*. SciELO. https://doi.org/10.1590/SciELOPreprints.164

Sabzalieva, E., & Valentini, A. (2023). *ChatGPT e inteligencia artificial en la educación superior: guía de inicio rápido*. https://unesdoc.unesco.org/ ark:/48223/pf0000385146_spa

Sánchez Vera, M. M. (2024). La inteligencia artificial como recurso docente: usos y posibilidades para el profesorado. *Educar*, *60*(1), 33-47. https://doi.org/10.5565/rev/educar.1810

Sarma, G. P., & Hay, N. J. (2017). Robust computer algebra, theorem proving, and oracle AI. *SSRN Electronic Journal*. https://doi.org/10.48550/arXiv.1708.02553

Selwyn, N. (2024). On the limits of Artificial Intelligence (AI) in education. *Nordisk Tidsskrift for Pedagogikk og Kritikk*, *10*, 3-14. http://doi.org/10.23865/ntpk.v10.6062

Su, J., Ng, D. T. K., & Chu, S. K. W. (2023). Artificial Intelligence (AI) Literacy in early childhood education: The challenges and opportunities. *Computers and Education: Artificial Intelligence*, *4*. https://doi.org/10.1016/j.caeai.2023.100124

Timotheou, S., Miliou, O., Dimitriadis, Y., Villagrá Sobrino, S., Giannoutsou, N., Cachia, R., Martínez Monés, A., & Ioannou, A. (2023). Impacts of digital technologies on education and factors influencing schools' digital capacity and transformation: A literature review. *Education and Information Technologies*, *28*, 6695-6726. https://doi.org/10.1007/s10639-022-11431-8

UNESCO (2016). *Educación 2030: Declaración de Incheon y Marco de Acción para la realización del Objetivo de Desarrollo Sostenible 4: garantizar una educación inclusiva y equitativa de calidad y promover oportunidades de aprendizaje permanente para todos*. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000245656_spa

Vanden Abeele, M. M. P. (2021). Digital wellbeing as a dynamic construct. *Communication Theory*, *31*(4), 932-955. https://doi.org/10.1093/ct/qtaa024

Vicerrectorado de Innovación Educativa (2023). *Guía para integrar las tecnologías basadas en inteligencia artificial generativa en los procesos de enseñanza y aprendizaje*. UNED.

World Health Organization (WHO). *WHO guideline: recommendations on digital interventions for health system strengthening*. https://apps.

who.int/iris/bitstream/handle/10665/311941/9789241550505-eng.pdf?ua=1

Yufei, L., Saleh, S., Jiahui, H., & Abdullah, S. M. S. (2020). Review of the application of artificial intelligence in education. *International Journal of Innovation, Creativity and Change, 12*(8), 548-562. https://doi.org/10.53333/IJICC2013/12850

Zhang, H., Lee, I., & Ali, S. (2023). Integrating ethics and career futures with technical learning to promote AI literacy for middle school students: An exploratory study. *International Journal of Artificial Intelligence in Education, 33*, 290–324. https://doi.org/10.1007/s40593-022-00293-3

# 6

# Artificial Intelligence Tools to Improve Accessibility in Education for People with Disabilities

PhD Carlos Hervás-Gómez
Universidad de Sevilla, Spain
hervas@us.es
https://orcid.org/0000-0002-0904-9041

PhD Ángela Martín-Gutiérrez
Universidad Internacional de La Rioja and Universidad de Sevilla, Spain
angela.martin@unir.net
https://orcid.org/0000-0001-9847-245X

María de los Ángeles Domínguez-González
Universidad de Sevilla, Spain
mariandg@us.es
https://orcid.org/0000-0002-9687-9325

Carmen Manzanares-Castillo
Universidad de Sevilla, Spain
carmenmanzanarescastillo@gmail.com
https://orcid.org/0009-0001-9876-2067

PhD Hăisan Angel-Alex
"1 Decembrie 1918" University of Alba Iulia, Romania
angel.haisan@uab.ro
https://orcid.org/0000-0002-0565-405X

PhD Nadia Barkoczi
Universitatea Tehnică din Cluj-Napoca, Romania
nadia.barkoczi@dspp.utcluj.ro
https://orcid.org/0000-0002-0514-2417

https://doi.org/10.36006/09643-1-06 

**Abstract**
The advancement of artificial intelligence (AI) is an undeniable issue and is increasingly present in education, including inclusive education. Many AI-based tools can enhance and support the cognitive potential of students with diversity, supporting quality education, which favors their full inclusion in society. Inclusive education contributes to reducing inequalities by promoting tolerance among all people. This study's main objective was to conduct a search, selection and subsequent review of existing AI-based tools that could be beneficial for improving the teaching-learning process and the quality of life of people with diversity. Following the results obtained, it is recommended that this line of research be continued with more in-depth studies to analyze the viability of each tool.

**Keywords:** accessibility, Artificial Intelligence, disability, diversity.

## 6.1. Introduction

UNESCO's (2022) recommendations on the Ethics of Artificial Intelligence address the approach and deployment of AI in the world's education systems. Educational institutions and administrative bodies relevant to the field of education should commit to further advancing digital literacy in AI in the classroom. Adequate AI literacy will empower the population and reduce digital divides and inequalities in access to digital technology resulting from adopting AI-based applications. Beyond the academic and future professional component, the aim is to help this group understand their development process and provide them with all the possible tools to make significant contributions to our society. The collaboration of all responsible bodies is needed to ensure that AI technologies empower learners and teachers to improve their experience, bearing in mind relational and social principles (UNESCO, 2022).

## 6.2. Artificial Intelligence in Education

The global landscape is becoming increasingly digitized, which has a particular impact on education today. The constant advances in Artificial Intelligence (AI), together with Machine Learning (ML) and Big Data, are practical and efficient tools for predicting the results of analysis encompassed within computationally demanding

engineering problems (Markou et al., 2024). Such devices have played an essential role in today's education sector and, therefore, in all socio-cultural domains (Borja & Camargo, 2024). Undoubtedly, AI offers helpful knowledge and information on many topics, but caution and contextualization must be exercised due to its susceptibility to misinformation and bias (Wang et al., 2024).

Fundamental aspects of the use of AI are the use, development and creation of content and digital tools that people must learn how to use and control for the development of digital competence. There is a need to design guidelines for teachers and students on how to use generative AI appropriately to provide intellectual and personal developmental support (Wang et al., 2024). Learning with technology and technological tools can reduce the difficulty and complexity and improve the efficiency of such learning, as long as it is adequately managed and controlled (Borja & Camargo, 2024).

At the same time, protecting the welfare and interests of global citizens underscores the pressing need to assess the rise of AI and chart a way forward based on the development of ethical frameworks that facilitate the regulation and growth of AI (Farhat et al., 2024).

AI makes allows analyzing the human cognitive process through tools such as Big Data, simulating the information process of human sight, hearing, touch, feeling, thinking and reasoning, and from this, it is possible to build one's neural network and generate algorithms that draw a visual representation (Borja & Camargo, 2024). Among them is the proliferation of sophisticated language models that can understand and develop human-like text, incorporating a component of greater accessibility and equality among academics (Farhat et al., 2024). Below is a list of tools that aim to improve accessibility and enrich the learning experience in the classroom.

## 6.3. Artificial Intelligence Tools to Improve Accessibility in Education for People with Disabilities

Below are some AI tools that aim to improve accessibility and personalized learning for students with disabilities, making read-

ing and accessing educational material a more inclusive, flexible and enriching experience. These tools are the following:

## Storysign[1]

Huawei developed this tool as a mobile application to make reading more accessible for students with hearing difficulties. Its principal function is to translate text into sign language. This application uses the device's camera to scan the text of children's books. An animated "Star" avatar automatically translates the text into sign language. On the positive side, it offers the ability to adjust the speed of translation and other settings to suit individual reading preferences.

The educational possibilities of StorySign in the context of accessibility for people with disabilities, especially for children with hearing disabilities, are broad and significant. Here are some of the highlights:

- Improving sign language literacy by providing a platform for deaf children to improve their reading skills in their native language, i.e., sign language. Making printed books accessible through real-time translation facilitates learning and practice of reading in an interactive and engaging environment.
- Fostering a love for reading: helps instill an early love for reading by making books more accessible and engaging for deaf children, which is critical for educational and personal development.
- Educational inclusion: Providing a tool that allows deaf children to access the content of books in sign language promotes inclusion in educational settings where deaf and hearing children learn together. It helps deaf children feel more integrated and participatory in the academic community.
- Support for parents and teachers: it allows parents and teachers who do not know sign language to share stories and educational material with deaf children.
- Development of comprehension skills: the application is not only limited to the literal translation of the text but also interprets the context and grammar to provide an understanding

1. https://storysign.storysign&hl=es&gl=us

of the material, which is essential for developing reading comprehension skills.
- Personalization and diversification of learning: StorySign offers various educational materials tailored to different interests and skill levels, allowing for a more personalized and diversified learning experience.
- Transition tool: For some students, StorySign acts as a bridge between learning sign language and developing skills in reading and writing text, facilitating a smoother transition to more varied forms of communication.

## Otter.ai[2]

The voice transcription application uses voice recognition and natural language processing technologies to convert conversation into text. This tool can improve accessibility in education, mainly because it allows access to auditory content and facilitates the creation of study materials, providing support for students with hearing diversity. In addition, it can improve lesson planning, collaboration and content sharing.

Some of the educational possibilities that Otter.ai offer are the following:

- Real-time transcription and note-taking for meetings: This is especially useful for students participating in conferences or seminars, as they can get detailed transcripts of the sessions to review later.
- Assisting journalists in transcribing interviews and taking notes for efficient reporting: Students in journalism or communication-related fields can significantly benefit from this function to process and analyze their interviews or research.
- Assists students in transcribing and summarizing lectures, facilitating the review and study of course material: This is particularly valuable for students seeking to maximize their understanding and retention of the material presented in lessons, allowing them to access accurate and detailed summaries for study.

2. https://otter.ai/

## Microsoft AI for accessibility[3]

Microsoft AI for Accessibility is a program aimed at amplifying human capabilities through artificial intelligence for people with disabilities. This initiative focuses on developing and implementing AI solutions that help overcome barriers to communication, employment and mobility for people with disabilities. Although its main focus is not educational per se, the tools and technologies developed under this program have significant applications in education, primarily to support students with different types of disabilities.

Some of the educational possibilities that Microsoft AI for Accessibility provides are the following:

- Improving accessibility in educational tools: Implementing AI technologies to make educational applications and platforms more accessible to students with visual, hearing or mobility disabilities. This includes improved screen readers, speech recognition and sign language interpretation technologies.
- Personalization of learning: Using AI to adapt educational content to the specific needs of learners, taking into account their disabilities and learning preferences. This may include adjustments to the speed of content presentation, complexity levels and interaction methods.
- Enhanced communication tools: Development of applications and devices that use AI to facilitate communication for students with speech or hearing disabilities, enabling them to participate more effectively in collaborative educational environments.
- Vision support: Implementing AI technologies that help students with visual impairments interact with digital and physical content, e.g. through text-to-speech, image description and assisted navigation in educational environments.
- Behavioral analytics for educational support: Use of AI to analyze the behavior and interaction of students with disabilities on online learning platforms to identify barriers to learning and adjust educational strategies to improve effectiveness.

3. https://www.microsoft.com/en-us/accessibility

- Accessibility in assessments and exams: Application of AI solutions to make evaluations more accessible to students with various disabilities, ensuring they can demonstrate their knowledge and skills on an equal footing.

## Voiceitt[4]

Voiceitt is a mobile application that uses artificial intelligence to make content accessible to students with speech difficulties. The app allows text to be converted into speech, making it easier for them to understand educational materials. Voiceitt analyzes the user's speech and creates a personalized voice model. This model is used to convert text into speech naturally and accurately. The application offers a variety of features that facilitate the accessibility of content for learners with speech difficulties. These features include text-to-speech conversion, language translation, subtitle generation and speech recognition.

Some of the educational possibilities that Voiceitt enables are as follows:

- Facilitating classroom communication: Voiceitt can help students with speech disabilities communicate more effectively with teachers and peers. This improves classroom participation and allows students to express their ideas and questions more clearly.
- Support in presentations and oral presentations: Students using Voiceitt can confidently participate in presentation activities and class discussions, as the tool allows them to convey their messages more understandably.
- Improved independence and self-esteem: By enabling students to communicate more effectively, Voiceitt can contribute to their independence and increase their self-esteem. This is vital for personal development and educational success.
- Use in assistive technology: Voiceitt can be integrated with other assistive technologies in educational settings, such as augmentative and alternative communication (AAC) devices, to provide a more complete communication solution.

4. https://www.voiceitt.com/

## Kurzweil 3000[5]

Kurzweil is a virtual educational assistance platform specialized in children with learning difficulties, such as dyslexia and dysgraphia or students with attention deficit disorder, as well as other needs. Thanks to artificial intelligence, this platform personalizes learning individually, adapting to the needs of each student. In addition, it uses AI to convert images into text or audio through optical character recognition to provide reading-aloud for readers, which is vital for students with visual or reading difficulties. It includes multiple text-highlighting tools, for example, with different colors, which promotes the organization of ideas for students with problems in understanding a text.

Some of the educational possibilities that Kurzweil 3000 provides are the following:

- Text reading: Kurzweil 3000 converts printed and digital text into speech, allowing students to listen to books, documents, and course materials aloud. This functionality is essential for students with reading or visual impairments, as it improves their access to educational content.
- Comprehension tools: The application includes tools that help improve reading comprehension, such as highlighters, sticky notes, and the ability to create outlines. These tools allow students to interact with the text more actively, facilitating better retention of information.
- Writing functions: Kurzweil 3000 offers writing support through word prediction, spelling correction, and grammar suggestions, which benefits students with dyslexia or writing difficulties. In addition, the dictation tool converts speech into text, providing another way for students to generate written content.
- Study and organize: With tools for creating flashcards, summarizing texts, and organizing ideas, Kurzweil 3000 supports students' study strategies and helps them develop organizational skills essential for academic success.
- Access to content in different languages: The platform's ability to read texts in multiple languages can be a significant ad-

5. https://www.kurzweil3000.com/KLogin.php

vantage for students learning a new language or those whose first language is not the primary language of instruction.

## Taptapsee[6]

This platform mainly helps people with visual diversity, as it provides explicit audio descriptions of environments, objects, people, or any image, thanks to artificial intelligence and vision technology, which makes allows identifying pictures through a device's camera. Artificial intelligence is present in this application when placing images to describe them since, using visual patterns, similarities and differences of familiar objects are compared for quick identification.

Some of the educational possibilities that TapTapSee offers are the following:

- Identification of didactic materials: TapTapSee can help students identify and differentiate didactic materials and resources, such as books, notebooks, and school supplies, facilitating their organization and independent access to these resources.
- Support hands-on learning activities: In subjects that include hands-on components, such as science or the arts, TapTapSee can assist students in identifying instruments, materials, and other items needed to conduct experiments, art projects, and more.
- Improved orientation and mobility in the educational environment: The app can help students become more familiar with and navigate more independently within the school environment by identifying site-specific features, such as classroom doors, signage, and common areas.
- Fostering independence and confidence: By enabling students with visual impairments to identify objects and text independently, TapTapSee contributes to their autonomy, confidence, and self-esteem, which are critical to their academic performance and emotional well-being.
- Integration into educational projects: Educators can integrate TapTapSee into classroom projects and activities to promote

6. https://taptapseeapp.com/

inclusion by designing assignments that leverage technology to include all students in collaborative learning and shared experiences.

- Reading support and information access: Although TapTapSee is more focused on object identification, it can be complemented with other AI tools and assistive technologies that convert text to speech to facilitate access to printed or written information, offering a more complete learning experience.
- Social Skills Development: Identifying objects and environments can bridge group and social activities, allowing students with visual impairments to participate more actively in group discussions and projects.

## Snap & Read[7]

Snap&Read is an artificial intelligence tool designed to improve accessibility and learning by offering a comprehensive solution for students with diverse needs, including reading difficulties, visual impairments and other learning challenges. This tool has many educational applications, facilitating access to curricular content and support for reading comprehension and writing.

Some of the educational possibilities provided by Snap&Read are as follows:

- Accessible reading: Snap&Read converts any printed or digital text into speech, enabling students with visual impairments, reading difficulties or dyslexia to access educational content equally.
- Personalization of learning: Allows text complexity to be adjusted to suit each student's reading comprehension needs, supporting pedagogical differentiation and personalized learning.
- Language support: With the ability to read texts in multiple languages, Snap&Read can be especially useful in multilingual educational environments and for students learning a new language.
- Integrated study tools: Underlining functionality and outlining help students organize information and study more effectively, improving retention and comprehension of content.

7. https://snapandread.com/

- Writing support: The tool offers writing assistance, such as word prediction and sentence construction, which is especially useful for students who struggle with writing and expressing ideas.
- Developing independence: By providing students with the tools to access and understand texts independently, Snap&Read fosters autonomy and self-confidence in learning.
- Universal access to knowledge: Snap&Read facilitates equitable access to information and educational resources, which creates an inclusive learning environment.

## Microsoft Seeing AI[8]

Microsoft Seeing AI is a tool that uses artificial intelligence to help people with some visual diversity make their day-to-day work or school life more accessible. Some of the possibilities offered by this tool are the following: it speaks text as fast as it appears on the screen in front of the camera, provides audio guidance for documents, locates barcodes to identify products, and recognizes faces and even emotions.

Some of the educational possibilities offered by Microsoft Seeing AI are the following:

- Reading printed and digital text: Seeing AI can read printed text in real-time, including books, documents, menus and labels, which facilitates access to educational material for visually impaired students.
- Object and scene identification: The tool can visually describe what the phone's camera captures, which can be used in educational activities to help students understand their immediate environment and in science experiments or field trips.
- Color and light recognition: This can be useful in art or design classes for students with visual impairments, allowing them to participate more actively and autonomously in creative projects.
- Barcode reading: This facilitates product identification in home economics classes or for teaching independent living skills to students with visual impairments.

8. https://www.microsoft.com/en-us/ai/seeing-ai

- Face and emotion recognition: This feature can be used to teach and reinforce the recognition of emotions and facial expressions in social or emotional education classes, which is especially valuable for students with visual impairments.
- Image description in other applications: Integration with other applications allows visually impaired students to receive descriptions of images and graphics in digital documents or educational websites, improving their understanding of the content.

## Beeline Reader[9]

Beeline Reader is an innovative tool that uses color gradients in the text to facilitate reading. It is especially designed for people with dyslexia, ADHD, or vision problems, although it also improves the reading experience for people without these conditions.

Some of the educational possibilities that Beeline Reader provides are the following:

- Improved reading comprehension: By visually guiding readers through the text with color gradients, Beeline Reader can help improve reading comprehension, allowing students to follow the text more efficiently and maintain concentration.
- Increased reading speed: Studies have shown that Beeline Reader helps readers finish articles more quickly and increases overall reading speed, which is beneficial for students with large volumes of reading material.
- Support for students with special needs: Specifically designed to be an inclusive tool, Beeline Reader is beneficial for students with dyslexia, ADHD or visual impairments, facilitating their access to educational material and improving their autonomy in learning.
- Use in diverse materials and platforms: The tool can be applied to various digital texts, from e-books and online articles to PDF documents, making it versatile for different educational needs and content formats.

9. https://www.beelinereader.com/

- Promoting independence in learning: By enabling students to better access and comprehend texts independently, Beeline Reader promotes independence and confidence in students with and without disabilities.
- Integration with educational platforms: Beeline Reader has been integrated with leading educational and accessibility platforms, such as Bookshare and Blackboard Ally, facilitating its adoption in academic environments and improving the accessibility of educational content for all students.

## Ava[10]

Ava is an application designed to facilitate real-time group communication, mainly intended for people with hearing difficulties. This application transcribes the participants' conversations and displays them on the screen. Participants speak, and the microphone picks up the audio, using speech recognition technology and algorithms to transcribe.

Ava offers several educational possibilities to improve the accessibility and inclusion of deaf and hard-of-hearing people in academic and e-learning environments.

Some of the educational options that Ava offers are the following:

- Live captioning for all situations: Ava provides live captioning solutions for deaf and hard-of-hearing people, making online and in-person conversations accessible. This is particularly useful in educational environments where clarity and comprehension are crucial to learning.
- Ava Scribe: This service combines Ava's artificial intelligence with professional Scribes to ensure accurate captioning without compromising quality. Ava Scribe is ideal for meeting ADA (Americans with Disabilities Act) requirements and providing a fully inclusive educational environment. It is beneficial when a high level of accuracy is required, such as lectures, master classes, and educational events.
- Ava Connect: Ava Connect allows closed captioning integration into any video conference with a single click while main-

10. https://es.ava.me/

taining all the functionalities that users appreciate about Ava. This feature is invaluable for students and educators in remote or hybrid learning environments, ensuring all participants can follow discussions without barriers.
- Transcripts and summaries of conversations: Ava also offers the ability to store transcripts and generate accurate summaries of conversations. This feature is helpful for students who wish to review class material or for educators who need to keep records of class discussions.
- Accessibility in diverse educational environments: Ava is helpful not only in the classroom but also in tutorials, study groups, conferences, and any other educational situation where clear communication is essential.

## VoiceOver (iOS)[11]

It is an accessibility feature built into iOS devices like iPhones and iPads. It offers screen reading for the visually impaired, where users activate VoiceOver in the accessibility settings, and once activated, it provides auditory feedback on what is on the screen, allowing users to navigate and use their devices without seeing the screen.

Some of the educational possibilities that VoiceOver enables are as follows:

- Improved accessibility: Voice tools can help students with visual impairments or reading difficulties by converting text to speech, allowing them to access educational content more effectively.
- Language learning: Speech technology can be a valuable tool for students learning new languages, providing accurate pronunciations and enabling listening and speaking practice in the target language.
- Improved reading and comprehension: By listening to text read aloud, students, especially those who are auditory learners, can improve their reading comprehension.
- Personalized feedback: Some AI tools can provide feedback on pronunciation and fluency when learning a new language, which is beneficial for independent practice.

11. Accessibility, Apple, ES.

- Motivation and engagement: Interaction with voice technologies can be more engaging for learners, especially younger learners, motivating them to participate actively in their learning.
- Teaching efficiency: Educators can use voice tools to create accessible learning materials, such as audiobooks or verbal instructions, saving time in lesson preparation and offering different content formats to meet the needs of all learners.

## Classcript[12]

Classcript is an artificial intelligence tool that transcribes and summarizes audio and video content played on a device. The application is easy to use and offers a variety of functions, including automatic transcription, automatic summarization and translation.

Some of the educational possibilities that Classcript allows are as follows:

- Audio and video transcription: Classcript can transcribe hours of audio or video content into unlimited text, which is invaluable for students with hearing disabilities or those who prefer to review study material in written format. The ability to choose the language from a list of over 50 languages makes this tool accessible to a global audience.
- Accurate transcripts: Classcript's AI is specifically trained to generate highly accurate transcripts. This accuracy ensures that students receive an accurate representation of the lecture material, which is crucial for learning and concept review.
- Transcript Ssummaries: Besides transcribing, Classcript can generate summaries of transcripts highlighting key points, important information, and reminders. This can help students focus on the most relevant aspects of the material, optimizing study time and improving information retention.
- Integrated chat for consultations: The tool includes an integrated chat that allows users to consult doubts about the class and receive instant answers. This feature promotes an interactive and dynamic learning environment where students can clarify concepts and further delve into the study material in an efficient manner.

12. https://www.classcript.com/

## 6.4. Discussion and Conclusions

Through technologies and AI, it is possible to evolve in the educational field and improve the teaching and learning process. Technologies allow us to adapt didactic activities automatically through smartphones, computers, or tablets. Through tools designed for this type of device, the subjects can acquire and develop competencies to have a real option of development and access in the midst of the technological era. The presence of AI represents an increasingly natural alternative for the development of the academic and professional profile of students, especially for people with diversity. The research reviewed highlights the community's awareness of the importance and advantages of knowing about AI to include students and future citizens due to the tremendous social, economic and educational impact of the development of these technologies. However, there are difficulties for teachers in implementing these tools in the classroom (Biggs, 2023).

Therefore, the great value and interest of AI training to develop digital content and create greater accessibility to this group at risk of exclusion is exposed. The acquisition and implementation of the critical elements to be digitally and technologically competent will facilitate the functionality and operability of students with diversity in the current environment. The aim is to train this group in using technological tools and devices and to adapt them to their immediate needs.

It is essential to design training that reaches the centers of the educational communities, based on the recommendations of UNESCO (2022), to include a proposal in the different educational plans of the member countries for its promotion, implementation and investment. Likewise, in training, it is necessary to strengthen the collaborative relationship with non-governmental entities linked to the development of AI technologies, enabling greater mastery and practical knowledge for a more inclusive society. Finally, it is essential to review and update the current educational materials and improve the instructions and tools for use in specific protocols.

It is recommended for future research to expand and redo the search for tools due to the continuous advancement of technology, as well as to implement each device in people with diversity to verify their current viability.

## Acknowledgements

This study was funded by the VI Research and Transfer Plan of the University of Seville (VI PPIT-US), as part of the project entitled "Development of Skills in the Production of Educational Videos with Artificial Intelligence for Teaching: An Initiative for Initial Teacher Training (VIDIA-EDU)" within the 4th Teaching Plan of the University of Seville (Spain). Call for Support for Teaching Coordination and Innovation (ref. 221). Call 2023/2024.

## References

Biggs, E. E. (2023). Strengthening professional networks to serve students with autism who have communication needs. *Intervention in School and Clinic, 58*(3), 173-182. https://doi.org/10.1177/10534512221081250

Borja-Acevedo, M., & Camargo-Mendoza, J. (2024). Music software with a machine learning-based feedback system as an alternative for initial piano study in children. *Inteligencia Artificial*, *27*(73), 92-110. https://doi.org/10.4114/intartif.vol27iss73pp92-110

Farhat, F., Silva, E., Hassani, H., Madsen, D., Sohail, S., Himeur, Y., Alam, M., & Zafar, A. (2024). The scholarly footprint of ChatGPT: a bibliometric analysis of the early outbreak phase. *Frontiers in Artificial Intelligence*, *6*. https://doi.org/10.3389/frai.2023.1270749

Markou, G., Bakas, N., Chatzichristofis, S., & Papadrakakis, M. (2024). A general framework of high-performance machine learning algorithms: application in structural mechanics. *Comput. Mech.* https://doi.org/10.1007/s00466-023-02386-9

UNESCO (2022). *Recommendation on the ethics of Artificial Intelligence.* United Nations Organization for Education, Science and Culture. https://unesdoc.unesco.org/ark:/48223/pf0000381137_spa/PDF/381137spa.pdf.multi

Wang, N., Wang, X., & Su, Y. (2024). Critical analysis of the technological affordances, challenges and future directions of generative AI in education: A systematic review. *Asia Pacific Journal of Education.* http://doi.org/10.1080/02188791.2024.2305156

Xie, T., Wang, X., Cifuentes-Faura, J., & Yongkang, X. (2023). Integrating immersive experience into hybrid education: a case study in fintech experimental education. *Scientific Reports*, *13*, 22762. https://doi.org/10.1038/s41598-023-50259-1

7

# Design, Implementation, and Evaluation of a Chatbot to Enhance Inclusive Learning through Universal Design for Learning in University Students[1]

PhD Judit Ruiz-Lázaro
Universidad Nacional de Educación a Distancia (UNED)
judit.ruiz@edu.uned.es
https://orcid.org/0000-0003-2036-0428

PhD Eva Jiménez-García
Universidad Europea de Madrid, Spain
eva.jimenez@universidadeuropea.es
https://orcid.org/0000-0001-6541-3517

PhD Sonia Martínez-Requejo
Universidad Europea de Madrid, Spain
sonia.martinez@universidadeuropea.es
https://orcid.org/0000-0001-6934-2664

PhD Sara Redondo-Duarte
Universidad Complutense de Madrid, Spain
saredo02@ucm.es
https://orcid.org/0000-0003-2012-8784

**Abstract**
Currently, there are various artificial intelligence tools, such as natural language processors, which are used to enhance teaching and learning processes. In this context, the use of virtual assistants is becoming increasingly common

1. This study was conducted within the framework of Research Project XSAN002310 "Chatbot for student support and formative assessment. Analysis, Design, Implementation" funded by Universidad Europea de Madrid and Banco Santander.

in higher education institutions. This study addresses the design, implementation, and evaluation of a chatbot designed to improve inclusive learning in university students. This artificial intelligence-based system was implemented with undergraduate and postgraduate students in the field of education at Universidad Europea de Madrid. To achieve this, an exploratory and descriptive study with a mixed-methods approach was conducted. A self-perception questionnaire was used as a research instrument to evaluate usability, accuracy, interaction, utility, and satisfaction criteria, along with gathering qualitative feedback. The results revealed highly positive student evaluations of the chatbot, consistently surpassing average ratings of 4.2 out of 5. Furthermore, the correlation between satisfaction with the chatbot and other questions regarding usability, accuracy, interaction, and utility showed direct and significant correlations in all cases. In conclusion, this virtual and conversational assistant proves to be a valuable practice in future chatbot designs for enhancing inclusive learning based on Universal Design for Learning.

**Keywords:** conversational agent, virtual assistant, Universal Design for Learning, chatbot, higher education.

## 7.1. Introduction

In recent decades, educational technology has had a significant influence on teaching and learning processes (Zorrilla-Puerto et al., 2023), as well as for student engagement (Ruiz-Lázaro et al., 2024). Particularly, artificial intelligence (AI) has emerged as a key factor, marking a transformation in the conception of the educational process (Jiménez-García et al., 2024; Redondo-Duarte et al., 2024). In the context of higher education, its integration has been driven by the widespread availability of large language models (LLM). In this regard, many authors highlight the role of educational chatbots in the learning process (Kuhail et al., 2023; Wu & You, 2023; Wang et al., 2021; among others).

### Conversational assistants in higher education

Chatbots are intelligent systems capable of adapting to individual student needs, offering personalized and contextual interactions, and facilitating student-machine communication (Okonkwo & Ade-Ibijola, 2021; Redondo-Duarte et al., 2024). In other words, chatbots engage with students through chat or conversa-

tion, providing automated information and guidance (Baltazar, 2023). In the context of higher education, these tools stand out for their ability to perform various functions, such as administrative, technical, and/or academic guidance, virtual tutoring, and personalized conversational academic support.

Recent studies have highlighted the usefulness of chatbots in improving academic outcomes, demonstrating enhancements in student learning and engagement compared to traditional teaching methods (Kuhail et al., 2023). While they offer benefits such as flexibility and accessibility, it is essential to ensure equitable, responsible, and ethical implementation, as well as to enhance the understanding of human emotions (Pack & Maloney, 2023; Tseng & Warschauer, 2023; Yeo, 2023).

## Universal Design for Learning for inclusive education through AI-based conversational agents

The Universal Design for Learning (hereafter, UDL) has emerged as a conceptual model aiming to address inclusivity and student diversity (CAST, 2018) through flexible and equitable learning environments (Meyer et al., 2014). It also seeks to overcome limitations and barriers of traditional educational models by recognizing the inherent heterogeneity among students in terms of learning styles, skills, and specific needs (Burgstahler, 2015). In this vein, UDL stands out as a distinct approach not only focused on adapting materials and instructional resources but also committed to addressing teaching and learning methods, strategies, and various modes of educational assessment (Elizondo, 2023). In this context, educators play a crucial role, as they need to tailor their teaching methods to the needs of each student (cultural, linguistic, and socioeconomic, among others), taking into consideration potential factors that may impact its implementation, such as time constraints and the number of students in the classroom (Shahmoradi et al., 2018).

Some natural language processing techniques, such as chatbots, emerge with the purpose of providing personalized learning that caters to the diversity of students. The use of chatbots in the educational context presents a significant opportunity for future teaching professionals to learn how to apply UDL in their daily teaching practices and create inclusive and equitable environments tailored to the needs of their students.

For this reason, the overall objective of this study was to assess the self-perception of university students regarding the implementation of a chatbot specifically designed to enhance learning linked to UDL. The specific objectives are five:

a) Evaluate the usability of the chatbot in the context of learning about UDL.
b) Analyze the accuracy of the chatbot in delivering information related to the principles of UDL.
c) Investigate the quality of interaction provided by the chatbot during the learning process about UDL.
d) Measure the utility of the chatbot as a support tool in understanding and applying UDL concepts.
e) Assess the satisfaction of university students regarding the implementation of the chatbot to enhance learning about UDL.

## 7.2. Methodology

To conduct this study, an exploratory and descriptive research approach with a mixed-methods design was employed.

### Participants

The study sample consisted of N=28 undergraduate and postgraduate students in the field of education at Universidad Europea de Madrid. The participants were selected from various stages, including both undergraduate and postgraduate levels, to ensure diversity in study programs. A total of 82.1% were students in the face-to-face Primary Education degree program, specifically in the Diversity Attention course, whereas 17.9% were postgraduate students specializing in Educational Guidance, specifically in the Development, Learning, and Education course.

### Strategies and instruments

To achieve the study's objective, a self-perception instrument was applied, specifically designed with a total of 8 items on a Likert scale ranging from 0 to 5 (where 0 indicates totally disa-

gree and 5 indicates totally agree). The instrument evaluates five dimensions: usability, accuracy, interaction, utility, and student satisfaction with the chatbot. Additionally, this scale was complemented with other questions related to general dimensions to provide additional information and qualitative feedback, aiming to gather more detailed perceptions about the student experience.

## Chatbot design

The chatbot was developed using advanced natural language processing and machine learning technologies. An intuitive chat interface was designed to allow students to interact naturally with the chatbot. The content was structured to address the fundamental principles of UDL, providing clear information and relevant examples. Interactive features, such as adaptive questions and answers, were implemented to personalize the learning experience based on individual student responses and needs.

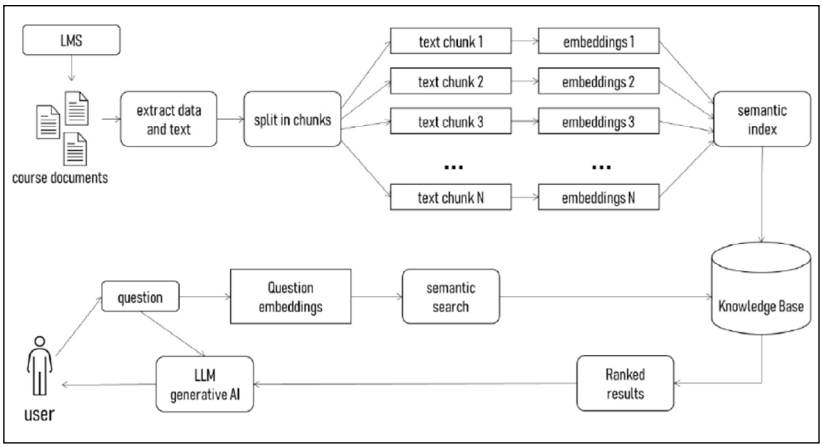



**Figure 7.1.** General architecture of the system. Source: developed by autor.

## Chatbot implementation

The use of the Chatbot was integrated into specific teaching related to UDL, where students could access it as an additional tool to enhance their understanding and application of concepts taught in class.

The process began with a brief introduction to the chatbot and guidance on how to access and use the tool. The participants were given a defined period to interact with the chatbot and explore its functions, which comprised two class sessions. Below are several examples of interaction with the chatbot:

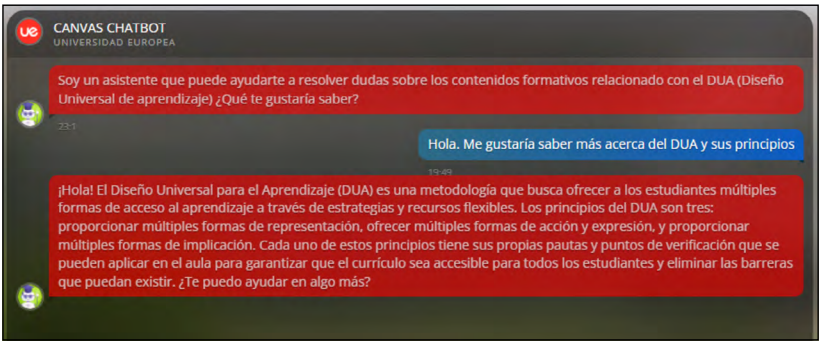



**Figure 7.2.** Interaction Example 1 with the chatbot on UDL. Source: developed by autor.

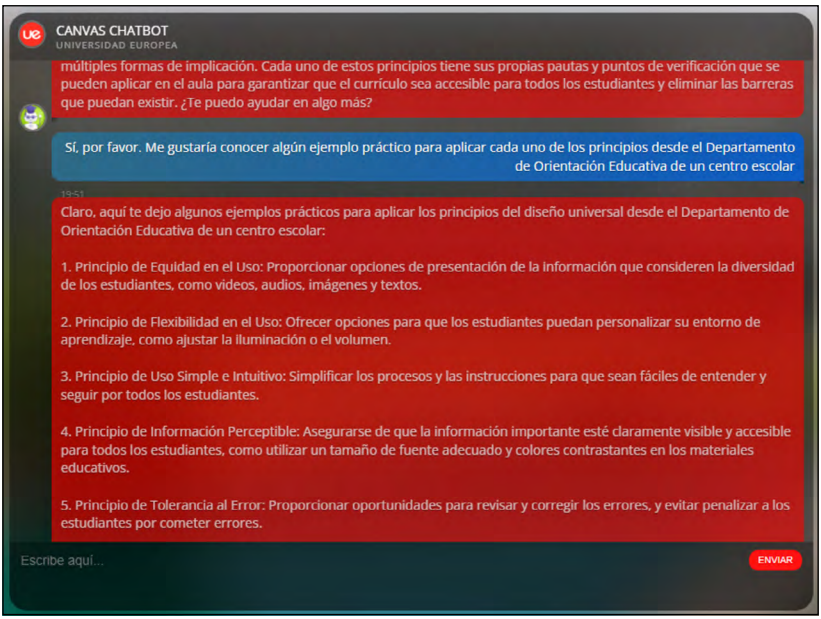



**Figure 7.3.** Interaction Example 2 with the chatbot on UDL. Source: developed by autor.

### Chatbot evaluation

The study was conducted using a non-random convenience sampling approach. Students from in-person undergraduate and semi-presential postgraduate programs at Universidad Europea de Madrid were selected, specifically those who were part of the classes where the researchers taught. An invitation to participate in the research was sent, providing a detailed explanation of the study's objectives and the role of the chatbot designed to enhance learning about UDL. Participation was entirely voluntary, and informed consent was obtained from each student before their inclusion in the study, ensuring data anonymity.

Subsequently, structured questionnaires were administered to gather data on the perceived usability, accuracy, interaction, utility, and satisfaction of students regarding the chatbot. Additionally, demographic data were collected for descriptive and exploratory analyses.[2]

## 7.3. Results

### Descriptive results

All evaluations provided by students regarding the chatbot were highly positive (Table 7.1), consistently surpassing the threshold of 4.2 out of 5 in all cases. The utility of the chatbot stood out with the highest average rating, reaching 4.75/5, demonstrating its effectiveness and relevance for students. Similarly, the usability of the chatbot was highlighted, achieving an average score of 4.68/5, emphasizing its user-friendly nature. In the interaction dimension, students perceived the chatbot's ability to understand their questions satisfactorily, giving it an average score of 4.54/5. In terms of overall satisfaction, the participants expressed a high level of contentment, with an average score of 4.54.

These results indicate that the chatbot was not only perceived as useful and efficient but also generated a satisfactory experience for the students.

2. Bellow is the link to the questionnaire.

**Table 7.1.** Descriptive results of the ad hoc self-perception instrument

| DIMENSION | ITEMS | MEAN | ST |
|---|---|---|---|
| Usability | Usability1: State whether you found the chatbot easy to use. | 4.68 | 0.61 |
| | Usability2: Were you able to resolve your doubts quickly and efficiently? | 4.43 | 0.74 |
| Accuracy | Accuracy1: Were the responses provided by the chatbot accurate? | 4.21 | 0.63 |
| | Accuracy2: Did you find the information you were looking for? | 4.29 | 0.90 |
| Interaction | Interaction1: Did the chatbot understand your questions correctly? | 4.54 | 0.79 |
| Utility | Utility1: State whether you found the chatbot useful. | 4.75 | 0.52 |
| Satisfaction | Satisfaction1: How satisfactory was your experience with the chatbot? | 4.54 | 0.58 |
| | Satisfaction2: Did the chatbot help you resolve your doubts, understand information better, or prepare for any assessments? | 4.36 | 0.63 |

Source: developed by autor.

## Other results based on the usability, accuracy, interaction, and utility of the chatbot

The result of the remaining questions posed to the students about usability (Figure 7.4) shows that 86% of the students took less than 5 minutes; on the other hand, 61% indicated that the chatbot was accessible from the PC.

Regarding accuracy and interaction (Figure 7.5), 93% of the participants stated that there were no incorrect or confusing responses, reflecting highly positive outcomes in terms of accuracy. As for interaction, once again, the results were highly satisfactory, with 68% of students indicating that the chatbot adequately informed them if it could not understand or answer their question.

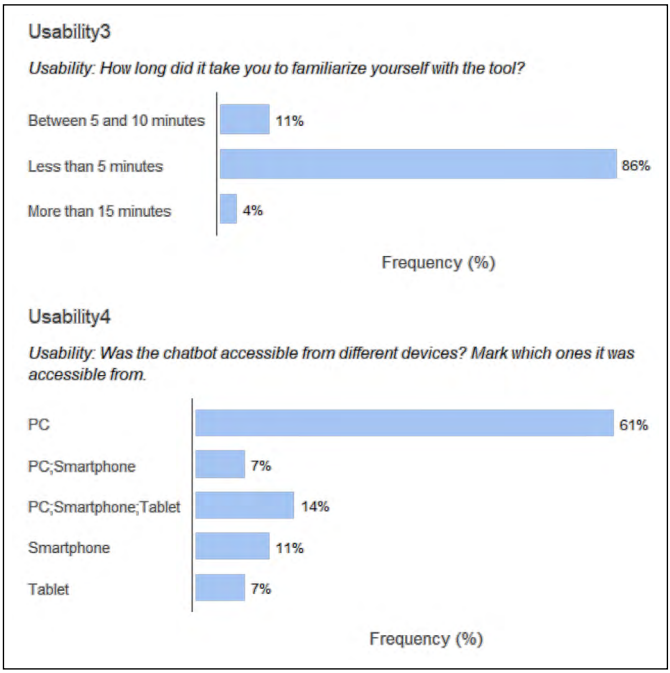



**Figure 7.4.** Other questions about usability.
Source: developed by author using Jamovi 2.4. software.

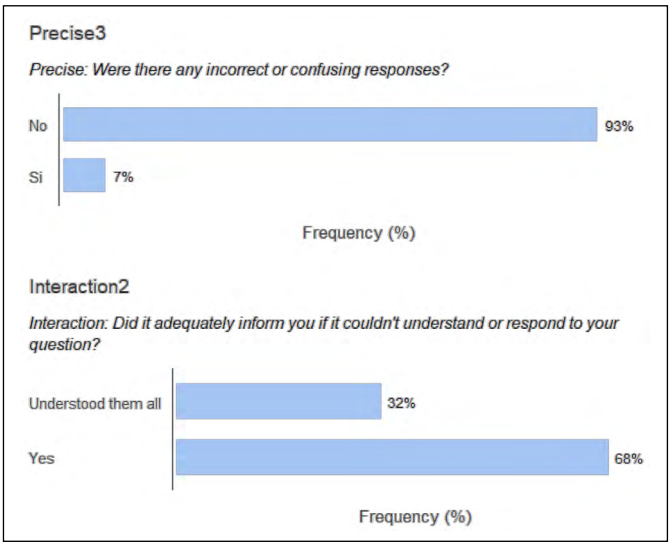



**Figure 7.5.** Other questions about accuracy and interaction.
Source: developed by author using Jamovi 2.4. software.

Regarding the questions Utility2: Do you consider the chatbot useful from an educational perspective? And Satisfaction3: would you like to have a chatbot trained to assist you with all the subjects you are studying? 100% of the students answered yes.

## Results based on chatbot satisfaction

Below are the results of the correlation between satisfaction with the chatbot experience and the rest of the questions. The results of the correlation analyses (see Figure 7.6) show direct and significant correlations in all cases (p = 0.05), indicating that higher satisfaction with the chatbot is associated with higher ratings from students in terms of usability, accuracy, interaction, and usefulness.

In terms of the intensity of the relationship, it is moderate in all cases, with the correlations between Satisfaction1 and Accuracy2 (r = 0.644) standing out more prominently. This means that, as satisfaction with the experience increases, so does the assessment of finding the sought information. The same holds true for Satisfaction1 and Utility1 (r = 0.644), indicating that, as satisfaction with the experience increases, the evaluation of the chatbot's utility also increases.

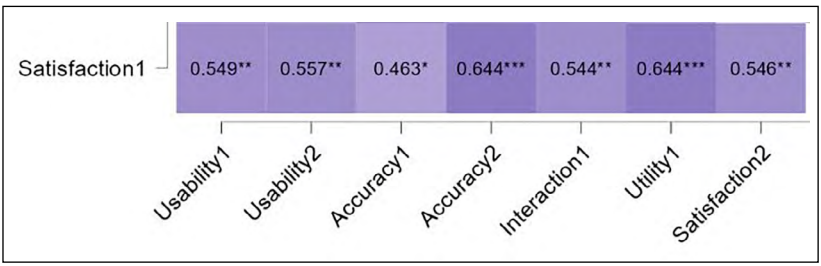



**Figure 7.6.** Correlations analysis. Source: developed by author using JASP 0.18.1.0 software.

Note. p < .05, ** p < .01, *** p < .001

Spearman's correlation coefficient: r = 0 no correlation; r < 0.2 very weak correlation; r between |0.20|and|0.40|weak correlation; r between |0.40|and|0.70|moderate correlation; r between |0.70|and|0.90|strong correlation; r >|0.90|very strong correlation; r = 1 perfect correlation.

## 7.4. Conclusions and Discussion

The use of virtual assistants is becoming increasingly common in higher education institutions. In this context, chatbots engage with students through chat or conversation, providing information and advice in an automated manner. This study addresses the design, implementation, and evaluation of a chatbot designed to enhance inclusive learning in university students. The overall objective of this study was to assess the self-perception of university students regarding the implementation of a chatbot specifically designed to enhance learning linked to UDL. The following are the conclusions of the study.

Firstly, regarding the usability of the chatbot in the context of learning about UDL, a positive reception from students was evident. The interface and navigation of the chatbot were rated as intuitive, facilitating interaction and access to information related to UDL. This finding suggests that the implementation of virtual assistants can contribute to improving accessibility and the user experience in educational environments since, as noted by Benito-Sánchez (2023), the implementation of virtual assistants can mitigate accessibility barriers and diversify learning strategies. Furthermore, the chatbot's ability to adapt to individual needs, as mentioned by Mateos (2023), demonstrates the potential for personalization in education, aligning with the principles of UDL.

Secondly, regarding the accuracy of the chatbot in delivering information related to the principles of UDL, the results indicate that the chatbot proved to be accurate and reliable in conveying key concepts. This aspect is crucial to ensure that the provided information is educationally sound, thereby supporting the chatbot's effectiveness as a reliable learning resource. The accuracy and reliability of this tool in delivering information align with the research of Gauna-Ferraz et al. (2024), who emphasize the importance of accuracy in AI-based educational interactions. On the other hand, the observed smooth interaction supports the conclusions of Villavicencio et al. (2021) regarding the enhancement of user experience through natural conversation systems.

Thirdly, concerning the quality of the interaction provided by the chatbot during the learning process about UDL, a smooth and contextualized communication was observed. Therefore, in line with studies such as Okonkwo & Ade-Ibijola (2021) and

Redondo-Duarte et al. (2024), it is affirmed that the chatbot's ability to adapt to the individual needs of students can provide personalized responses that enhance a more enriching and interactive learning experience.

Fourthly, regarding the utility of the chatbot as a support tool in understanding and applying UDL concepts, the results revealed that students perceived the chatbot as a complementary tool. Its ability to provide clear explanations, specific examples, and additional resources significantly contributed to the effective understanding and application of UDL principles. In terms of utility, the positive perception of students reinforces the findings of Cruz et al. (2021), who argue that the perceived utility of technology is essential for its adoption and effectiveness in the educational domain.

Fifthly, university student satisfaction regarding the implementation of the chatbot to enhance learning about UDL is notably positive. The majority of students expressed satisfaction with the experience, emphasizing the convenience, availability, and additional support provided by the chatbot in their learning process.

In conclusion, the virtual chatbot designed, implemented, and evaluated for educational purposes on UDL is not only capable of providing information and/or answers to questions efficiently but can also automate tasks and offer personalized advice and guidance. Therefore, this chatbot directly contributes to the creation of more inclusive and accessible learning environments. Its ability to simulate human conversation not only enhances the student experience but also provides a versatile tool for educational support, enabling the application of personalized strategies aligned with the fundamental principles of UDL. In this regard, the strategic integration of chatbots in educational environments cannot only improve communication efficiency but also enrich the learning experience through adaptability and personalization, which are essential aspects of UDL.

Regarding the limitations of the study, self-perception can be influenced by various factors, including participants' prior expectations and their level of familiarity with similar technologies. Additionally, the sample may not fully represent the diversity of students in university settings and was not randomly selected. Future research could address this limitation by including

more diverse samples and combining quantitative and qualitative data to gain a more comprehensive understanding of the student experience. Moreover, as a research prospect, there is a need to implement its use among other university students, as well as external users.

This study highlights the feasibility and benefits of integrating chatbots in higher education, supporting both accessibility and the effectiveness of inclusive learning, in line with the principles of UDL.

## References


Baltazar, C. (2023). Herramientas de IA aplicables a la educación. *Technology Rain Journal, 2*(2), e15-e15.

Benito-Sánchez, P. (2022). Hábitos en el uso de los asistentes virtuales de voz entre la población de personas con discapacidad visual. *RED Visual: Revista Especializada en Discapacidad Visual*, 80, 71-82. https://doi.org/10.53094/UQBX7021

Burgstahler, S. (2015). *Universal Design in Higher Education: Promising Practices. DO-IT*. University of Washington. https://www.washington.edu/doit/sites/default/files/atoms/files/Universal%20Design%20in%20Higher%20Education_Promising%20Practices.pdf

CAST (2018). *Universal Design for Learning Guidelines, version 2.2*. http://udlguidelines.cast.org

Cruz, O. D. C., Mariño, G. A., Tejada, J. B., & More, O. A. R. (2021). La usabilidad percibida de los chatbots sobre la atención al cliente en las organizaciones: una revisión de la literatura. *Interfases, 14*, 184-204.

Elizondo, C. (2023). Retos y oportunidades de la LOMLOE para la educación inclusiva. *Dosier Graó, 8*, 5.

Gauna-Ferraz, R. A., Vital Ferraz, V. M., Morosetti Ferreira, C. C., Vaz Paiva, J., & Carneiro Sarturi, R. (2024). El buen uso de las tecnologías y la inteligencia artificial en la educación: investigación y prácticas educativas. In *Libro de resúmenes de trabajos a IRED'23. III Conferencia internacional de investigación y V Jornadas de investigación e innovación educativa*.

Jiménez-García, E., Orenes-Martínez, N., & López-Fraile, L. A. (2024). Rueda de la pedagogía para la inteligencia artificial: adaptación de la rueda de Carrington. *RIED-Revista Iberoamericana de Educación a Distancia, 27*(1), 87-113. https://doi.org/10.5944/ried.27.1.37622

Kuhail, M.A., Alturki, N., Alramlawi, S. & Alhejori, K. (2023). Interacting with educational chatbots: A systematic review. *Education and Information Technologies*, *28*, 973-1018. https://doi.org/10.1007/s10639-022-11177-3

Mateos, J. E. G. (2023). El ABC de los chatbots en la educación: una aproximación. *Revista Cubana de Educación Superior*, *42*(1), 462-482.

Meyer, A., Rose, D. H., & Gordon, D. (2014). *Universal Design for Learning: Theory and Practice*. CAST.

Okonkwo, C.W., & Ade-Ibijola, A. (2021). Chatbots applications in education: A systematic review. *Computers and Education: Artificial Intelligence*, *2*, 100033. https://doi.org/10.1016/j.caeai.2021.100033

Pack, A., & Maloney, J. (2023). *Using generative artificial intelligence for language education research: Insights from using OpenAI's ChatGPT*. TESOL Quarterly. https://doi.org/10.1002/tesq.3253

Redondo-Duarte, S., Martínez-Requejo, S., Jiménez-García, E., & Ruiz-Lázaro, J. (2024). The potential of educational chatbots for the support and formative assessment of students. In Ibrahim, M., Aydoğmuş, M., & Tükel, Y. (Ed.). *New Trends and Promising Directions in Modern Education* (pp. 113-148). Palet Yayinlari.

Redondo-Duarte, S., Ruiz-Lázaro, J., Jiménez-García, E. & Martínez-Requejo, S. (2024). Didactic Strategies for the Use of AI in the Classroom in Higher Education. En Arinushkina, A. A. (Ed.), Integration Strategies of Generative AI in Higher Education, 113-148. IGI Global. https://doi.org/10.4018/979-8-3693-5518-3.ch002

Ruiz-Lázaro, J., Jiménez-García, E. y Huetos-Domínguez, M. (2024). Revisión sistemática sobre el uso de la tecnología en educación y el compromiso de los estudiantes en la última década. *Campus Virtuales*, *14*(1), 139-152. https://doi.org/10.54988/cv.2025.1.1318

Shahmoradi, L., Changizi, V., Mehraeen, E., Bashiri, A., Jannat, B., & Hosseini, M. (2018). The challenges of e-learning system: Higher educational institutions perspective. *Journal of Education and Health Promotion*, *7*(116), 1-6. https://doi.org/10.4103/jehp.jehp_39_18

Tseng, W., & Warschauer, M. (2023). AI-writing tools in education: If you can't beat them, join them. *Journal of China Computer-Assisted Language Learning*, *3*(2), 258-262. https://doi.org/10.1515/jccall-2023-0008

Villavicencio, O. E. C., Ordóñez, M. P. Z., Pardo, M. R. V., & Ramón, R. A. R. (2021). Comparativa de tendencias de desarrollo de software móvil. *3c TIC: Cuadernos de Desarrollo Aplicados a las TIC*, *10*(1), 123-147.

Yeo, M. A. (2023). Academic integrity in the age of artificial intelligence (AI) authoring apps. *TESOL Journal*. https://doi.org/10.1002/tesj.716

Wang, J., Hwang, G. H., & Chang, C. Y. (2021). Directions of the 100 most cited chatbot-related human behavior research: A review of academic publications. *Computers and Education: Artificial Intelligence*, *2*, 100023.

Wu, R., & Yu, Z. (2023). Do AI chatbots improve students learning outcomes? Evidence from a meta-analysis. *British Journal of Educational Technology*. https://doi.org/10.1109/ACCESS.2020.2988252

Zorrilla-Puerto, J., Lores-Gómez, B., Martínez-Requejo, S. y Ruiz-Lázaro, J. (2023). El papel de la robótica en educación infantil: revisión sistemática para el desarrollo de habilidades. *RiiTE Revista Interuniversitaria de Investigación en Tecnología Educativa*, *15*, 188-194. https://doi.org/10.6018/riite.586601

# 8

# Society and Artificial Intelligence: Chatbots in the Educational Process

PhD Marta Aguilar-Gil
Universidad de Sevilla, Spain
maguilar6@us.es
https://orcid.org/0000-0002-8038-3421

**Abstract**
One of the most important sociological phenomena in the current panorama is Artificial Intelligence (AI). In the near future, the application of this type of technology is expected to revolutionize different social sectors, such as health, marketing, industry, communication, etc. Inevitably, this will prompt changes in certain social structures. A recent response to this has been the outlining of the first European AI law, which will come into force in 2026 to regulate different social challenges. The educational sector will also need to adapt to face the social changes brought about by AI. In this chapter we focus on the potential and/or limitations that chatbots have for the educational community and how these are geared towards the self-regulation of learning. The application of these types of programmes, based on AI, is slowly being incorporated into the educational system as a very useful tool, but it also poses certain challenges to the system.

**Keywords:** Artificial Intelligence, chatbots, education, society.

## 8.1. Introduction

In the academic world, Artificial Intelligence offers significant benefits in efficiency in relation to administration, teaching and especially research tasks. AI can handle large amounts of data (Big Data), which makes knowledge in the field of research easier to interpret, analyse, correlate and be accessible to a larger percentage of the population. The different AI applications, pro-

grams or assistants that are being introduced in primary and secondary education today take three different forms: 1) intelligent conversational software agents (chatbot); 2) the creation of online platforms for self-learning; and 3) the use of educational robotics. Chatbots have proved to be very useful when tutoring students; they are capable of answering and addressing questions and adapting to the student's learning. During the COVID-19 pandemic, the creation and use of online platforms was widely adopted, creating very efficient learning spaces. In this scenario, educational robots can be useful when carrying out collaborative learning, developing practical cases in a fun and more entertaining way (Moreno, 2019, p.263-265).

The possibilities that AI offers as a methodological resource look very promising in the field of educational. This is reflected in one of the objectives set out in the latest Spanish education law, Organic Law 3/2020, of December 29, to adapt the educational system to the challenges of the 21st century, which includes the use of AI.

A rigorous and scientific analysis of the social and economic impact of AI in education is therefore necessary in order to address the challenges and risks faced by the educational system as a consequence of the new scenarios derived from the development of AI. In this discussion, the analysis focuses on chatbot programs applied to education.

## 8.2. Society, Artificial Intelligence and Education

We currently find ourselves, through our growing knowledge of AI, at the gates of a new technological revolution that will exponentially change all areas of the lives of individuals and society. Opinions range from the most optimistic to the most pessimistic, from a future free of cares to one of the loss of free will, with humans being under the control of machines and robots. We lurch from hope to despair, and back again. In a scenario where we have seen the potential power of Information Technology, we still lack all the information to make a safe and accurate diagnosis. Thus, while our quest for knowledge and our adaptability pushes us to embrace the future, our anxieties and concerns make us hesitant.

Since the middle of the last century, progress has been made in the development of new technologies, and this has been accompanied by the theorization of what could happen in the individual, collective, productive, economic, environmental, educational, and health spheres, to name a few. The field of social sciences defined the new emerging society as the information and communication society. Other definitions followed suit: knowledge society (Bell, 1976), network society (Castells, 1999), risk society (Beck, 1998) and liquid society (Bauman, 1999). Nevertheless, the one thing that united all these theories and research was the important role that knowledge and its influence on information and communication would play in the future. This led to the question, yet again, of who would control this knowledge and how it would be used in everything related to digitalization, globalization, production methods and the future of science.

Although the development of these new technologies came from those who had economic power rather than political power, it was soon clear that individuals and social groups could collaborate in the construction of this new reality, possibly leading to an even greater democratic participation in decision-making. However, the onset of the new century saw the rapid growth of technological innovations and their application in all spheres of life, and this increased the uncertainty and anxiety in the minds of individuals and institutions. This has been further exacerbated by the current global crisis in areas as fundamental as politics, the environment, the economy, social inequalities, health epidemics, war conflicts, communication networks, education, and new types of disinformation. In other words, we find ourselves in a panorama of instability, of continuous, persistent change. In addition to this, there are enormous advances being made in the field of genetics, nanotechnology and robotics (Ray Kurzweil), all of which means that the use of AI in a global context poses, at the very least, a source of concern. This evident revolution, which is no longer so latent, must be contemplated as a sudden interruption of the historical continuum, a rupture of the existing social and economic order, from what has been a progressive conception of history.

Recently, faced with this rapid and immense revolution in AI and the systemic risk it presents, state and interstate governments, under a degree of sociopolitical and economic pressure,

have taken the first steps towards managing this risk by establishing legislative processes to ensure that those at the core of this revolution are not large multinational economic groups whose partiality and exploitation of social and individual control is primarily for economic gain. To manage this risk, the role of civil society, the media and education is extremely important.

In this new emerging society, in which wide-ranging changes are already occurring at an unprecedented rate, where AI will occupy a prominent place, education is a key tool to define not only how society should be configured, but who can access these new technologies, under what conditions, when and how. Training, learning, and improving the skills of citizens and workers for current and future times is an essential requisite. Since the current mode of intervention in political decision-making is strongly related to the existing education model, it is appropriate to analyze the interrelationship between AI and education. That is the focus of this chapter.

As a reference framework for education, we refer to the 2030 Sustainable Development Agenda, approved by the United Nations (UN) in 2015, whose Sustainable Development Goal (SDG) number 4 is the following: 'Ensure inclusive, equitable and quality education and promote lifelong learning opportunities for all'. For consideration in line with this objective is the UNESCO requirement of a human-centerd approach to AI, where the objective is to "include the role played by AI in solving current inequalities in terms of access to knowledge, research and the diversity of cultural expressions, and ensure that AI does not widen the technological gap within and between countries" (UNESCO, 2023).

With this in mind, UNESCO prepared educational material (UNESCO, 2021) aimed at promoting the training of those responsible for formulating educational policies related to AI, in order to promote shared understanding of the opportunities and challenges that AI provides in the field of education. The document is a guide on how to proceed in the face of the influence of AI in education, how to improve education and what to do to achieve SDG 4, highlighting, above all, the role of AI in its ethical, inclusive and equitable role, the improvement of teaching and learning through AI, and the coexistence of individuals with new emerging educational trends.

## 8.3. Artificial Intelligence: A Brief Historical, Conceptual and Normative Contextualization

### Historical contextualization

The genesis of Artificial Intelligence can be pinpointed as coming from the work of the American neuroscientists McCulloch and Pittis (1943). These scientists created the first neural calculation model with which they tried to imitate the behaviour of the brain's neurons. Years later, Alan Turing (1950) published a paper under the title "Computing Machinery and Intelligence", in which he raised the question of whether machines could think, which gave rise to the Turing test (a tool to evaluate whether a machine has intelligent behaviour). Subsequently, in 1956, a group of scientists from the fields of computer science and neural networks met at Dartmouth College with the aim of presenting various projects related to games and reasoning programs. Very little came out of that meeting, except for the origin of the term Artificial Intelligence, a concept coined by John McCarthy (1956) to name this new line of research, which was an independent and specific field within computing. MacCarthy, as indicated in the Recovery, Transformation and Resilience Plan (2023) of the Spanish Government, defined AI as "the science and engineering of making intelligent machines, especially intelligent computer programs" (para. 10).

In the 1960s, there was a hiatus in the development of this technology due to its elevated cost, which meant it was only feasible in large research centres. An important milestone in this decade was the creation of the programs Logical Theory and General Problem Solver (GPS), both developed by the Americans Newell and Herbert (1972), and which were used for the resolution of mathematical theorems and problems in general. According to Pertusa (2023), the 1970s and 1980s were decades in which AI made great progress, especially in the workplace. Many companies, through this technology, saw how they could improve efficiency and effectiveness ratios in their workers, so the implementation of this technology gradually spread over the decades that followed. Starting in the 1980s and 1990s, large computer programs were at a much more advanced stage in

terms of information processing capacity; the algorithms were increasingly more complex, had the capacity for autonomous learning, and were designed for decision-making. Implementation of these computer programs experienced a boom in the sectors of medicine and business management. Over the last twenty years, progress has focused on robots. These machines are capable of interacting with the physical world; they can maintain contact with humans through language, develop learning techniques, and manage large amounts of data. In the current decade, AI is expected to continue evolving, with greater implementation in all sectors of society, such as medicine, robotics, autonomous driving and learning. We are at a complex moment in time in light of all the sectors affected and the uncertainty generated by AI, especially in the world of work, where it is feared that many jobs will disappear. We are facing what some refer to as the fourth industrial revolution. In the future, according to Arbeláez (2021), AI will be able to introduce specific approaches such as symbolic AI and machine learning. By imitating human thinking, symbolic AI uses algorithms to solve real-world problems and specific situations, while machine learning, through mathematical models, can handle large amounts of data, create classifications and provide results. Both approaches are important for natural language development and future AI programs.

These complex machines can learn and adapt as they interact with the environment. As sociologist Edgar Morin stated (*El País*, January 28, 2024), "technology progresses, thinking regresses."

## Concept of Artificial Intelligence

Artificial Intelligence aims to imitate human intelligence in its ability to communicate, think, react and even reason. According to the dictionary of the Royal Spanish Academy (2023), it is a "scientific discipline that deals with creating computer programs that execute operations comparable to those carried out by the human mind, such as learning or logical reasoning." Authors on the subject of AI put forward varying definitions of this technology. The different versions that exist usually refer to rationality or human behaviour regarding the efficiency of this technology.

To contextualize the concept, we can cite a few of the many definitions. Alluding to the creators of this discipline, AI could

be defined as "the use of computer programs and programming techniques to shed light on the principles of intelligence, and on human intelligence in particular (Boden, 1984, p. 28). Alternatively, a less specific definition would be "a set of techniques, algorithms and tools that allow us to solve problems for which, a priori, a certain degree of intelligence is necessary, in the sense that they are "problems that challenge even the human brain" (García, 2012, p.5). We also have the definition put forward by the Ministry of Science, Innovation and Universities of Spain (2019) that "Artificial Intelligence can be understood as the science and engineering that allows us to design and program machines capable of carrying out tasks that require intelligence to be completed" (para. 12).

Given these definitions, and especially considering the challenges that this technology poses on the global scene, "sociologists will have an essential role in this. At the moment, computer programs imitate a human mind, as if they were individual and autonomous minds, but the human mind is basically social" (Collins, 2009, p.188). If we want robots to be more like humans, we must take into account the social dimension. In other words, our social interaction with others, our thinking, our emotions, and our intelligence depend on the social relationships we engage in.

## Regulatory framework for Artificial Intelligence

One of the main issues on the agenda of Western leaders is the advancement, investment and progress of this technology and, consequently, there is concern as to how to ensure it is regulated. Industry and large companies that use technology want to delay its regulation for as long as possible, since, with no ethical and moral limits, they can take advantage of this legal loophole.

On December 11, a draft of the first European regulation on Artificial Intelligence was established by the Presidency of the European Parliament and the European Council. The Government of Spain, on its electronic administration portal, indicates that the main objective of this draft is that all programs marketed in European territory must respect fundamental human rights and European values; otherwise they will be prohibited. This provisional agreement currently forbids "cognitive-behavioral

manipulation, non-selective removal of facial images from the Internet or CCTV images, emotion recognition in the workplace and in educational institutions, social scoring, biometric categorization for inferring sensitive data, such as sexual orientation or religious beliefs, and some cases of predictive policing for individuals" (para. 14).

## 8.4. Attitudes and Perceptions towards the Use of Artificial Intelligence in the Classroom

It is clear that the incorporation of Artificial Intelligence in education calls for pedagogical models to change and adapt. Changes are being implemented gradually, but in the immediate future, teaching-learning methods at a global level need to undergo an educational revolution. Let us now look more closely at attitudes and perceptions regarding this technology, especially those of teachers, by reviewing a set of recent studies.

One of these studies is the latest Ipsos Global Education Monitor (2023), which analyses the latest advances in the objectives set by the European Union in terms of education. This report includes a country comparison, key education indicators and information on recent and ongoing policy developments at all educational levels in EU countries. A survey was carried out in 2023, in 29 countries, with a sample of 23,248 adults across Asia, North America, Latin America and Europe. The report concludes that teachers´ attitudes towards the use of AI are generally positive, but not equally so in all countries. One in five thinks that it will have a negative result on students. Curiously, among the countries that think that this effect will be more negative than positive are countries such as Canada, France, Italy and the United States. Moreover, the report states that, in most countries, one in three thinks that AI should not be banned in schools. Regarding teacher training, in general terms, more than 65% think that teacher training is necessary; in Spain, 62% consider it essential.

Another report that also provides interesting data in this regard is the one carried out by the research institute of the technology consultancy Capgemini (2023), which surveyed teachers, family members and students, with a sample of 7,200 respond-

ents across Asia, Europe and North America. In this report, a significant number of teachers were concerned about the ChatGPT program, with 48% of them having either banned it in the classroom or restricted it for specific activities, since they believed that creativity and writing could be affected. Despite this perception towards this program, the majority of people surveyed approve the benefits of AI programs in general and consider that study and evaluation plans need to be adapted to this technology; 85% believe that education in digital skills is beneficial for the future of students and that the positive consequences outweigh the risks.

## 8.5. Chatbots as a Methodological Resource in Learning

### What are chatbots?

Among the AI programs being developed in the 1960s was the so-called ELISA program in the United States, in 1966. This program was the origin of chatbots, and aimed to give the impression that a person was talking to another person instead of to a machine. Chatbots continued to be developed with limited success, until the beginning of the new millennium with the arrival of Smarter Child, where communication could be maintained in a colloquial style using natural language. This program made its foray into platforms like Messenger and was very successful until 2007, when a problem with the patent and a buyout by Microsoft made it disappear. Since then, other types of assistants have come into our lives, such as Siri, Google Assistant, Alexa, etc.

When defining chatbots, authors express varying views; some differentiate them from virtual assistants and others view them as the same and interchangeable. What authors do agree on is that the differences are rather technical, thus, for us non-experts, we will consider Chatbots and virtual assistants as the same thing.

We could say that a chatbot is an assistant or conversation program between a person and a machine: "chatbots are programs that can interact with users using natural language. They are virtual assistants capable of establishing a dialogue between

a computer and a human, either by writing text or using their voice" (Dimitriadis, 2020, p.47).

They act by giving responses that have been programmed or structured in advance. In the most complex ones, mathematical models are used, such as algorithms, which make these machines learn automatically, and they can interact with humans by processing natural language.

## Chatbots in education

Since the COVID-19 pandemic, there has been a boom in learning platforms, and especially chatbots. The pandemic has been an important milestone in the development and use of chatbots by students, teachers and families. People discovered the benefits of these programs, where anyone could connect and resolve problems from anywhere in the world and at any time, without the need for a teacher to be present.

Chatbots develop different educational functions. On the one hand, there are those that offer administrative assistance and guidance in the educational and academic field and, on the other hand, those that focus on learning and teaching, through which tutorials can be delivered, exercises presented and activities completed to achieve the pedagogical objectives through a very efficient interactive role.

The following examples are among the most used Chatbots aimed at pedagogical work. Firstly, virtual assistants (these answer questions and help to learn) are among the most used: Duolingo is popular for learning languages and grammar, adapting to the student's level; and Mathbot is used for learning mathematics, with each problem being explained step by step to facilitate understanding of the process. Secondly, there are intelligent tutoring system programs (these analyze the student's evolution, identifying the tasks in which the student needs to improve, and adapting the content to meet this need). Among the most popular systems are the programs Dreambox Learning and Thinkster Math, which are both used in the subject of mathematics and follow the student's evolution, adapting the contents and explanations to his/her level, and clarifying doubts along the way. Lastly, there are adaptive learning platforms (these enable the creation of personalized content for each student based on his/

her needs), such as Smart Sparrow, which allows teachers to personalize teaching experiences at different levels and to meet the different needs of their students.

A teacher´s choice of chatbot will depend on the specific skills he/she is looking to teach, as well as the methodology to be used in learning. In summary, from the presented examples of these programs, and depending on the task being performed or the pedagogical objective for which each activity is intended, chatbots can be framed or classified within the following four aspects: 1) learning; 2) resolution of problems or doubts, both administrative and teaching; 3) tutoring; and 4) adaptive or individualized content.

Some authors propose a broader classification, classifying chatbots according to: administrative or management tasks; frequent questions; student support; motivation; practice of skills and abilities; simulations; reflection and metacognition; and learning evaluation (Brustenga et al., 2018, p.19). What is evident is that this technology has many adaptive capabilities in the field of teaching and learning.

## 8.6. Advantages and Challenges of Chatbots in the Educational System

According to studies carried out regarding chatbots in the field of education, the results are very positive; "the objectives of chatbots in education can be described by one of the following categories: improvement of skills, efficiency of education and motivation of students" (Wollny et al., 2021, p.7). In general, students are more comfortable and motivated using technology; today's students were born in the technological era and their socialisation with these types of programs, video games, etc., is part of the norm. They feel much more comfortable talking to a machine which does not control them and does not make value judgments, where the relationship is more one-to-one. Even the visual format can be very attractive, which encourages students to express themselves with greater freedom. Another important aspect is the personalization of learning. By adjusting to the pace of learning of each student, these programs are invaluable in

tackling school failure. They are particularly important in supporting children with various disabilities, who struggle to learn in the classroom, by enabling them to continue at the same pace as the class. Interactive learning, therefore, encourages students to make their own decisions about their own learning, increases their self-perception and reinforces their confidence. The self-regulation of learning has a lot to do with the socio-constructivist theory, which points to the student as the main author of his/her knowledge and learning; the student has to be able to learn and solve problems and situations on his/her own, with the role of the teacher as a guide and mentor. In meetings to adapt university studies to the Bologna Plan, those present welcomed this form of learning, valuing it highly. Learning by competencies has also been incorporated into primary and secondary education and, therefore, chatbots offer an enriching tool to learn and work by competencies. Having the ability to organize one's own learning is considered one of the basic competencies in the learning process and has therefore become a relevant competency within the framework of the current strategies of the European Union (2018).

There are authors, such as Zimmerman (2008), who consider the self-regulation process as an open process consisting of three phases. The first phase is the planning phase, where the activity to be carried out is firstly organized, driven by the desired outcome, the reason for doing the task, etc., which are factors that promote student motivation. The second phase covers self-control, self-organization, and self-learning. The third phase is the assessment of the work learned and an analysis of strategies for the next activity.

The majority of studies on the advantages of chatbots focus on students, especially on knowing their perception of this technology and evaluating their academic results from its use. However, the role of teachers has been less studied. One of the advantages for teachers, achieved through the use of technology, is that they no longer need to be the owners of knowledge, since there is an entire virtual world of knowledge where books are no longer the tool for learning. Teachers can direct students as to where to go for the answers. The teacher´s role becomes one of helping students develop critical, personal, emotional and intellectual analysis skills, using technological tools. With this shift away

from the traditional method of transmitting knowledge, the teacher can focus on other issues related to the learning process.

One of the disadvantages of this technology is that programs are usually created by large companies, and this means that they often do not meet the proposed learning objectives. To better understand the educational needs, there must be greater collaboration between teachers and the companies that create these educational tools. There are very few chatbots available that have been created by teachers. Many teachers lack the skills required to manage the complexity of the programs, and need to be offered training. Likewise, teachers need to be involved more directly with companies in the preparation of teaching guides and their objectives. These teaching programs can be adapted to meet the needs of individual students, which is one of the benefits of using these programs, but this is beyond the scope of most teachers, and collaboration is required between educational agents and companies or publishers.

Another disadvantage is that the technology, content and activities are not well-adapted to students with disabilities, thus this area needs more attention, particularly to help teachers work with families in a more fluid and communicative way, participating in the learning process through chatbots. One of the variables that appear in the Pisa reports is the importance of family involvement in the educational development of the student. There are several studies that support the idea that the greater the degree of participation of families in the learning centres, the better the students´ academic results. Among some examples are the Rimkeby School in Stockholm, or the studies carried out at Harvard University, where they have a specific line of communication between family and education. Chatbots could further promote communication and facilitate tutoring between families and teachers.

The authors Okonkwo and Ade-Ibijola (2021) identify possible issues that will need to be addressed. Firstly, there is the ethical issue: What is going to happen to our privacy? Where is our data going to go from conversations? Secondly, how is this technology going to be evaluated? These authors point out that, at the moment, we have few tools for this task. Thirdly, there may be negative effects regarding the student's attitude when implementing this tool. Lastly, investment is needed in programming

the appropriate responses of the human language, and having the adequate time and resources to carry out each of the appropriate adaptations of the programs.

It is evident that the role of teachers is going to change, and this poses a new challenge in the generation of learning situations, which will require a review of the study plans of the Faculties of Education Sciences and of course a radical change in the education system. Society is changing and teacher training has to change to be in line with the new social realities. For this to happen, a greater investment in technological resources and training is needed. Let's hope we are not too late.

## 8.7. Conclusion

It is evident that AI is part of our lives and its development and implementation in the immediate future is unstoppable. The educational system is not blind to this; for some years now, educational processes have been carried out through platforms and conversational assistants such as chatbots.

Chatbots designed with pedagogical approaches in line with educational needs and projects are an invaluable tool that has achieved very good academic results for both students and teachers. These pedagogical approaches have to be based on theoretical models, such as the socio-constructivist theory.

We must continue our research into chatbots, creating new chatbots that can offer a more individualized approach to learning, particularly for students with disabilities. Further studies are also needed on how to involve the family as a member of the school community in accessing these chatbots.

The school community (teachers, students and family) must be involved in the development of these programs or assistants; they must be part of the design, development, and implementation and evaluation process. Most programs are led by technology companies, often ignoring the teaching needs. These companies pay more attention to general content of the subjects than to competencies and pedagogical foundations. Understanding the needs of the students who will be using these assistants is essential. To this end, joint collaboration is necessary. Despite all the possibilities and potential of these programs, chatbots are

still mainly used in subjects related to science and language learning, with an obvious gap in social sciences.

One of the great challenges posed by these assistants is the training of teachers, and the new role they face within the teaching-learning process in a society where knowledge is no longer only in the hands of teachers. Teachers need to adapt their role, putting the teaching focus on imparting values and a critical view of the world around us.

In order to meet the objectives, set by the Spanish Government in this regard, and by the rest of the countries of the European Union, further investment in education is required. Not all students have the same resources to access technologies, and our education system, although it is adapting, is doing so very slowly.

In line with the development of AI, which is occurring at a rapid pace, there has to be the development of legal guidelines. The European Union needs to regulate more efficiently the ethical aspects that we are facing today. This is even more important when we consider that the education sphere affects our young population, and failure to manage this effectively can have complex consequences for the future.

## References


Arbeláez-Campillo, D., Villasmil, J., y Rojas-Bahamón, M. (2021). Inteligencia artificial y condición humana: ¿Entidades contrapuestas o fuerzas complementarias? *Revista de Ciencias Sociales (Ve)*, *XXVII* (2), 502-513.

Bauman, Z. (1999). *Modernidad líquida*. Fondo de Cultura Económica.

Beck, U. (1998). *La sociedad del riesgo. Hacia una nueva modernidad*. Paidós.

Bell, D. (1976). *El advenimiento de la sociedad posindustrial*. Alianza.

Boden, M. (1984). *Inteligencia artificial y hombre natural*. Tecnos.

Capgemini Research Institute (2023). *Digital skills and technology in secondary education survey*. https://www.capgemini.com/es-es/wp-content/uploads/sites/16/2024/09/Final-Infographic-Digital-Skills-2.pdf

Castells, M. (1999). La era de la información: economía, sociedad y cultura. La sociedad red. Siglo XXI.

Collins, R. (2009). *Perspectiva sociológica. Una introducción a la sociología no obvia*. Universidad Nacional de Quilmes.

Dimitriadis, G. (2020). Evolution in education: chatbots. *Homo Virtualis*, *3*(1), 47-54. https://ejournals.epublishing.ekt.gr/index.php/homvir/article/download/23456/19700

García, A. (1912). *Inteligencia artificial: fundamentos, práctica y aplicaciones*. RC Libros.

García-Brustenga, G., Fuertes-Alpiste, M., y Molas-Castells, N. (2018). *Briefing paper: los chatbots en educación*. Universitat Oberta de Catalunya. https://doi.org/10.7238/elc.chatbots.2018

Gobierno de España. (2024, February). Plan de Recuperación, transformación y resiliencia. https://planderecuperacion.gob.es/noticias/que-es-inteligencia-artificial-ia-prtr#:~:text=que%20posteriormente%20McCarthy%20definir%C3%ADa%20como,especialmente%20programas%20de%20computadora%20inteligentes%22

IPSOS (2023). *Global Education Monitor*. https://www.ipsos.com/sites/default/files/ct/news/documents/2023-09/Ipsos%20Global%20Education%20Monitor.pdf

Ley Orgánica 3/2020, de 29 de diciembre, por la que se modifica la Ley Orgánica 2/2006, de 3 de mayo, de Educación. Boletín Oficial del Estado, 340, de 30 de diciembre de 2020. https://www.boe.es/eli/es/lo/2020/12/29/3/con

McCarthy, J. et al. (1955). *A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence*. https://www-formal.stanford.edu/jmc/history/dartmouth /dartmouth.html

McCulloch, W., & Pitts, W. (1943). A logical calculus of the ideas immanent in nervous activity. *The Bulletin of Mathematical Biophysics*, *5*(4), 115-133. https://doi.org/10/djsbj6

Ministerio de Ciencia, Innovación y Universidades (2019). *Estrategia española de I+D+I en inteligencia artificial*. http://www.ciencia.gob.es/

Moreno, R. (2019). La llegada de la inteligencia artificial a la educación. *Revista de Investigación en Tecnologías de la Información*, *7*(14).

Morín E. (January 28, 2024). La tecnología progresa, el pensamiento retrocede. *El País*. https://elpais.com/ideas/2024-01-28/la-tecnologia-progresa-el-pensamiento-retrocede.html?event_log=oklogin

Newell, A., &Simon, H. A. (1972). *Human problema solving*. Englewood Cliffs, Prentice-Hall.

Okonkwo, C. W., & Ade-Ibijola, A. (2021). Chatbots applications in education: A systematic review. *Computers and Education: Artificial Intelligence*, *2*, 100033. https://doi.org/10.1016/j.caeai.2021.100033

Pertusa, J. (2023). Inteligencia artificial aplicada a la educación el futuro que viene. *Supervisión21*, *69*, 1-28. https://doi.org/10.52149/sp21

Presidencia Española del Consejo de la UE (2023, 9 December). Ley de Inteligencia Artificial: el Consejo y el Parlamento llegan a un acuerdo sobre las primeras normas del mundo para la IA (comunicado de prensa). https://spanish-presidency.consilium.europa.eu/es/noticias/consejo-parlamento-acuerdo-primeras-normas-mundiales-inteligencia-artificial/

Ray Kurzweil, R. (2012). *La Singularidad está cerca. Cuando los humanos transcendamos la biología*. Lola Books.

Real Academia Española. (s.f.). Inteligencia artificial. En *Diccionario de la lengua española*. https://dle.rae.es/inteligencia#2DxmhCT

Turing, A. M., (1950), Computing machinery and intelligence. *Mind, 50*, 433-460.

UNESCO (2019). *International Conference on Artifcial Intelligence and Education. Final Report. Planning Education in the AI Era: Lead the leap.* https://unesdoc.unesco.org/ark:/48223/pf0000370967

UNESCO (2021). *La inteligencia artificial y educación: guía para las personas a cargo de formular políticas.* https://unesdoc.unesco.org/ark:/48223/pf0000379376

UNESCO (2023). *La inteligencia artificial en la educación.* https://www.unesco.org/es/digital-education/artificial-intelligence

Wollny, S., Schneider, J., Di Mitri, D., Weidlich, J., Rittberger, M., y Drachsler, H. (2021). Are we there yet? A Systematic literature review on chatbots in education. *Frontiers in Artificial Intelligence, 4*, 654924. https://doi.org/10.3389/frai.2021.654924

Zimmerman, BJ (2008). Investigating Self-Regulation and Motivation: Historical Background, Methodological Developments, and Future Prospects. *American Educational Research Journal, 45*, 166-183.

9

# I Am not as Rich as Alexander the Great, but I Can Have my own AI-RISTOTLE

PhD Jonatan Castaño-Muñoz[1]
Universidad de Sevilla, Spain
jcastanno@us.es
https://orcid.org/0000-0002-6112-2728

PhD Celia Moreno-Morilla
Universidad de Sevilla, Spain
cmoreno8@us.es
https://orcid.org/0000-0003-0566-4319

Manuel Reina-Parrado
Universidad de Sevilla, Spain
mreinap@us.es
https://orcid.org/0000-0002-0801-0938

**Abstract**
Human tutoring is one of the most effective methods to prevent school failure and reduce early school dropout. Due to their high cost and low scalability, digital technologies have been used to approach or complement human tutoring, although their relative efficacy remains low. This chapter delves into the role of digital technologies in the implementation of tutorials exploring how Artificial Intelligence (AI) may be used as a complement to human tutors to provide educational accompaniment to students who attend schools in areas of low socioeconomic level. In our contribution, we present the methods and main results of a workshop of experts in which, following a design-thinking

1. Jonatan Castaño Muñoz acknowledges the support of the "Ramón y Cajal" grant RYC2020- 030157 funded by MCIN/AEI/ 10.13039/501100011033 and by "ESF Investing in your future" for this work.

approach, we developed AI-mediated propositions aimed at maximizing the efficacy and efficiency of educational accompaniment. The experts proposed the creation of an adaptive virtual learning environment (AI-RISTOTLE), based on local AI, that respects the ethical principles and integrates accompaniment functionalities. Moreover, the experts agreed that this environment should make use of the potential of AI to include tools that critically reflect personal and sociocultural identity, improve family participation, offer social and emotional support, provide adequate feedback including metacognitive elements, and develop the digital competence of the students.

**Keywords:** Artificial Intelligence, tutoring, Low-SES, Primary Education, experts, design thinking.

## 9.1. Introduction

In the last decades, we have witnessed an increase of socioeconomic inequalities worldwide (Blanchet & Martínez-Toledano, 2023; OECD, 2011; Seguino et al., 2013). In Spain, by the end of 2022, the risk of poverty reached a general rate of 20.4% (9.6 million people), which was 32.2% in the child and adolescent population (Canals et al., 2023). Currently, poverty and social exclusion derive from job insecurity, academic deficiency and the fragility of social and family networks (Subirats, 2004), as well as from more recent challenges, such as the housing crisis and the digital divide (Malgesini, 2021).

Early School Dropout (hereinafter, ESD) is interpreted as an indicator of the inefficacy of education systems (Bernardo et al., 2020), and it is an important predictor of the risk of youth poverty. Despite the improvement experienced in the last years, in Spain, the rate of ESD continues to be especially high, with 13.9% in the year 2022 (vs the average ESD of 9.6% in EU-27). Furthermore, the ESD rates are unequally distributed, being especially high among men (16.5%) and in some autonomous communities (above 19%) (Spanish Ministry of Education and Vocational Training, 2023). Likewise, this phenomenon is much more pronounced in the socioeconomically disadvantaged population and in areas with social transformation needs, where it generates adverse consequences at the individual level (e.g., illiteracy, unemployment, social insecurity, job insecurity, lack of hygiene and healthiness, etc.) and at the social level (e.g., econo-

my, sustainability, social cohesion, wellbeing, security, etc.), thus contributing to the reproduction of the extant inequalities in society (González-Rodríguez et al., 2019).

The European Commission and the Organization for Economic Co-operation and Development (OECD) specify that one of the weaknesses of education systems in their struggle against ESD is the absence of adequate counselling in the academic and professional career of students (European Commission, 2015; OECD, 2023). This counselling must offer personalized accompaniment (academic, professional and social) and aid the attainment of vital alternative projects. Therefore, addressing it requires rethinking the educational counselling that is carried out in schools, attending to the diversity of situations and complex trajectories of young people and fostering personal growth and empowerment (Rossier et al. 2020). Moreover, at the social level, situated learning and critical consciousness must be promoted to contribute to the social transformation and community development of the areas with the highest ESD rates (Romero-Rodríguez et al., 2022).

At the classroom level, educational counselling is specified in the tutorial function. School tutoring may be interpreted as a process of counselling and accompaniment for students (and other members of the educational community). Therefore, tutors must plan actions with the aim of improving the learning processes by attending to the specific needs of the tutees in dimensions such as attention to diversity, previous levels and knowledge, academic difficulties, and socioeconomic and cultural differences, at both the individual and community levels (Del Río & Codés, 2007).

Personalized tutoring has been considered the most effective method in the educational scope, due to its great impact on academic performance (Nickow et al., 2020; Sirinides et al., 2018). Furthermore, it also improves the confidence, expectations, motivation, self-concept and psychological wellbeing of the students (Partington, 2020; Prowse, et al., 2021; Turnbull, 2022). Thus, tutoring is presented as an adequate tool to mitigate some common problems in educational contexts of special vulnerability, such as lack of confidence, motivation and interest in academic work during non-school hours, as well as to effectively promote equity (Carlana & La Ferrara, 2021; Nickow et al.,

2020) and reduce academic failure. One of the main limitations of personalized tutoring is its high cost in human resources, since it is based on one-to-one interactions for relatively long periods of time. Consequently, personalized tutoring has been traditionally reserved for people of medium-high social status with economic resources to cover the cost (e.g., private schools or private tutors). Therefore, attaining more efficient, scalable and inclusive personalized tutoring is a key challenge in the struggle against inequality in education systems.

Information and Communication Technologies (ICTs) have been considered an option to improve the provision of tutorials. An example of this is the implementation of Computer-aided Instruction (CAI). These systems automatically provide feedback and suggestions based on the answers of the students to a set of questions (usually multiple-choice tests), and they often automatically adapt the next steps of the teaching to the students' level. Another approach is represented by Intelligent Tutoring Systems (ITS), which pose a further level, since they analyze not only the answers but also the methods and processes used by the students, providing more detailed feedback about each step (VanLehn, 2011). Lastly, technologies have also been used to improve and flexibilize human tutoring by conducting them online, as was experienced during the COVID-19 lockdown (Carlana & La Ferrara, 2021; Gortazar et al., 2023). Although the costs have been reduced, and both CAI and ITS show positive effects on the learning of students, the use of these systems for tutoring has not attained the efficacy of one-to-one human tutoring in any of their versions (VanLehn, 2011).

Recent developments in AI systems are also presented as an opportunity to improve the efficacy of technology-supported personalized tutoring (Chen et al., 2020). Darvishi et al. (2024) highlighted the potential of AI as a personal assistant for students, offering personalized reminders, real-time feedback to improve writing, and recommendations on when and what to study. The scientific literature shows that these systems can emulate aspects of personalized teaching, such as human conversations (specifically using large language models), or even surpass them, as in the case of the analysis of data about the behavior, activities and learning of students (Lin et al., 2023). Moreover, for students at risk of social exclusion, personalized tutoring

based on AI elements could be especially beneficial. Firstly, it could allow expanding tutorials of higher quality to a population that has never received it. Secondly, personalization (content, pace and methods) and specific support could be key elements for academic success in a context with a great disparity of performance levels, cultural practices, etc. Thirdly, the recent advances in AI could provide tools to improve the development of metacognitive skills (compared, for instance, to ITS, which do not incorporate this technology). Fourthly, it would allow using AI, especially generative AI, enabling the exploration of contributions of technology to the improvement of psychosocial aspects (e.g., motivation, self-concept, expectations, etc.) and relational aspects. Lastly, it could contribute to the development of the digital competence of students and to the use of ICTs for productive purposes.

The aim with AI is to improve the efficacy of technology-mediated tutoring, for example, integrating it in ITS (Lin et al., 2023), rather than replacing the human element, which is fundamental in disadvantaged contexts, complementing it in a way that it offers an improved and more affordable experience of guided and personalized learning at the reach of any individual, regardless of their socioeconomic condition. This chapter explores how AI can contribute to this goal by presenting the prototype of a proposal of AI-based virtual learning environment (VLE), which aims to improve the accompaniment of students in areas with social transformation needs (ASTN). Specifically, we present the results of a participatory workshop conducted with AI experts using the design thinking methodology. Next, we describe the methodology followed in the workshop, discuss the obtained results, and finally present the conclusions drawn from the findings.

## 9.2. Research Context

In the framework of the research project entitled *The digitization of Andalusian schools with greater presence of students with low socioeconomic level* (project 2022/00000398 of the 6th Research Plan of the University of Seville), the process of digital transformation was analyzed in eight schools located in ASTN in Andalusia

(Spain). Through a qualitative research design, interviews were carried out with principals, teachers and students of each of the participating schools during the first semester of the year 2023. Then, a specific content analysis of the transcriptions was performed to extract the main challenges faced by these schools. By triangulating the view of principals, teachers and students, eleven coinciding challenges were identified: (1) Information, (2) Educational accompaniment outside of the classroom, (3) Personalization of learning, (4) Attention to diversity, (5) Evaluation of learning, (6) Counselling, (7) Digital competence, (8) Families, (9) Absenteeism, (10) Educational innovation, and (11) Evaluation of the school. After rethinking each of these challenges, we considered that AI systems could be a powerful resource in their total or partial overcoming. Therefore, an expert workshop with researchers and professionals specialized in AI was organized, where the experts imagined and proposed AI-mediated solutions to the main challenges.

## Selection of participants for the expert workshop

For the selection of participants, we firstly performed a study of the most outstanding profiles in the application of AI in the Spanish educational scope. Then, to reduce the list and send invitations for participation, a set of inclusion criteria were established: (1) being a researcher in a Spanish university with a renowned scientific production in this specific scope, (2) being a practitioner with a renowned professional career in this specific scope, (3) being specialized in AI and in at least one of the eleven challenges identified in the previous section, and (4) having research or professional experience in ASTN. In order to be included in the study, the experts had to meet at least 2 of the 4 inclusion criteria. Additionally, gender parity in the group was ensured.

## Prioritization and selection of challenges

Prior to the realization of the workshop, the experts were contacted through an online form, where they were asked, in a ranking format, about the eleven challenges identified during the course of the investigation. To this end, they had to attend to

two criteria: 1) viability of AI to solve or aid in said problem, and 2) level of importance of the challenge in relation to ASTN. The four challenges with the greatest score, and therefore considered most relevant, were: information, personalization, families, and accompaniment.

### Development of the workshop: design thinking

The workshop was carried out in November 2023 in the Faculty of Education at the University of Seville. To solve the four challenges cited in the previous section, the design thinking methodology was followed, as it was considered an optimal option for the generation of innovative and practical ideas/solutions, and based on its collaborative and negotiated character. The experts worked for five hours on the resolution of the challenges. They were organized in pairs, and they were assigned a challenge based on their specialization. Although each pair was in charge of their challenge, all experts worked on all challenges to provide original ideas that contributed to their resolution. The development of the workshop was focused on three of the five phases of design thinking: think, design and evaluate.

## 9.3. Results

The results presented in this chapter refer to the prototype proposed by the experts for the resolution of *Challenge 1: Educational accompaniment*. The resolution of this challenge was led by a researcher specialized in counselling processes and AI, and a practitioner (teacher and teaching counsellor) with experience in schools located in ASTN and the use of AI in education. Their proposition to improve educational accompaniment was the creation of an adaptive virtual learning environment (VLE) improved through AI systems (hereinafter, AI-RISTOTLE) that includes elements aimed at educational accompaniment. Figure 9.1 shows the cross-sectional criteria that were initially defined by the experts and which guided every stage of the design of their prototype:

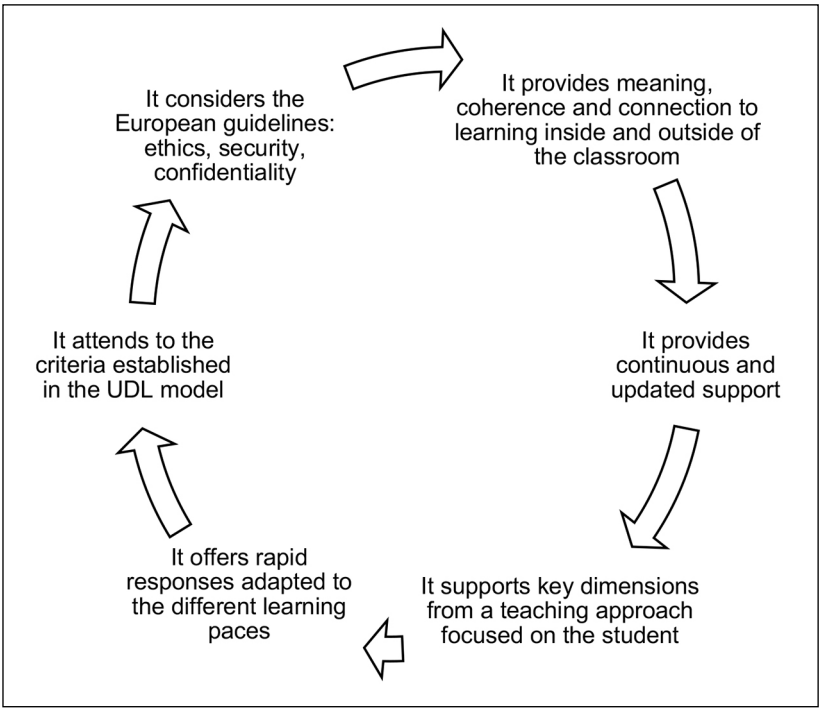



**Figure 9.1.** Criteria considered in the virtual learning environment. Source: developed by authors.

The experts justified the design of their prototype from the following general objective: "Create contexts, propose processes and provide learning resources with the aid of AI for a comprehensive and adaptive accompaniment, according to the paces and personal and sociocultural situations (UDL)". Moreover, they highlighted four guiding principles for the design of AI-RISTOTLE:

- Continuous learning of AI-RISTOTLE based on Machine Learning.
- Local AI, that is, trained from specific data of the school and its context.
- Emotional AI adapted to the age and psychosocial profile of the students.
- AI tools that facilitate collaborative and situated learning.

These four elements are considered key elements to offer each student the academic-personal support they need, from the place where it is provided, and attending to the characteristics of their culture. Next subsections describe the characteristics of AI-RISTOTLE proposed in the expert workshop:

### Reflect (critically) the personal and sociocultural identities of the students

The experts suggested that AI-RISTOTLE should use the potential of AI to adapt the academic materials and contents to the interests and culture of the students of ASTN to improve their attention and motivation. They also stated that the incorporation of characteristic elements of students' culture must be combined and compared, in some cases, with cultural elements of other social strata (and even from other places of the world), with the aim of facilitating the development of a critical consciousness about their own culture (an example mentioned in the workshop was to rethink the meaning of forced marriage by cultural "appropriation" at 14 years of age). Moreover, the incorporation of other cultural elements could help to expand and break social and information bubbles, which would result in the creation of new horizons and future expectations. The practitioner who participated in the design of this prototype described the success of a similar experience in a school located in a marginal neighborhood of Seville, where "after carrying out initiatives of this sort, there was a decrease in the dropout rate and an increase in the students' academic performance. In the end, adolescents who thought that school were not for them ended up in vocational training".

### Create bonds between the families and the school (third space)

In the development of AI-RISTOTLE, it is important to stress the aim of transforming it into an intersection point between the families and the school. Having the support and interest of the families is key for the academic (and socio-personal) success of the students. AI-RISTOTLE must become a space recognised and positively valued by both the families and the students. The social, collaborative and adaptive character of this environment

could be key to attain the creation of a "third space" that goes beyond the sum of interests and practices of the families and the school itself. AI-RISTOTLE must be sensitive to the inclusion of the families and promote the creation of learning communities to contribute to their literacy and empowerment. In this sense, AI is more than an educational tool; it is a catalyst for social transformation and cultural enrichment. Through Machine Learning (ML) techniques, AI can gradually analyze the interests and concerns expressed by the families in documents and discussions with the school. The latter can use this information to further involve the families and create virtual spaces within the VLE related to these topics to attain a first approximation of the families to the use of VLE, in order to expand its use in other scopes. Additionally, this analysis of school documents that are used to communicate with the families may also allow improving said documents within the school context. In this sense, it is very important for the communication between the families and the school to be fluid. The use of AI to adapt the school communications to the socioeconomic language and context of the families in disadvantaged environments can contribute to strengthening the communication bond. This would have a positive impact on the involvement of the family in the educational process.

### Offer emotional and social support for the learning of the students

The social and emotional aspects play a very important role in information processing and the acquisition of learning. Thus, they stand out for the fact that AI-RISTOTLE must include elements to work on the socioemotional skills of the students (e.g., empathy, active listening, teamwork, resilience, interpersonal communication, etc.).

Moreover, all the experts agreed that the incorporation of emotionally sensitive AI systems in AI-RISTOTLE (e.g., affective computing) is a key element of special importance in ASTN. These systems can gather, process, identify and respond to the emotional states of the students. Therefore, they optimize the emotional support, adapting the loads, paces and educational resources to the individual, emotional and cognitive needs of each moment.

Lastly, the experts also pointed out the importance of using AI systems to strengthen the social learning and connections of students. They proposed to employ AI to facilitate social learning by identifying and connecting the students with their peers with similar interests or complementary skills (e.g., through the content analysis of academic works or other documents). Similarly, this idea can be extended to connect students from disadvantaged environments with students from other environments, with the aim of sharing and expanding cultural views and mutually breaking the cultural information bubbles, or even with more suitable/adequate teachers and educators.

### Provide automatic and personalized feedback as support to learning

According to the experts, the lack of family accompaniment outside the classroom for the realization of school assignments has a great impact on student performance in the most disadvantaged environments. AI may help in this regard by providing automatic and highly adaptive feedback that surpasses that of CAI systems, adapting to the pace and level of each student. Furthermore, generative AI may provide examples adapted to the interests of the students and adjust the language of the generated feedback. This results in a cycle of constructive feedback that prevents the frustration and discouragement derived from feedback that is not in line with the individual needs of the students. One of the experts stated that: "In these contexts, where the variety of paces and levels is so wide, automatic feedback helps students to advance at their own pace and provides a feeling of control and confidence in their learning process [...]. With automatic feedback, students are greatly empowered, by overcoming this limitation of non-accompaniment in the family context". Additionally, AI-generated feedback may contribute to the development of metacognitive strategies, helping students to establish realistic goals and self-evaluate their understanding (including processes and results) in a more efficient manner compared to non-AI-based ITS, granting more autonomy to the students and allowing them to develop their learning capacity.

### Promote the development of safe digital and practical competences in technology

The experts stated that the introduction of digital training in disadvantaged areas using AI-RISTOTLE is an opportunity for the development of student digital competence. The design of AI-RISTOTLE must contribute to developing a positive relationship with digital technologies, overcoming the most common practices of the students (mediated by mobile phones and aimed at leisure). The need to implement digital practices and to use tools for studying can help to promote habits of digital wellbeing and safety, which, in some cases, are not fully developed in the family environment. Moreover, the introduction of AI-based elements brings students closer to the adequate use of emerging technologies. AI could be used to detect inadequate uses of technology in AI-RISTOTLE and provide recommendations on how to improve them. One of the experts underlined that "contemplating this aspect is key, since it could have an important impact on the development of adequate practices regarding the correct and safe use of technology [...]. Furthermore, this usually motivates the students; they always want to learn new concepts".

## 9.4. Conclusions and Practical Implications

The reflections presented in this chapter highlight the transforming role of AI in educational accompaniment, especially in disadvantaged contexts. In the search for methods that approach the ideal of efficacy of personalized human tutoring (Bloom, 1984), AI emerges as a promising technology that overcomes some limitations of other technologies that have previously attempted to improve educational accompaniment.

AI offers unique characteristics to work on educational accompaniment in disadvantaged environments. According to our study, if AI is continuously trained, with local data and respecting ethical criteria, the integration of this technology in a VLE has great potential. Firstly, it can facilitate the adaptation of materials and activities to the cultural context of the students, while inducing the latter to reflect critically on said context. Secondly,

it may help to create communication bonds between the families and the school. Thirdly, it would allow identifying and analyzing the emotional states of the students, even outside of the classroom, and consequently adapting education. Fourthly, it can provide elements to facilitate social learning and connections among students. Fifthly, this study highlights the potential of AI to provide a more adapted feedback compared to other technologies, even offering personalized scaffolding to develop metacognitive competences. Lastly, it can also contribute to the development of productive digital competences and practices.

However, it must be taken into account that this chapter only presented the design phase of AI-RISTOTLE through design thinking. This allowed us to identify its target design characteristics, although it needs to be implemented and tested in real environments. Therefore, despite the promising possibilities, we are still in the initial stages of understanding how AI can effectively transform education in disadvantaged schools.

The implementation of an AI-mediated VLE like the one proposed in this chapter (AI-RISTOTLE) is not exempt from challenges. The difficulties of implementing this technology include its effective integration in schools, the guarantee of access to an adequate technological infrastructure, and the need for continuous and specialized teacher training. Moreover, for AI-RISTOTLE to be successful, it is essential to change the mentality of all the parties involved in the educational process: teachers, students and families. This requires promoting motivation, adapting approaches and creating a suitable environment for AI-assisted learning that expands beyond the classroom. These challenges pose the critical question of how to attain the effective use of this technology in the mentioned disadvantaged contexts. In this sense, further research is required to delve into the factors that facilitate the adoption of educational technologies in these environments.

To sum up, although the literature is beginning to demonstrate that AI can offer functionalities for the improvement of tutoring, in order to achieve a significant impact, it is fundamental to address the practical and human challenges associated with the implementation of specific developments (such as AI-RISTOTLE) and carry out exhaustive tests to guarantee that these tools effectively adapt to the specific needs and contexts of the

students. Furthermore, we must be realistic and remember that, for the time being, the human element is key, and that AI systems offer better results when they support (not replace) humans (Darvishi et al., 2024).

## References


Bernardo, A., Tuero, E., Almeida, L., & Núñez, J. (2020). *Motivos y factores explicativos del abandono de los estudios. Claves y estrategias para superarlo*. Pirámide.

Blanchet, T., & Martínez-Toledano, C. (2023). Wealth inequality dynamics in Europe and the United States: Understanding the determinants. *Journal of Monetary Economics, 133*, 25-43. https://doi.org/10.1016/j.jmoneco.2022.11.010

Bloom, B. S. (1984). The 2-sigma problem: The search for methods of group instruction as effective as one-to-one tutoring. *Educational Researcher, 13*(6), 4-16. https://doi.org/10.3102/0013189X013006004

Canals, L., Llano, J.C., Sanz, A., & Urbano, C. (2023). El estado de la pobreza en las Comunidades Autónomas 2023. *European Anti-Poverty Network (EAPN)*.

Carlana, M. y La Ferrara, E. (2021). Apart but connected: Online tutoring and student outcomes during the COVID-19 pandemic. *HKS Working Paper*, RWP21-001. http://dx.-doi.org/10.2139/ssrn.3777556

Chen, L., Chen, P., & Lin, Z. (2020). Artificial Intelligence in education: A review. *Ieee Access, 8*, 75264-75278. https://doi.org/10.1109/ACCESS.2020.2988510

Darvishi, A., Khosravi, H., Sadiq, S., Gašević, D., & Siemens, G. (2024). Impact of AI assistance on student agency. *Computers & Education, 210*, 104967. https://doi.org/10.1016/j.compedu.2023.104967&#8203

Del Río, D. S., & Codés, M. M. (2007). *Orientación educativa y tutoría*. Sanz y Torres.

European Commision (2015). *A Whole School Approach to Tackling Early School Leaving*. European Union. https://education.ec.europa.eu/sites/default/files/document-library-docs/early-school-leaving-group2015-policy-messages_en.pdf

González-Rodríguez, D., Vieira, M. J., & Vidal, J. (2019). Factors that influence early school leaving: a comprehensive model. *Educational Research*, 61(2), 214-230. https://doi.org/10.1080/00131881.2019.1596034

Gortazar, L., Hupkau, C., & Roldán, A. (2023). *Online Tutoring Works: Experimental Evidence from a Program with Vulnerable Children*. https://www.esade.edu/ecpol/en/publications/online-tutoring-works-experimental-evidence-from-a-program-with-vulnerable-children/

Lin, C. C., Huang, A. Y., & Lu, O. H. (2023). Artificial Intelligence in intelligent tutoring systems toward sustainable education: A systematic review. *Smart Learning Environments, 10*(1), 41. https://doi.org/10.1186/s40561-023-00260-y

Malgesini, G. (2021). *Género y pobreza: determinantes sociales de la salud y el acceso a servicios sociosanitarios de las mujeres*. EAPN España.

Ministerio de Educación, Formación Profesional y Deportes (2023). *Explotación de las variables educativas de la Encuesta de Población Activa: nivel de formación y formación permanente. Avance de resultados 2023*. https://www.educacionyfp.gob.es/dam/jcr:43237823-e07f-47b6-93b9-a008e5ef2cbc/nota-resumen-2023.pdf

Nickow, A., Oreopoulos, P., & Quan, V. (2020, July). The impressive effects of tutoring on PreK-12 learning: A systematic review and meta-analysis of the experimental evidence. Working paper 27476. *National Bureau of Economic Research*. https://doi.org/10.3386/w27476

OECD (2011). *Divided we Stand: Why Inequality Keeps Rising*. OECD.

OECD (2023). Proposal for an action plan to reduce early school leaving in Spain. *OECD Education Policy Perspectives*, 71. https://doi.org/10.1787/0c249e7a-en

Partington, A. (2020). Personalised learning for the student-consumer. *Frontiers in Education, 5*, 529628). https://doi.org/10.3389/feduc.2020.529628

Prowse, A., Ruiz Vargas, V., & Powell, S. (2021). Design considerations for personalised supported learning: implications for higher education. *Journal of Further and Higher Education, 45*(4), 497-510. https://doi.org/10.1080/0309877X.2020.1789915

Romero-Rodríguez, J.-M., Hinojo-Lucena, F. J., Aznar-Díaz, I., & Gómez-García, G. (2022). Digitalización de la universidad por covid-19: impacto en el aprendizaje y factores psicosociales de los estudiantes. *RIED. Revista Iberoamericana de Educación a Distancia, 25*(2), 153-172. https://doi.org/10.5944/ried.25.2.32660

Rossier, J., Urbanaviciute, I., Gander, F., & Hofmann, J. (2023). Vulnerabilities and psychological adjustment resources in career development. In *Withstanding Vulnerability throughout Adult Life* (chapter 16). Palgrave Macmillan. https://doi.org/10.1007/978-981-19-4567-0_16

Seguino, S., Sumner, A., Van der Hoeven, R., Sen, B., & Ahmed, M. (2013). *Humanity divided: Confronting inequality in developing countries*. UNDP.

Sirinides, P., Gray, A., & May, H. (2018). The impacts of reading recovery at scale: Results from the 4-year i3 external evaluation. *Educational Evaluation and Policy Analysis*, *40*(3), 316-335. https://doi.org/10.3102/0162373718764828

Subirats, J. (2004). *Pobresa i exclusió social. Un análisis de la realitat espayola i europea*. Fundació la Caixa.

Turnbull, A. (2022). Feeling feedback: Screencasting assessment feedback for tutor and student well-being. *The Law Teacher*, *56*(1), 105-118. https://doi.org/10.1080/03069400.2021.1968168

Van Lehn, K. (2011). The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems. *Educational Psychologist*, *46*(4), 197-221. https://doi.org/10.1080/00461520.2011.611369

10

# The Use of Artificial Intelligence Tools among University Students and its Association with Personality Traits

PhD Joaquín Rodríguez-Ruiz
Universidad de Córdoba, Spain
joaquin.rodriguez-ruiz@fulbrightmail.org
https://orcid.org/0000-0002-9742-6694

PhD Raquel Espejo-Siles
Universidad de Córdoba, Spain
raquel.espejo@uco.es
https://orcid.org/0000-0002-0929-950X

PhD Inmaculada Marín-López
Universidad de Córdoba, Spain
inmaculada.marin@uco.es
https://orcid.org/0000-0002-4312-6063

**Abstract**
Despite constant increase in the use of Artificial Intelligence tools in educational settings, nothing is known about students' personality traits associated with the use of these resources. Thus, the objective of this study was to explore possible links between Artificial Intelligence use and personality traits among university students. A cross-sectional ex-post facto quantitative study was conducted with 1761 undergraduate students ($M_{age}$ = 20.30; $SD$ = 2.76). Validated questionnaires were administered for data collection, always under the supervision of members of the research team. According to multinomial regression analysis, neuroticism and extraversion were related to sporadic use and frequent use, respectively. Agreeableness increased the odds of using Artificial Intelligence to solve every day doubts and neuroticism to do academic work. Conscientiousness was negatively related to the use of Artificial Intelligence to do academic work and to create fake content. Higher scores in open-

ness increased the likelihood of creating fake content using Artificial Intelligence. These results provide novel information about personal characteristics associated with the use of Artificial Intelligence tools among university students. Educators should consider this information when implementing Artificial Intelligence into their educational strategies.

**Keywords:** Artificial Intelligence, university students, personality traits.

## 10.1. Introduction

Artificial Intelligence (AI) was born in the XX century, athough it was not until very recently that it became highly accessible to the general population, having an impact on our daily lives and showing the potential to be applied to different dimensions of society (Crompton & Burke, 2023; O´Dea & O´Dea, 2023). It has even been speculated that Artificial Intelligence has the capacity to change people´s behaviors (Gillath et al., 2021). Artificial Intelligence comes with a number of benefits, but it also entails some risks. Its benefits include automatization of mechanical and bureaucratic tasks (Karan & Angadi, 2023) and fast data processing (Alqahtani et al., 2023), whereas the most cited risks are related to privacy concerns (Sarker, 2023) and the hypothetical increase of unemployment (Xie & Wang, 2023). International institutions, such as the European Union, are even laying on the table possible guidelines for regulating Artificial Intelligence (Benvenuti et al., 2023).

Education is one of the fields with the highest use of Artificial Intelligence (Lee, 2023). Students do not perceive it as a risk and stress on the need to include artificial intelligence in digital education (Lozano & Fontao, 2023). In this sense, some experts in the field claim that educational institutions should make use of Artificial Intelligence (Wang et al., 2023) and that future generations of workers should be currently instructed in the use of Artificial Intelligence (Benvenuti et al., 2023). In fact, a new paradigm has been proposed -Positive Artificial Intelligence Education-, aiming at improving people´s well-being through fostering the positive use of Artificial Intelligence in education (Bittencourt et al., 2023). Nevertheless, education should be always adapted to the characteristics of learners, and nothing is known about the

psychological features of students who tend to use Artificial Intelligence. Consequently, the aim of the present study was to analyze the possible relation between the use of Artificial Intelligence tools (AIT) and personality traits among university students.

The most accepted model of personality is the Big Five (Golberg, 1990). It includes five dimensions of personality that range between two extremes, namely: openness, conscientiousness, extraversion, agreeableness and neuroticism. People scoring high in openness stand out in creativity and have a wide variety of interests. Conscientiousness refers to a goal-oriented and structured lifestyle, focusing on details. Extraversion is characterized by sociability and expressiveness. Agreeableness involves kindness by helping and taking care of others. Neuroticism is related to emotional imbalance, expressed by irritability or anxiety. According to a systematic review, these personality dimensions are linked to academic achievement and technology use (Feher & Vernon, 2021). A research project conducted by Berger et al. (2017) with a sample of Swiss university students found that high scores in conscientiousness and low scores in agreeableness predicted immediate responses to smartphone messages. A recent meta-analysis revealed that extraversion is strongly related to social networks use and openness correlates with the use of ICT for educational aims (Joshi et al., 2023). Considering the existing body of research focused on personality traits and technology use, it is necessary to shed light on the relation between personality traits and the use of Artificial Intelligence tools.

Some studies have addressed the relation between personality traits and attitudes towards Artificial Intelligence. For instance, Park and Woo (2022) conducted an online survey in South Korea to explore whether the five dimensions of personality were associated with emotional (positive/negative) and cognitive (sociality/functionality) attitudes towards Artificial Intelligence. They found a relation between neuroticism and negative emotions, as well as sociality towards Artificial Intelligence. Extraversion was also related to negative emotions but linked with a perception of low functionality. The association between personality dimensions and general attitudes towards Artificial Intelligence was also investigated by Schepman and Rodway (2023) in the United Kingdom through an online survey. Their findings showed that extraversion and openness predicted positive atti-

tudes towards Artificial Intelligence, whereas agreeableness and conscientiousness were predictors of negative attitudes. Although these empirical results pave the way to a promising body of research regarding associations between personality and Artificial Intelligence, further evidence is needed to determine how personality traits are related to the use of Artificial Intelligence tools.

### The current study

The prevalence of use of Artificial Intelligence tools is rapidly increasing among the general population. They are easily accessible, and its use is normalized, but there is no evidence about the psychological characteristics of people who use these tools. Previous research has linked diverse technology usage with personality traits. In addition, an emergent body of research is focused on personality dimensions associated with attitudes towards Artificial Intelligence. Nonetheless, to the best of our knowledge, the link between personality traits and the use of artificial intelligence tools has not been empirically tested. Consequently, the objective of the present study was twofold: to analyze whether different personality traits are related to the frequency of use of Artificial Intelligence tools (O1); and to identify associations between personality traits and different types of use of Artificial Intelligence tools (O2). Based on existing literature about attitudes towards Artificial Intelligence, it was hypothesized that the use of Artificial Intelligence tools would be more frequent among individuals scoring high in extraversion and openness (H1). Regarding the type of use, it was expected that openness would be linked with using Artificial Intelligence to create content, conscientiousness to support their academic tasks, introversion to interact with someone, and neuroticism to bolster one's own opinions (H2).

## 10.2. Method

### Participants

The sample, involving 1761 participants, was selected by convenience and accessibility. Data from 74 participants were eliminated because they did not give consent (9), they did not have

an appropriate level of the Spanish language (6) or they did not answer the control question correctly (59). The final sample was composed by 1687 individuals from the University of Córdoba (Spain). The participants were enrolled in the university degrees of Primary Education (41%), Early Childhood Education (32%), Psychology (12.8%), Social Education (10.5%), and Double Degree program in Primary Education and English Studies (3.6%). Their mean age was 20.30 years (*SD* = 2.76). Regarding gender, 78.6% of participants self-identified as female, 21.2% as male, 0.2% identified as neither female nor male, and 0.1% identified with both the female and male genders. The participants were distributed in different user profiles depending on the use of AIT they self-reported as follows: 32.7% non-users, 20% experiencer users, 36.3% sporadic users, and 11% frequent users.

## Instruments

The use of AIT was measured by an *ad hoc* scale with two items. The first item was *How often have you used Artificial Intelligence tools (ChatGPT, DeepL, Ideogram, etc.) in the last 12 months?* The participants were given a 6-point response scale with the following options: 1 = never, 2 = once, 3 = more than once, but not as often as monthly, 4 = monthly, 5 = weekly, and 6 = every day. The second item was *What have you used these AIT for?* The participants were given the following eight different options, where they could answer as many as they deemed necessary: 1) to solve every day doubts, 2) to look for information to bolster my opinions, 3) need for interaction with someone, 4) to do academic work for me, 5) to solve doubts regarding academic work, 6) to create fake images, 7) to create fake audios, and 8) to create fake videos.

Personality traits were measured by the Big Five Inventory-10 (*BFI-10*; Rammstedt & John, 2007). It consists of 10 items with 5 response options (1 = strongly disagree, 5 = strongly agree).

## Procedure

This study used a cross-sectional *ex-post facto* quantitative research design. Data collection was carried out using self-reported measures through electronic devices, under the supervision of members of the research team.

Faculty members were informed about the study objectives, and the anonymity and confidentiality of their responses, and they were asked to collaborate in the data collection during their regular class hours. Participation was voluntary and individuals were free to decline or withdraw at any stage of data collection. Those who agreed to take part in the study were provided with a QR code to access a Google form and complete the questionnaires within a 10-minute period. This procedure adheres to both international and national law and ethical standards, and it was approved by the Ethical Committee of the University of Córdoba.

### Data analysis

Bivariate Pearson's correlations were run including all the study variables. A multinomial regression on AIT use profiles was performed to analyze the relation among each AIT use profile and the personality traits. Finally, six logistic regressions were carried out to study the prediction of each type of AIT use by the personality traits, also including age and gender. The participants were classified in different user profiles: individuals reporting no use of AIT were classified as non-users; those who reported having used AIT once were classified as experiencer users; those who reported using AIT more than once without reaching monthly use or using it monthly were classified as sporadic users; and those who indicated using AIT weekly or daily were classified as frequent users. The gender variable was recoded as female = 1 and male = 2 for regression analysis. For correlation and regression analyses, the items assessing the purposes of AIT use to create fake images, to create fake audios and to create fake videos were coded as a single variable measuring AIT use to create fake content. All these analyses were carried out using SPSS v.25.

## 10.3. Results

According to Pearson's correlations, the frequency of Artificial Intelligence use was positively related to extraversion ($r$ = .06) and male gender ($r$ = .11). Using Artificial Intelligence to solve everyday doubts was related to more agreeableness ($r$ = .08), low neuroticism ($r$ = -.07) and male gender ($r$ = .12). Using Artificial In-

telligence to do academic tasks instead of the student him/herself was negatively correlated with conscientiousness ($r$ = -.16) and openness ($r$ = -.08), and was positively correlated with male gender ($r$ = .08). Finally, using Artificial Intelligence to solve doubts about academic tasks and to create fake content was related to female gender ($r$ = -.11) and openness ($r$ = .09), respectively.

A multinomial regression analysis was run for experiencer, sporadic and frequent AIT user profiles predicted by the personality traits (extraversion, agreeableness, conscientiousness, neuroticism, and openness), age and gender. This analysis showed that being an experienced user was predicted by older age (OR = 1.46); being a sporadic user was predicted by high neuroticism (OR = 1.14) and older age (OR = 1.96); whereas high extraversion (OR = 1.16) and older age (OR = 1.97) predicted being a frequent user.

Logistic regression coefficients predicting the different AIT uses included in this study found that AIT use to solve every day doubts was predicted by high agreeableness (OR = 1.16) and male gender (OR = 1.63). AIT use to do academic work was predicted by low conscientiousness (OR = 0.68), high neuroticism (OR = 1.17), and male gender (OR = 1.57). AIT use to solve doubts regarding academic work was predicted by female gender (OR = .62). Finally, AIT use to create fake content was predicted by low conscientiousness (OR = 0.70), high openness (OR = 1.88) and male gender (OR = 2.35).

## 10.4. Discussion

Artificial Intelligence tools are highly accessible to the current society for different purposes. However, nothing is known about personality traits associated to the use of these resources. Previous research has found that personality traits predict academic performance (Zell & Lesick, 2022) or a wide variety of online behaviors (Stachl et al., 2020). Thus, the aim of this study was to analyze whether different personality traits are related to the frequency of use of Artificial Intelligence (O1), and to the use of Artificial Intelligence tools for different purposes among university students (O2).

Regarding the first objective, the multinomial regression analyses showed that older age predicts all categories (experiencer,

sporadic, and frequent users). Artificial Intelligence is designed to respond to requirements, and such requirements could be more demanding for older students, which may influence their frequency of use. In line with existing literature relating extraversion and Internet use (Blackwell et al., 2017), this study found that a high level of extraversion increases the odds of frequent AIT use. Moreover, extraversion has been related to a positive attitude towards artificial intelligence in a recent study conducted by Schepman and Rodway (2023). Extraversion is characterized by seeking stimulation and the tendency to experiment positive emotions (Costa & McCrae, 1992), which could increase the interest in using Artificial Intelligence tools. Therefore, the link between Artificial Intelligence use and the motivation to explore may explain this high frequency of AIT use among extrovert individuals.

The second objective aimed at exploring the association between personality traits and the use of Artificial Intelligence tools for different purposes. In this sense, the use of Artificial Intelligence tools to solve every day doubts was linked to high agreeableness and low neuroticism. Agreeable people tend to be respectful and calm, thus they could use Artificial Intelligence tools to solve usual discrepancies that emerge in social settings and avoid conflicts (Tehrani & Yamini, 2020). Neurotic individuals can be suspicious of technology and reticent to technological innovation (Özbek et al., 2014). Therefore, they can mistrust the answer provided by Artificial Intelligence.

The use of Artificial Intelligence tools to do academic work instead of the student was negatively related to conscientiousness. The relation between conscientiousness and academic honesty has been reported in a meta-analysis by Lee et al. (2020). According to our results, conscientiousness could be protective against cheating even when Artificial Intelligence provides an easier and more sophisticated possibility to cheat (Crawford et al., 2023). In contrast, elevated levels of neuroticism increased the odds of using Artificial Intelligence to doing academic work. A meta-analysis by Giluk and Postlethwaite (2014) highlighted that there is an inconsistent link between neuroticism and unethical academic behavior. The relation between neuroticism and the use of Artificial Intelligence for academic dishonesty might be affected by other factors, such as self-efficacy (De Feyter et al., 2012). Emotional stability is a precursor of self-efficacy, which is

related to academic performance (Schmitt, 2007) and less academic plagiarism (Fatima et al., 2020). Future studies should explore factors mediating the relation between neuroticism and the use of Artificial Intelligence for academic dishonesty.

Furthermore, openness was negatively associated with using Artificial Intelligence to do academic work instead of the student. Individuals with high scores in openness to experience are characterized by being intelligent, creative, and curious (Peabody & Goldberg, 1989). These characteristics may lead to a preference for doing the work by themselves over the use of artificial methods (Karim et al., 2009). On the other hand, openness was related to a higher use of Artificial Intelligence to create fake content. This is congruent with characteristics shown by opened people, such as creativity and variety of interests (Goldberg, 1990), and with previous research reporting the relation between openness and the spreading of fake news in social media (Shrestha & Spezzano, 2022). In addition to high openness, the use of Artificial Intelligence to create fake content was predicted by low conscientiousness. Similar results were found by Prasmara and Wijaya (2017), who reported that the motivation for faking could be motivated by the preference for new things and the creativity of people with high openness, but it could be prevented by the need of highly conscientious individuals to be honest.

This study has some strengths but also limitations that should be mentioned. Probably, the biggest strength is that we report novel insight into a hot topic nowadays: Artificial Intelligence use by students. Moreover, the large sample size grants robust reliability to our findings. The rigorousness in data collection should be also highlighted, as the participants were supervised by members of the research team at all times. Nevertheless, the sample was selected by convenience and there is an imbalanced gender representation. Moreover, data were collected using self-reports, which may lead to response bias, such as social desirability bias. Finally, the cross-sectional design does not allow establishing chronological links among variables. Future studies should delve into this body of research by testing these findings in representative samples and considering other age ranges. In addition, conducting longitudinal research on the topic would be useful to find mediating factors in the relation between personality traits and artificial intelligence use.

Even with some limitations, our findings have important implications for policy and practice. As different personality traits were found to be related to the use of Artificial Intelligence tools for several purposes, educators should take into account this information when implementing Artificial Intelligence into their educational strategies. Furthermore, these results should be considered to prevent undesirable practices associated with Artificial Intelligence tools, such as fake content production.

## References


Alqahtani, T., Badreldin, H. A., Alrashed, M., Alshaya, A. I., Alghamdi, S. S., Saleh, K. B., Alowais, S. A., Alshaya, O. A., Rahman, I., Al Yami, M. S., & Albekairy, A. M. (2023). The emergent role of artificial intelligence, natural learning processing, and large language models in higher education and research. *Research in Social and Administrative Pharmacy*, *19*(8), 1236-1242. https://doi.org/10.1016/j.sapharm.2023.05.016

Benvenuti, M., Cangelosi, A., Weinberger, A., Mazzoni, E., Benassi, M., Barbaresi, M., & Orsoni, M. (2023). Artificial intelligence and human behavioral development: A perspective on new skills and competences acquisition for the educational context. *Computers in Human Behavior*, *148*, 107903. https://doi.org/10.1016/j.chb.2023.107903

Berger, S., Wyss, A. M., & Knoch, D. (2018). Low self-control capacity is associated with immediate responses to smartphone signals. *Computers in Human Behavior*, *86*, 45-51. https://doi.org/10.1016/j.chb.2018.04.031

Bittencourt, I. I., Chalco, G., Santos, J., Fernandes, S., Silva, J., Batista, N., Hutz, C., & Isotani, S. (2023). Positive Artificial Intelligence in education (P-AIED): A roadmap. *International Journal of Artificial Intelligence in Education*. https://doi.org/10.1007/s40593-023-00357-y

Blackwell, D., Leaman, C., Tramposch, R., Osborne, C., & Liss, M. (2017). Extraversion, neuroticism, attachment style and fear of missing out as predictors of social media use and addiction. *Personality and Individual Differences*, *116*, 69-72. https://doi.org/10.1016/j.paid.2017.04.039

Costa, P. T., & McCrae, R. R. (1992). The five-factor model of personality and its relevance to personality disorders. *Journal of Personality Disorders*, *6*(4), 343–359. https://doi.org/10.1521/pedi.1992.6.4.343

Costa Mastrascusa, R., Loli, M., De Albuquerque, N. S., Virissimo, S. L., Foletto Moura, M., & Quarti Irigaray, T. (2023). Evaluating the complete (44-item), short (20-item) and ultra-short (10-item) versions of the Big Five Inventory (BFI) in the Brazilian population. *Scientific Reports*, *13*(1), 1-5. https://doi.org/10.1038/s41598-023-34504-1

Crawford, J., Cowling, M., & Allen, K. A. (2023). Leadership is needed for ethical ChatGPT: Character, assessment, and learning using artificial intelligence (AI). *Journal of University Teaching & Learning Practice*, *20*(3), 02. https://doi.org/10.53761/1.20.3.02

Crompton, H., & Burke, D. (2023). Artificial intelligence in higher education: the state of the field. *International Journal of Educational Technology in Higher Education*, *20*(22). https://doi.org/10.1186/s41239-023-00392-8

De Feyter, T., Caers, R., Vigna, C., & Berings, D. (2012). Unraveling the impact of the Big Five personality traits on academic performance: The moderating and mediating effects of self-efficacy and academic motivation. *Learning and Individual Differences*, *22*(4), 439-448. https://doi.org/10.1016/j.lindif.2012.03.013

Fatima, A., Sunguh, K. K., Abbas, A., Mannan, A., & Hosseini, S. (2020). Impact of pressure, self-efficacy, and self-competency on students' plagiarism in higher education. *Accountability in Research*, *27*(1), 32-48. https://doi.org/10.1080/08989621.2019.1699070

Feher, A., & Vernon, P. A. (2021). Looking beyond the Big Five: A selective review of alternatives to the Big Five model of personality. *Personality and Individual Differences*, *169*, 110002. https://doi.org/10.1016/j.paid.2020.110002

Gillath, O., Ai, T., Branicky, M. S., Keshimiri, S., Davison, R. B., & Spaulding, R. (2021). Attachment and trust in Artificial Intelligence. *Computers in Human Behavior*, *115*, 106607. https://doi.org/10.1016/j.chb.2020.106607

Giluk, T. L., & Postlethwaite, B. E. (2014). Big Five personality and academic dishonesty: A meta-analytic review. *Personality and Individual Differences*, *72*, 59-67. https://doi.org/10.1016/j.paid.2014.08.027

Goldberg, L. R. (1990). An alternative "description of personality": The big-five factor structure. *Journal of Personality and Social Psychology*, *59*(6), 1216-1229. https://doi.org/10.1037/0022-3514.59.6.1216

Joshi, A., Das, S., & Sekar, S. (2023). How Big Five personality traits affect information and communication technology use: A meta-analysis. *Australasian Journal of Information Systems*, *27*.

Karan, B., & Angadi, G. R. (2023). Artificial Intelligence integration into school education: A review of Indian and foreign perspectives. *Millennial Asia, 0*(0). https://doi.org/10.1177/09763996231158229

Karim, N. S. A., Zamzuri, N. H. A., & Nor, Y. M. (2009). Exploring the relationship between Internet ethics in university students and the Big Five model of personality. *Computers & Education, 53*(1), 86-93. https://doi.org/10.1016/j.compedu.2009.01.001

Lee, S. D., Kuncel, N. R., & Gau, J. (2020). Personality, attitude, and demographic correlates of academic dishonesty: A meta-analysis. *Psychological Bulletin, 146*(11), 1042–1058. https://doi.org/10.1037/bul0000300

Lee, S. E. (2023). Otherwise than teaching by artificial intelligence. *Journal of Philosophy of Education, 57*, 553-570. https://doi.org/10.1093/jopedu/qhad019

Lozano, A., & Blanco Fontao, C. (2023). Is the education system prepared for the irruption of Artificial Intelligence? A study on the perceptions of students of Primary Education Degree from a dual perspective: Current pupils and future teachers. *Education Sciences, 13*, 733. https://doi.org/10.3390/educsci13070733

O'Dea, X., & O'Dea, M. (2023). Is Artificial Intelligence really the next big thing in learning and teaching in higher education? A conceptual paper. *Journal of University Teaching & Learning Practice, 20*(5). https://doi.org/10.53761/1.20.5.05

Özbek, V., Alniacik, Ü, Koc, F., Akkilic, M. E., & Kas, E. (2014). The impact of personality on technology acceptance: A study on smart phone users. *Social and Behavioral Sciences, 150*, 541-551.

Park, J., & Woo, S. E. (2022) Who likes Artificial Intelligence? Personality predictors of attitudes toward Artificial Intelligence. *The Journal of Psychology, 156(*1), 68-94. https://doi.org/10.1080/00223980.2021.2012109

Peabody, D., & Goldberg, L. R. (1989). Some determinants of factor structures from personality-trait descriptors. *Journal of Personality and Social Psychology, 57*(3), 552-567. https://doi.org/10.1037/0022-3514.57.3.552

Prasmara, A., & Wijaya, N. H. S. (2017). Relations between Big Five personalities, motivation to fake, and applicant faking behavior. *Jurnal Manajemen dan Kewirausahaan, 19*(2), 85-90. https://doi.org/10.9744/jmk.19.2.85-90

Rammstedt, B., & John, O. P. (2007). Measuring personality in one minute or less: A 10-item short version of the Big Five inventory in

English and German. *Journal of Research in Personality*, *41*(1), 203-212. https://doi.org/10.1016/j.jrp.2006.02.001

Rammstedt, B., Lechner, C., & Danner, D. (2021). Short forms do not fall short: A comparison of three (extra-)short forms of the Big Five. *European Journal of Psychological Assessment*, *37*(1), 23–32. https://doi.org/10.1027/1015-5759/a000574

Rammstedt, B., Roemer, L., & Lechner, C. M. (2023). Consistency of the structural properties of the BFI-10 across 16 samples from eight large-scale surveys in Germany. *European Journal of Psychological Assessment*. https://doi.org/10.1027/1015-5759/a000765

Sarker, I. H. (2022). AI-based modeling: Techniques, applications and research issues towards automation, intelligent and smart systems. *SN Computer Science*, *3*(158). https://doi.org/10.1007/s42979-022-01043-x

Schepman, A., & Rodway, P. (2023). The General Attitudes towards Artificial Intelligence Scale (GAAIS): Confirmatory validation and associations with personality, corporate distrust, and general trust. *International Journal of Human-Computer Interaction*, *39*(13), 2724-2741. https://doi.org/10.1080/10447318.2022.2085400

Schmitt, N. (2007). The interaction of neuroticism and gender and its impact on self-efficacy and performance. *Human Performance*, *21*(1), 49-61. https://doi.org/10.1080/08959280701522197

Shrestha, A., & Spezzano, F. (2022). Characterizing and predicting fake news spreaders in social networks. *International Journal of Data Science and Analytics*, *13*, 385-398. https://doi.org/10.1007/s41060-021-00291-z

Stachl, C., Au, Q., Schoedel, R., Gosling, S. D., Harari, G. M., Buschek, D., Völkel, S. T., Schuwerk, T., Oldemeier, M., Ullmann, T., Hussmann, H., Bischl, B., & Bühner, M. (2020). Predicting personality from patterns of behavior collected with smartphones. *Proceedings of the National Academy of Sciences*, *117*(30), 17680-17687. https://doi.org/10.1073/pnas.1920484117

Tehrani, H. D., & Yamini, S. (2020). Personality traits and conflict resolution styles: A meta-analysis. *Personality and Individual Differences*, *157*, 109794. https://doi.org/10.1016/j.paid.2019.109794

Wang, T., Lund, B.D., Marengo, A., Pagano, A., Mannuru, N.R., Teel, Z.A., & Pange, J. (2023). Exploring the potential impact of Artificial Intelligence (AI) on international students in higher education: Generative AI, chatbots, analytics, and international student success. *Applied Sciences*, *13*, 6716. https://doi.org/10.3390/app13116716

Xie, X., & Wang, T. (2023). Artificial Intelligence: A help or threat to contemporary education. Should students be forced to think and do their tasks independently? *Education and Information Technologies*. https://doi.org/10.1007/s10639-023-11947-7

Zell, E., & Lesick, T. L. (2022). Big Five personality traits and performance: A quantitative synthesis of 50+ meta-analyses. *Journal of Personality, 90*(4), 559-573. https://doi.org/10.1111/jopy.12683

# 11

# Emotions in Digital Learning: Assessing the Emotional and Pedagogical Impact of Historical Simulations through ChatGPT in University Classrooms

PhD Pablo Rosser
Universidad Internacional de La Rioja, Spain
pablo.rosser@unir.net
https://orcid.org/0000-0002-9802-7169

PhD Seila Soler
Universidad Isabel I, Spain
seilaaixa.soler@ui1.es
https://orcid.org/0009-0001-9125-3382

**Abstract**
This work investigates how historical simulations integrated with artificial intelligence affect university students' emotional responses. With the increasing adoption of digital technologies in education, particularly post-COVID-19, this study utilizes a quasi-experimental design and the Positive and Negative Affect Schedule (PANAS) to measure specific emotions during simulations. The results reveal significant variations in students' emotions, highlighting calm and empathy as predominant responses, although anxiety and distress are reported in different simulation phases. Implementing ChatGPT showed a significant impact on pedagogical interest and the perception of AI in education, suggesting that these technologies can be valuable tools to enrich students' educational and emotional experiences. The study advocates for a thoughtful and ethical integration of AI in teaching, emphasizing the need for teacher training modules that prepare educators for an effective and conscious use of emerging technologies.

**Keywords:** Artificial Intelligence, historical simulations, emotions in learning, ChatGPT in education, student emotional responses.

## 11.1. Introduction

### Current state of affairs

The advancement of digital technology has marked a turning point in the contemporary educational landscape (Sun & Zhu, 2022; Zhu, 2023). In this context, the present study is situated at the confluence of two crucial areas of modern pedagogy: the integration of artificial intelligence in teaching and its influence on students' emotional responses (Koong Lin, 2022).

The rise of artificial intelligence technology, particularly conversational assistants like ChatGPT, has opened new avenues in education (Karakose, 2023). These technologies offer significant potential to personalize learning and make it more interactive, presenting unique challenges, especially regarding their impact on the emotional and cognitive dimensions of learning (Lin et al., 2023). Despite growing interest in integrating AI tools in education, there is a notable research gap on how these technological interactions affect students' emotions and, in turn, their learning process (Catania et al., 2019).

Recognizing this gap, this study aims to investigate the emotional and pedagogical impact of historical simulations mediated by ChatGPT in a university setting. The choice of historical simulations for this study is not random; history, as a discipline, provides fertile ground for exploring complex emotions and varied perspectives (Bai, 2023; Candel et al., 2023; Shavab et al., 2021; Soler & Rosser, 2023). The use of ChatGPT in this context is presented as a pedagogical innovation, whose effect on empathy, interest, and other students' emotional responses to historical events is still a largely unexplored territory.

### Justification

The justification for this research is grounded in the increasing adoption of digital technologies in education, especially following the global transformation driven by recent events like the COVID-19 pandemic (Burzić et al., 2021; Reyes-Mercado et al., 2022; Şahin & Şahin, 2022). This transformation has accelerated the need to understand how digital tools, specifically those driven by artificial intelligence, can be used effectively and ethically

in educational contexts. Moreover, this study addresses the need for a deep analysis of how the integration of these technologies impacts emotions, a crucial aspect of students' cognitive development and well-being.

We propose to address these issues through a rigorous methodological approach, using a quasi-experimental research design and emotional measurement tools adapted to the educational environment's needs (Gülen, 2018; Muniandy et al., 2022; Saavedra Bautista & Valencia, 2014). The research contributes valuable insights into digital education, offering perspectives on how AI-mediated simulations can enrich students' educational and emotional experiences. The findings are intriguing for formulating pedagogical strategies that effectively integrate artificial intelligence, providing a balance between technological innovation and students' emotional and cognitive development in the digital age.

### Research hypotheses

This study proposes hypotheses to assess the impact of historical simulations via ChatGPT in education. H0 indicates that they do not significantly affect students' emotions or understanding of history, while H1 suggests a positive impact in these areas. H2 examines the increase in interest and positive perception towards AI in education. H3 considers differences in emotional response and interest in ChatGPT by age and gender. H4 argues that ChatGPT improves historical understanding and retention. Lastly, H5 asserts that it promotes digital and critical skills in future teachers.

## 11.2. Objectives

General objective: This study investigates the impact of historical simulations through ChatGPT on the emotional and pedagogical training of future teachers, focusing on the Didactics of History, Geography, and Teaching of Economics, to analyze how these experiences affect student emotions and their interest in this technology.

Specific objectives: We aim to analyze how ChatGPT affects student emotions (calm, empathy, anxiety, distress) in historical simulations and evaluate its didactic effectiveness, seeking to de-

termine pedagogical implications for teacher training based on student emotional feedback.

## 11.3. Methodology

### Research design

This quasi-experimental research examines the impact of historical simulations via ChatGPT on teacher training, focusing on student emotional response and interest in the pedagogical use of technology, using a repeated measures design to compare reactions and attitudes before and after the simulation (Soler & Rosser, 2024).

### Participants

An exhaustive sample of 41 Education and Master of Secondary Teaching students, all enrolled in History, Geography, and Economics courses, was used.

### Instruments

A questionnaire via Google Forms and an adapted version of the Positive and Negative Affect Schedule (PANAS) (Watson et al., 1988), focused on calm, empathy, anxiety, and distress, was applied to measure emotions in simulations with ChatGPT. This modification allowed for a detailed evaluation of student emotional evolution, framed within broader research on emotions and AI in education (Rosser & Soler, 2023, 2024; Soler & Rosser, 2024), using SPSS Statistics version 29.0.1.0 for statistical analysis.

### Procedure

This study explored the impact of interactive simulations via ChatGPT, involving students in roles of historical characters and thematic projects, followed by debates and questionnaires to assess emotional reactions and pedagogical perceptions. Qualitative and quantitative analyses were used, respecting ethical standards such as informed consent. Despite its rigor, limitations

such as the specific sample are recognized, which may restrict the generalization of results.

## 11.4. Results

### Emotions before, during, and after performing the simulation with ChatGPT in future teachers of three subjects

To directly test the effectiveness of a tool like historical simulation using ChatGPT, we wanted to conduct an in-depth analysis of the emotions experienced by the students in using this novel tool.

**Frequency**: During the simulation, variations in participants' emotions by phase were identified. Initially, "calm" predominated (63.5%), followed by "empathy" (26.2%), with lower incidences of "anxiety" and "distress." When assuming roles, "calm" slightly decreased, while in the *delicate phase*, "distress" significantly increased (32.5%), contrasting with the *satisfactory phase*, where "calm" was notably recovered (66.7%). At the *end of simulation*, "calm" rose to 74.6%, indicating a positive emotional resolution at the end of the experience.

**Table 11.1.** Frequencies

| | | Start of simulation | First-time action | Delicate phase | Satisfactory phase | End of simulation |
|---|---|---|---|---|---|---|
| N | Valid | 126 | 126 | 126 | 126 | 126 |
| | Missing | 0 | 0 | 0 | 0 | 0 |
| Mean | | 1.4921 | 1.7063 | 2.7540 | 1.3730 | 1.4206 |
| Median | | 1.0000 | 1.0000 | 3.0000 | 1.0000 | 1.0000 |
| Mode | | 1.00 | 1.00 | 4.00 | 1.00 | 1.00 |
| Std. Deviation | | .74561 | .86780 | 1.04832 | .58970 | .86119 |

Source: developed by authors.

To interpret the results in the context of the research, we must firstly remember the main objective, that is, how students react emotionally to an educational simulation with ChatGPT. The results of these analyses will give us a detailed view of the emotional evolution of the participants in different stages of the simulation.

**Start of the simulation**: Table 11.2 highlights the initial emotions of students in educational simulations with ChatGPT, showing that 63.5% of them were very calm at the start, reflecting comfort and absence of concern. A total of 26.2% felt moderately calm, suggesting comfort in facing the new experience. Then, 7.9% were less calm, possibly indicating initial anxiety. Lastly, only 2.4% experienced low calm, evidencing minimal significant negative emotional reactions at the start of the simulation.

**Table 11.2.** Frequencies at the start of the simulation

| | | Frequency | Percentage | Valid percentage | Cumulative percentage |
|---|---|---|---|---|---|
| Valid | 1.00 | 80 | 63.5 | 63.5 | 63.5 |
| | 2.00 | 33 | 26.2 | 26.2 | 89.7 |
| | 3.00 | 10 | 7.9 | 7.9 | 97.6 |
| | 4.00 | 3 | 2.4 | 2.4 | 100.0 |
| | Total | 126 | 100.0 | 100.0 | |

Source: developed by autor.

The findings establish an initial emotional baseline for students in simulations, with the majority feeling calm, which could indicate a positive predisposition towards innovative educational technologies like ChatGPT. This initial emotional state is key, as it can influence student interaction with the simulation and its impact on learning, suggesting comfort with the environment and absence of threat or significant concern at the start of the educational experience.

**Initial choice (action or character)**: Table 11.3 reveals that, when choosing an action or character in the simulation, 50.8% of the students remained calm, indicating persistence of initial comfort. However, an increase in empathy and anxiety (33.3%) was observed, suggesting that the choice awakens emotional challenges and dilemmas. This change could stem from the need to make significant decisions or greater identification with assigned roles. A total of 10.3% experienced an increase in these emotions, possibly reflecting challenges in decision-making or immersion in the role, while 5.6% showed an intense reaction, possibly due to identification with the character or situation.

**Table 11.3.** Frequencies of first-time action

| | | Frequency | Percentage | Valid Percentage | Cumulative Percentage |
|---|---|---|---|---|---|
| Valid | 1.00 | 64 | 50.8 | 50.8 | 50.8 |
| | 2.00 | 42 | 33.3 | 33.3 | 84.1 |
| | 3.00 | 13 | 10.3 | 10.3 | 94.4 |
| | 4.00 | 7 | 5.6 | 5.6 | 100.0 |
| | Total | 126 | 100.0 | 100.0 | |

Source: developed by author.

The findings show that the initial choice in ChatGPT simulations retained student calm while elevating complex emotions like empathy and anxiety. This phenomenon indicates deep emotional involvement, which is essential for an immersive and effective learning experience. The observed emotional evolution could significantly influence student perception and learning from the simulation, promoting their emotional and pedagogical growth, and posing emotional challenges and dilemmas from the start.

**Delicate phase**: Table 11.4 shows an emotional change in the "delicate phase" of the simulation, with a notable decrease in calm (12.7%) and an increase in distress and empathy, indicating a greater challenge for the students. This change suggests that the simulation induces a stressful phase, impacting the emotional state of the participants. The majority experienced intense emotions (31.7% empathy/distress), with 23% showing even higher levels, and 32.5% reaching the maximum of these emotions, evidencing the simulation's ability to generate a profoundly emotive and authentic experience.

**Table 11.4.** Frequencies of action in the delicate phase

| | | Frequency | Percentage | Valid percentage | Cumulative percentage |
|---|---|---|---|---|---|
| Valid | 1.00 | 16 | 12.7 | 12.7 | 12.7 |
| | 2.00 | 40 | 31.7 | 31.7 | 44.4 |
| | 3.00 | 29 | 23.0 | 23.0 | 67.5 |
| | 4.00 | 41 | 32.5 | 32.5 | 100.0 |
| | Total | 126 | 100.0 | 100.0 | |

Source: developed by authors.

The results underscore the effectiveness of ChatGPT in evoking intense emotions like distress and empathy, which are crucial in educational contexts that simulate high-pressure environments. This emotional change demonstrates the success of the simulation in replicating real-life dynamics, highlighting the value of ChatGPT as an educational tool for teaching emotional management and decision-making under pressure, which are essential components in learning. The ability to provoke such authentic emotional reactions affirms its pedagogical potential.

**Satisfactory phase**: Table 11.5 shows that, in the satisfactory phase of the simulation, 66.7% of the students returned to a state of calm, indicating that they overcame previous challenges and found satisfactory solutions or outcomes. This return to calm suggests a positive resolution and sense of achievement, which is essential for an effective educational experience. Although 31% show moderate calm, who are possibly still processing the experience, only a small percentage experienced less calm, reflecting that, for some, the resolution was not completely satisfactory or emotional challenges persisted.

**Table 11.5.** Frequencies of action in the satisfactory phase

| | | Frequency | Percentage | Valid percentage | Cumulative percentage |
|---|---|---|---|---|---|
| Valid | 1.00 | 84 | 66.7 | 66.7 | 66.7 |
| | 2.00 | 39 | 31.0 | 31.0 | 97.6 |
| | 3.00 | 1 | .8 | .8 | 98.4 |
| | 4.00 | 2 | 1.6 | 1.6 | 100.0 |
| | Total | 126 | 100.0 | 100.0 | |

Source: developed by author.

The results show that the simulation led the students through an emotional process that ended in satisfaction and calm, after overcoming intense challenges. This return to calm emphasizes the pedagogical effectiveness of the simulation, providing realistic experiences and emotional closure, which is the key to learning and personal development.

**Conclusion of the simulation**: Table 11.6 shows that 74.6% of the students concluded the simulation feeling calm, indicat-

ing a positive or neutral perception of the experience, despite previous challenges. This high rate of calm demonstrates a satisfactory closure, with students feeling relaxed and possibly content with the process and outcomes. A total of 16.7% experienced moderate calm, reflecting ongoing reflection or emotional processing, while a small percentage still felt uneasy, possibly due to the challenges faced or the need to process the experience.

**Table 11.6.** Frequencies of action after the simulation

| | | Frequency | Percentage | Valid percentage | Cumulative percentage |
|---|---|---|---|---|---|
| Valid | 1.00 | 94 | 74.6 | 74.6 | 74.6 |
| | 2.00 | 21 | 16.7 | 16.7 | 91.3 |
| | 3.00 | 1 | .8 | .8 | 92.1 |
| | 4.00 | 10 | 7.9 | 7.9 | 100.0 |
| | Total | 126 | 100.0 | 100.0 | |

Source: developed by author.

The results indicate that the simulation offers an enriching educational experience, concluding positively for the majority, with students feeling calm and presumably satisfied. This reflects the success of the simulation in meeting its pedagogical and emotional goals, highlighting its value as a learning tool.

**Implications for research**: The study demonstrates that simulations with ChatGPT promote emotional stages aligned with teaching emotional management and empathy in historical contexts, highlighting the importance of preparing students for stress in critical phases. It underscores the need for emotional management strategies, post-simulation reflection, personalized feedback, and continuous support to facilitate learning and emotional adaptation, requiring future research to optimize the integration of educational technologies.

## 11.5. Discussion

This study aimed to determine how simulations with ChatGPT affect the training and the emotional and pedagogical percep-

tions of future teachers, highlighting the impact of AI on education. It emphasizes the transformative role of educational technology, highlighting its capacity to renew pedagogical strategies and meet varied learning needs (Zhu, 2023). The importance of various learning methodologies for student performance has been underscored by (Koong Lin, 2022), with AI transforming areas like visual communication design and educational evaluation (Drozdikova-Zaripova & Sabirova, 2020; Sun & Zhu, 2022).

Studies indicate significant emotional changes in simulations, evidencing the effectiveness of affective computing and affective tutoring through AI (Koong Lin, 2022). The pedagogical interest in ChatGPT and its potential as a teaching tool are confirmed (Chaudhry et al., 2023; Karakose, 2023; Rosser & Soler, 2023, 2024; Soler & Rosser, 2024).

## 11.6. Conclusion

The study demonstrates that historical simulations mediated by ChatGPT in university education contradict the initial hypothesis about the limited emotional and cognitive impact of AI, showing significant improvements in understanding and empathy towards historical events. ChatGPT not only increases student interest in AI as an educational tool but also facilitates greater knowledge retention and promotes digital and critical skills. It highlights ChatGPT's potential to enrich teacher training and the learning experience, suggesting the integration of AI in pedagogy to foster immersive and meaningful learning while addressing students' emotions and well-being.

## References

Bai, S. (2023). The impact of gamification teaching methods on elementary students' learning interest: A case study based on history class. *Journal of Education, Humanities and Social Sciences*, *22*, 460-466. https://doi.org/10.54097/ehss.v22i.12504

Burzić, A., George, L., Mahmood, H., Smith, P., Tan, H. X., & Smith, D. P. (2021). P1 The adoption of digital technology in respiratory education in response to the covid-19 global pandemic. *Thorax*, *76*(Sup-

pl 1), A85-A85. https://doi.org/10.1136/thorax-2020-BTSabstracts.146

Candel, E. C., de-la-Peña, C., & Yuste, B. C. (2023). Pre-service teachers' perception of active learning methodologies in history: Flipped classroom and gamification in an e-learning environment. *Education and Information Technologies*. https://doi.org/10.1007/s10639-023-11924-0

Catania, F., Di Nardo, N., Garzotto, F., & Occhiuto, D. (2019). *Emoty: An Emotionally Sensitive Conversational Agent for People with Neurodevelopmental Disorders*. http://hdl.handle.net/10125/59641

Chaudhry, I. S., Sarwary, S. A. M., El Refae, G. A., & Chabchoub, H. (2023). Time to revisit existing student's performance evaluation approach in higher education sector in a new era of ChatGPT. A case study. *Cogent Education*, *10*(1), 2210461. https://doi.org/10.1080/2331186X.2023.2210461

Drozdikova-Zaripova, A. R., & Sabirova, E. G. (2020). Usage of digital educational resources in teaching students with application of "flipped classroom" technology. *Contemporary Educational Technology*, *12*(2), ep278. https://doi.org/10.30935/cedtech/8582

Gülen, S. (2018). Determination the effect of STEM integrated argumentation based science learning approach in solving daily life problems. *World Journal on Educational Technology Current Issues*, *10*(4), 266-285. https://doi.org/10.18844/wjet.v10i4.4087

Karakose, T. (2023). The utility of ChatGPT in educational research potential opportunities and pitfalls. *Educational Process: International Journal*. https://edupij.com/index/arsiv/58/296/the-utility-of-chatgpt-in-educational-researchpotential-opportunities-and-pitfalls

Koong Lin, H.-C. (2022). Employing AI chatbot-based tutoring systems and STEAM 6e scaffold to implement cooperative learning of maker education. *Impact*, *5*, 14-16. https://doi.org/10.21820/23987073.2022.5.14

Muniandy, T., Sharif, S., & Mariappan, M. (2022). The effect of robotics program on students attitude towards science. *Malaysian Journal of Social Sciences and Humanities (MJSSH)*, *7*(4), e001422–e001422. https://doi.org/10.47405/mjssh.v7i4.1422

Reyes-Mercado, P., Barajas-Portas, K., Kasuma, J., Almonacid-Duran, M., & Alfredo, Z.-A. G. (2022). Adoption of digital learning environments during the COVID-19 pandemic: Merging technology readiness index and UTAUT model. *Journal of International Education in Business*, *16*(1), 91-114. https://doi.org/10.1108/JIEB-10-2021-0097

Rosser, P., & Soler, S. (2023). Resonancia emocional en estudiantes universitarios: un análisis del impacto de metodologías activas y pedagogía crítica en el espectro emocional del aprendizaje. In M. J. S. Villalba, M. J. A. del Olmo, F. J. F. Cerero, & M. M. Rueda (Eds.). *Desafíos educativos a través de la interdisciplinariedad en la investigación y la innovación* (pp. 105-113).

Rosser, P., & Soler, S. (2024). La aplicación de la teoría de la respuesta del lector y la educación pluralista en la didáctica de la historia de la Revolución industrial: un enfoque hermenéutico educativo a partir de IA y ChatGPT. In *Propuestas educativas multidisciplinares en el marco de los Objetivos del Desarrollo Sostenible (ODS) y la Agenda 2030*. Egregius.

Saavedra Bautista, C. E., & Valencia, J. A. P. (2014). Una mirada a los estilos de aprendizaje de los estudiantes de la UPTC desde la noción de nativo digital. *Revista Academia y Virtualidad, 7*(2), 41-52. https://doi.org/10.18359/ravi.317

Şahin, F., & Şahin, Y. L. (2022). Drivers of technology adoption during the COVID-19 pandemic: The motivational role of psychological needs and emotions for pre-service teachers. *Social Psychology of Education: An International Journal*, *25*(2-3), 567-592. https://doi.org/10.1007/s11218-022-09702-w

Shavab, O. A. K., Yulifar, L., Supriatna, N., & Mulyana, A. (2021). Gamification in history learning: A literature review. *Proceedings of the 6th International Conference on Education & Social Sciences (ICESS 2021)*, Semarang, Indonesia. https://doi.org/10.2991/assehr.k.210918.047

Soler, S., & Rosser, P. (2023). Empatizar con los conflictos bélicos para trabajar el ODS 16. Creación de una situación de aprendizaje a partir de la simulación urbana. In *Hacia una Educación con basada en las evidencias de la investigación y el desarrollo sostenible*. Dykinson.

Soler, S., & Rosser, P. (2024). Desafiando los límites del aprendizaje histórico: una propuesta educativa innovadora basada en la pedagogía crítica, ia y chatgpt para comprender la Guerra Civil Española, la dictadura franquista y la Transición democrática. In *Las ciencias sociales, las humanidades y sus expresiones artísticas y culturales: una tríada indisoluble desde un enfoque educativo*. Dykinson.

Sun, Q., & Zhu, Y. (2022). Teaching analysis for visual communication design with the perspective of digital technology. *Computational and Mathematical Methods in Medicine*, 2411811. https://doi.org/10.1155/2022/2411811

Watson, D., Clark, L. A., & Carey, G. (1988). Positive and negative affectivity and their relation to anxiety and depressive disorders. *Journal of Abnormal Psychology*, *97*(3), 346-353. https://doi.org/10.1037//0021-843x.97.3.346

Zhu, A. (2023). Navigating the digital shift: the impact of educational technology on pedagogy and student engagement. *Journal of Education and Educational Research*, *6*(6), 11-14. https://doi.org/10.54097/jeer.v6i1.14131

12

# Training GPT as a Standardized Patient

Mercedes Lorena Pedrajas López
Universidad Antonio de Nebrija, Spain
mpedrajas@nebrija.es
https://orcid.org/0000-0003-4257-9260

Ana Sanz Cortés
Universidad Antonio de Nebrija, Spain
asanzco@nebrija.es
https://orcid.org/0000-0002-5153-5860

Eva García Carpintero-Blas
Universidad Antonio de Nebrija, Spain
egarcibl@nebrija.es
https://orcid.org/0000-0002-4984-2511

Esther Martínez Miguel
Universidad Antonio de Nebrija, Spain
emartinezmi@nebrija.es
https://orcid.org/0000-0002-5153-5860

Sara Uceda Gutiérrez
Universidad Antonio de Nebrija, Spain
suceda@nebrija.es
https://orcid.org/0000-0002-1467-5186

**Abstract**
The integration of artificial intelligence (AI) into learning environments poses a challenge in advancing towards more efficient interactive methodologies. The use of AI-based learning assistants, especially generative language models like OpenAI's GPT, can expand the scope of methodologies such as clinical simulation by generating interactions where AI assumes the role of a standardized patient. Clinical simulation recreates, substitutes, and/or extends real experi-

ences through guided experiences that evoke or replicate substantial aspects of the real professional context in a fully interactive manner. The standardized patient is an actor trained to perform predefined responses based on the students' behaviour and performance. With appropriate AI training, focused on instruction and adaptation to different patient profiles based on their health-disease processes, it is possible to design and implement clinical simulation scenarios where students interact with it. The authenticity of AI allows achieving a high degree of fidelity, and its scope surpasses the limits of synchronous in-person demand of a standardized actor, exponentially multiplying the capacity to generate simulated learning environments. This chapter outlines the keys to integrating AI as a standardized patient into simulated learning experiences.

**Keywords:** Artificial Intelligence (AI), standardized patient, clinical simulation.

## 12.1. The importance of simulation in university education

Simulation in university education is crucial for preparing students in various professional fields. It provides a realistic environment to apply theories and skills acquired in the classroom, promoting critical thinking and teamwork (Gormley et al., 2023). These learning experiences transform the student into the protagonist, with the professor as a guide (Cheng et al., 2016). Simulation evolves with technology, integrating virtual environments and augmented reality to offer immersive experiences that prepare students for future challenges (Kononowicz et al., 2019). Clinical simulation with standardized patients is particularly valuable in the training of healthcare professionals. These patients reproduce physical symptoms and emotions, allowing students to improve diagnostic, communication, and decision-making skills in a safe and educational environment (Abshire et al., 2020). The use of ChatGPT (GPT) as a standardized patient in clinical simulation is relevant in healthcare, offering realistic interactions that enhance communication skills and competencies in patient care, especially in terms of clinical assessment and reasoning. Its versatility allows adapting to various clinical scenarios, enriching the simulation experience. The combination of advanced technology and traditional simulation methods prepares healthcare professionals to face complex scenarios in their future practice. Therefore, the con-

vergence of simulation and technological innovation is key to achieving educational excellence in healthcare.

## 12.2. ChatGPT as a Tool for Learning

In the current digital era, AI has emerged as a revolutionary tool in education, offering innovative opportunities to enhance the teaching-learning process. AI recreates human intelligence processes through algorithms and systems that analyse massive data to identify patterns, make decisions, and predict outcomes. Unlike traditional programs, it can learn and adapt, enabling machines to perform tasks that previously required human intervention (Rouhiainen, 2018). GPT stands out as a versatile and valuable tool for teachers and researchers seeking to optimize the educational experience (Leng, 2024; Abdellatif et al., 2022; Kung et al., 2022). OpenAI's GPT-4, a natural language-based virtual assistant, has found application in various sectors, including customer service, computing, health, and education. Its ability to process text and adapt to different domains has made it a versatile and valuable tool for optimizing experiences in these fields (Morcela, 2023).

Regarding the use of GPT in teaching health-related subjects, several authors have highlighted that its use has provided students with information quickly, without waiting for responses from teachers, thanks to its ability to gather information on a wide variety of topics to assist students in real-time and available 24 hours a day (Leng, 2024; Abdellatif et al., 2022; Kung et al., 2022).

## 12.3. Understanding how GPT Works

Once the pillars of clinical simulation and the characteristics of AI are understood, they are proposed to train GPT-4 as a standardized patient.

Before working with GPT-4, it is important to understand how it functions. It is a tool that operates based on language analysis and can comprehend and generate text similarly to how a human would. The essence of its operation lies in machine learning and the ability to anticipate patterns; thus, it has been

trained to analyse and understand the structure and meaning of sentences, adapting to a wide range of queries and commands. Its ability to generate contextually appropriate responses is based on the vast amount of information it has absorbed during its training, so the more it is used, the better it will adapt its responses to the user.

Being a language analysis-based tool, the choice of verbs and the formulation of prompts are fundamental aspects to shape the identity and style of the Chat; therefore, it is advisable to consider the following:

- Verbs: Their choice can influence the tone and style of the generated responses. More formal or informal, active or passive verbs contribute to the construction of GPT's analysis and response pattern. If the characteristics of the character's personality are properly defined, it is recommended to work with verbs that can provide coherence. For example, using expressions with passive verbs like "tell me about..." may imply a "service" pattern for which the Chat is designed, which could break the simulated role of identity. It is suggested to use questions with active verbs such as "what do you think about...", "how do you feel that...", or "give me an example...", and observe which of them generates responses consistent with the desired outcome.
- Formulation of Prompts: Linked to the choice of the verb, it is important that, before using the patient created in a simulation, the prompt that will guide the experience is clearly formulated. The "prompt" is the precise and specific instruction that helps generate the activity, that is, the exact statement of what is expected of the Chat during that period. Once the identity has been worked on, when bringing it into the simulation space, it is important to clearly communicate what is expected of it. For example, it can be said: "Now we will simulate that you are a patient attending a psychological consultation. I will ask you questions as your psychologist to understand what is happening to you, and you must respond as the patient, using the information provided earlier in a creative way." In this case, the proposed role, the working context, the objective of the activity, and how the previously provided information is expected to be used are observed.

- Context Markers: These are keywords that will grant coherence to the character. In the context of a clinical simulation, where a complete life history will be provided, the use of dates, proper names, or locations will help improve identity construction. The responses generated by the Chat will be more consistent with the objectives. Therefore, it is important to consider these markers when designing the simulation briefing, so that students can formulate questions using these keywords.

## 12.4. Establishing the GPT Identity as a Standardized Patient

It may seem like a significant challenge to give it an identity, considering the tool's functionality, but it will be the time of practice and some specific guidelines that will help with this:

- Define the traits that characterize its personality: this involves having a clear image of the person in question, focusing on the details that will influence its communication style. It is essential to define aspects such as communication tone, topics of interest, level of linguistic formality, age, characteristic expressions or slang, and gender of the character being represented.
- To ensure the consistency of the defined character, it is crucial to develop a chat dedicated exclusively to building that profile. This involves avoiding contradictory instructions to GPT regarding its interactions, questions, or writing style. Suddenly switching to another profile can disrupt its learning process. Therefore, it is recommended to create a new designated chat with the name of the character and dedicate time to interact with him or her to improve consistency.
- It is essential to define the specific context in which the interaction will take place. By understanding this context, potential discrepancies between questions asked and the Chat's responses can be minimized. Therefore, it is fundamental to determine the clinical context that is desired to be simulated this time.
- Finally, in the process of constructing the character's identity, it is crucial to provide feedback to the tool. If during the conversations to develop this identity, the interactions do not meet expectations, it is important to communicate this using

the evaluation function provided along with the response or reconsider the formulation of the question. The model's adaptability is based on patterns and data correlations, so these evaluations are of great value in improving its performance.

Once the identity is defined, it is necessary to design the clinical context that frames the standardized patient being worked with. To ensure the credibility of this profile, it is ideal to provide GPT with detailed case information.

In this regard, since the interaction occurs through the exchange of electronic messages, it may not be necessary to consider the phenotypic characteristics of the patient, but demographic characteristics should be considered. These variables, along with the medical history, symptoms, and signs relevant to the case and of clinical interest, should be well defined. All of this facilitates the AI having all the necessary information to contextualize the case and achieve the most natural and coherent behavior possible throughout the entire interview or interaction.

Some other issues to consider in defining the patient profile refer to how the AI should behave during the interaction with the student. It is important to provide clear instructions on the purpose of the interaction and the role that GPT will play in it; these instructions should be consistent with standardized patient training in clinical simulation methodologies (Ruiz & Caballero, 2014).

Therefore, it is recommended to:

- Instruct GPT to speak in detail about the relevant topics for the case without providing any clues necessary for the student's approach or resolution.
- Request that it behaves naturally throughout the interaction.
- Emphasize the need for GPT to internalize its role as a standardized patient and 'feel' as if it were actually the person/patient being portrayed.
- Indicate to GPT the need for consistency in the message throughout the interaction that takes place in the exchange of electronic messages.

On the other hand, the design of standardized responses for a simulated patient is crucial for the simulation success, as it di-

rectly influences the student's performance, similar to interacting with a real patient during clinical practice. These standardized responses will include information on emotional communication, clinical evolution, and shared patient decisions processes, enabling the student to effectively apply their skills to achieve the health goals set for the patient. It is essential to provide a detailed and coherent description of the health problem and its context, which will stimulate the student´s interpersonal and clinical skills development and facilitate their training.

It is relevant to note that AI used as a simulated patient does not possess consciousness or emotions, and although it simulates a conversation, it lacks the deep understanding and empathy characteristic of human intelligence. Its operation is based on patterns and statistical correlations to provide relevant responses, which means that, at times, its responses may not be as expected. Therefore, to define the role that AI assumes as a standardized patient, it is necessary to establish the corresponding context and narrative. Additionally, the profile of the student with whom the AI will interact should be considered, taking into account their level of knowledge, maturity, and expected learning outcomes.

The design of logical interaction is relatively simple, but the difficulty lies in training responses that fit the context, situation, and personality of the standardized patient when the student deviates from what is expected. In this sense, creating scripted behavioural trees representing the sequence of responses for each case will be helpful.

## 12.5. How to Integrate GPT as a Standardized Patient in the Curricular Design

Given the potential impact of GPT, academics must integrate it in the whole teaching-learning process, including curricula design, learning outcomes, methods and assessment methodologies (McCoy et al., 2020).

### Learning outcomes

To maximize the effectiveness of simulated situations and comprehensively address student development, it is important to

consider both the cognitive and emotional aspects of the proposed practice when presenting the objectives in agreement:

- Cognitive objectives should consider both the knowledge and skills for the correct development and resolution of the situation presented through AI.
- Affective objectives encompass the abilities to establish an empathetic relationship even though the standardized patient is AI, those aimed at assessing the difficulties of the simulation situation and enhancing learning capacity, and those related to reflection and self-efficacy.

Below is a guide table for formulating these learning outcomes in clinical simulation (Table 12.1):

**Table 12.1.** Learning outcomes in simulation scenarios with AI as a standardized patient

| | Type of objetive | Description |
|---|---|---|
| Cognitive | Knowledge in clinical practice | Applies theoretical concepts in a practical context.<br>Demonstrates a deep understanding of the simulated pathology or condition. |
| | Technical skills | Integrates technical procedures with acquired theoretical knowledge.<br>Demonstrates specific technical skills related to the simulated clinical situation. |
| | Decision making | Makes clinical decisions based on available information.<br>Evaluates and prioritizes healthcare-clinical issues effectively. |
| | Communication | Demonstrates appropriate communication skills with the standardized patient.<br>Adapts communication to the environment in which the experience takes place. |
| Affective | Empathy and sensitivity | Shows empathy towards the simulated patient, acknowledging their feelings and concerns.<br>Demonstrates sensitivity to cultural and social diversity. |
| | Stress and pressure management | Manages stress and pressure in the clinical situation.<br>Handles the difficulty of using the chat as part of the simulated situation (developing resilience). |
| | Reflection and self-evaluation | Reflects on own practice and seeks opportunities for improvement.<br>Provides constructive evaluations to peers. |

## Formative rubric

Based on the learning outcomes, the design of a formative rubric to assess student performance in simulation with AI as a standardized patient is necessary to provide measurable and specific feedback (Adamson et al., 2013). For its proper development, the following points need to be considered:

- Define learning outcomes: This aspect involves not only identifying cognitive and affective objectives, as previously indicated, but also ensuring they are aligned with the overall simulation goal.
- Identify evaluation criteria in activities that are measurable and specific. Depending on the scope of application as a standardized patient, these may include clinical knowledge and reasoning, or effective communication. Empathy and sensitivity should always be present in the exercise.
- Establish performance levels, each of which should have clear and specific descriptions. An example would be: unsatisfactory, basic, competent, and outstanding.
- Develop levels` description. It should be as detailed as possible and objectively recorded through the written information in the chat, which the teacher will later have access to.
- Structure the rubric according to categories that establish the relative weight of performance, according to the importance of each.
- Include a space for specific teacher comments that encompass both strengths and areas for improvement.
- Seek feedback from other teachers or clinical-healthcare professionals to ensure the validity of the rubric. Adjustments may be made if needed.

A formative rubric example for the affective outcome of maintaining empathetic communication with the standardized patient would be:

- Insufficient (1): The student demonstrates poor communication with the patient, showing no empathy or recognition of their concerns or feelings.
- Basic (2): The student communicates adequately with the patient, although improvement in empathy and clarity could be made.

- Competent (3): The student demonstrates effective communication with the patient, showing empathy and using clear and understandable language.
- Excellent (4): The student establishes exceptional communication with the patient, demonstrating empathy, understanding, and effectively adapting to the patient's needs.

A formative rubric example for the cognitive objective of identifying symptomatology in the first session of clinical assessment is provided below:

- Insufficient (1): The student fails to correctly identify the symptoms presented by the patient.
- Basic (2): The participant identifies some symptoms of the patient but omits important details or makes errors in the description.
- Competent (3): The student identifies the majority of the patient's symptoms accurately and comprehensively, providing detailed and relevant descriptions.
- Excellent (4): The student accurately identifies all of the patient's symptoms, providing thorough descriptions and demonstrating an understanding of the clinical importance of each.

## Simulation scenario preparation

Before the scenario begins, students should receive a briefing or prebriefing that provides them with sufficient context to aim for specific learning objectives. This introduction is defined by the Agency for Healthcare Research and Quality as the guidance that provides students with preparatory instructions and information before the simulation session (Lioce et al., 2020).

It may include the creation of a safe container (Rudolph et al., 2014; Turner & Harder, 2018), which is a learning space free from judgment where all participants commit to reality and fiction (commitment from instructors to recreate reality and commitment from students to abstract from the rest and focus on fiction as a recreation of that reality), confidentiality (information about what happened is not shared with students from other courses or groups), and competence (all participants are intelligent, competent, and strive to learn).

With or without a safe container, the briefing involves providing students with key information to address the simulation scenario, and in the case of simulation with AI as a standardized patient, it should include some specific considerations. Since it is a digital or telemedicine consultation, it is important to indicate to students that they must always maintain the professional role they assume in the simulation, taking care of their interaction with the same considerations as with a real patient in face-to-face consultation or intervention. The interpersonal distance in digital health care may be increased by simulation with AI as a standardized patient, due to the interface and the type of language that the AI uses. In this sense, it will be necessary to emphasize the importance of not losing the reality-fiction commitment with the AI. To facilitate AI responses tailored to the proposed clinical case for which it has been trained, students must also consider the information provided in the fourth key, regarding verbs and prompts.

## Debriefing

Debriefing is the phase where knowledge is constructed. Students, guided by the instructor, reflect on the action and build knowledge, generating a framework of shared thinking where error is an ally and reflective practice (Schön, 1992) is promoted. Furthermore, discussion of thinking frameworks and the search for and proposal of alternative actions or solutions in future situations are encouraged (Díaz & Cimadevilla, 2019). Reviewing the simulated episode by analyzing actions and reflecting on the role of thought processes, psychomotor skills, and emotional states in them allows maintaining and improving performance in the future. In general, and regardless of the model used, debriefing can be structured into three phases (Motola et al., 2013):

- Reaction Phase: This phase is aimed at dissipating cognitive obstacles and generating a conducive framework for analysis by exploring and verbalizing students' emotions during the simulation, seeking to prevent them from interfering with cognitive processes. In addition, an atmosphere conducive to reflective conversation should be generated, and individual and collective discourse should be harmonized around what happened during the simulation.

- Analysis Phase: This phase focuses on reflection, on analysis for the search and construction of mental models that explain why the student acted the way they did, through guided inquiry questions from the instructor, which, far from providing standard solutions, stimulate doubt and controversy, thus guiding reflection.
- Summary Phase: The experience is synthesized, generating a shared mental framework of possible actions and decisions in future actions, and the session is closed with some dynamics that allow distilling key concepts of the knowledge built in the session.

### Evaluating the experience

Self-efficacy is a framework that can help determine students' learning experience when this methodology is applied. This is defined as the individual's perception of their ability to successfully perform a task (Bandura, 1977). Although this variable is not a precise indicator of the level of learning, it is defined as a predictor of the student's success in achieving it (Barrios et al., 2017). In health sciences, simulation with a standardized patient is considered more effective than traditional training for improving learning-related self-efficacy (Merchán-Baeza et al., 2021).

Therefore, it is recommended to use a measurement instrument with optimal psychometric qualities validated for the target population. An example could be the General Self-efficacy Scale, created by Schwarzer & Jerusalem (1993).

## 12.6. Conclusion

The growing influence of artificial intelligence in various areas, including education, highlights the need not only to ensure that students acquire AI literacy but also, given the potential impact of this technology, update curricula to reflect this new landscape. Academics must reflect on how these advancements will affect curriculum design, assessment methodologies, and pedagogical approaches. Therefore, it is crucial to continuously research and evaluate to achieve the effective integration of AI-

based learning tools in education. This challenge raises the following question: How can we productively incorporate the use of AI in classrooms?

In the health education area, clinical simulation with standardized patients emerges as conducive to this integration scenario, which can also benefit from the potential of AI to multiply the scope of clinical simulation learning experiences.

## References


Abdellatif, H., Al Mushaiqri, M., Albalushi, H., Al-Zaabi, A. A., Roychoudhury, S., & Das, S. (2022). Teaching, learning and assessing anatomy with Artificial Intelligence: The Road to a better future. *International Journal of Environmental Research and Public Health*, *19*(21), 14209. https://doi.org/10.3390/ijerph192114209

Abshire, M. A., Li, X., Basyal, P. S., Teply, M. L., Singh, A. L., Hayes, M. M., & Turnbull, A. E. (2020). Actor feedback and rigorous monitoring: Essential quality assurance tools for testing behavioral interventions with simulation. *PloS one*, 15(5), e0233538. https://doi.org/10.1371/journal.pone.0233538

Adamson, K., Kardong-Edgren, S. y Willhaus J. (2013). An updated review of published simulation evaluation instruments. *Clinical Simulation in Nursing*, *9*, e393-e400. http://dx.doi.org/10.1016/j.ecns.2012.09.004

Bandura A. (1977). Self-efficacy: Toward a Unifying theory of behavioral change. *Psychological Rev*, *84*(2), 91-215.

Barrios, S., Urrutia, M. y Rubio, M. (2017). Impacto de la simulación en el desarrollo de la autoeficacia y del locus de control en estudiantes de enfermería. *Educación Médica Superior*, *31*(1), 125-136. https://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0864-21412017000100012&lng=es&tlng=es

Cheng, A., Morse, K. J., Rudolph, J., Arab, A. A., Runnacles, J., & Eppich, W. (2016). Learner-centered debriefing for health care simulation education: Lessons for faculty development. Simulation in healthcare. *Journal of the Society for Simulation in Healthcare*, *11*(1), 32-40. https://doi.org/10.1097/SIH.0000000000000136

Díaz, D. A., & Cimadevilla, B. (2019). Educación basada en simulación: *debriefing*, sus fundamentos, bondades y dificultades. *Simulación Clínica*, *2* (1), 95-103. https://dx.doi.org/10.35366/RSC192F

Gormley, G. J., Carr, D., Murphy, P., Tallentire, V. R., & Smith, S. E. (2023). Unlocking the learning potential of simulation-based education. *British Journal of Hospital Medicine, 84*(12), 1-8. https://doi.org/10.12968/hmed.2023.0353

Kononowicz, A. A., Woodham, L. A., Edelbring, S., Stathakarou, N., Davies, D., Saxena, N., Tudor Car, L., Carlstedt-Duke, J., Car, J., & Zary, N. (2019). Virtual patient simulations in health professions education: Systematic review and meta-analysis by the digital health education collaboration. *Journal of Medical Internet Research, 21*(7), e14676.

Kung TH, Cheatham M, Medenilla A, Sillos C, De Leon L, Elepaño C, et al. (2022). Performance of GPT on USMLE: potential for AI-assisted medical education using large language models. *PLoS Digit Health, 2*(2), e0000198.

Leng, L. (2024). Challenge, integration, and change: GPT and future anatomical education. *Medical Education Online, 29*(1), 2304973. https://doi.org/10.1080/10872981.2024.2304973

Lioce L. (Ed.), Lopreiato J. (Founding Ed.), Downing D., Chang T.P., Robertson J.M., Anderson M., Diaz D.A., Spain A.E. (Eds.), &Terminology and Concepts Working Group (2020). *Healthcare Simulation Dictionary* (2nd edition). Agency for Healthcare Research and Quality. https://doi.org/10.23970/simulationv2

McCoy, L. G., Nagaraj, S., Morgado, F., Harish, V., Das, S., & Celi, L. A. (2020). What do medical students actually need to know about artificial intelligence? *NPJ Digital Medicine, 3*, 86. https://doi.org/10.1038/s41746-020-0294-7

Merchán-Baeza, J. A., González-Sánchez, M., & Pérez-Cruzado, D. (2021). Simulación con pacientes estandarizados en ciencias de la salud: una revisión sistemática. *Revista Chilena de Terapia Ocupacional, 22*(2), 25-43. https://doi.org/10.5354/0719-5346.2021.61071

Morcela, Ó. A. (2023). GPT: la IA está aquí y nos desafía. *Revista Internacional de Ingeniería Industrial, 6*, 3-6. http://www3.fi.mdp.edu.ar/otec/revista/index.php/AACINI-RIII/article/view/67

Motola, I., Devine, L. A., Chung, H. S., Sullivan, J. E., & Issenberg, S.B. (2013). Simulation in healthcare education: A best evidence practical guide. *Med. Teach., 82*(10) 1511-1530. https://doi.org/10.3109/0142159X.2013.818632

Rouhiainen, L. (2018). *Inteligencia artificial. 101 cosas que debes saber hoy sobre nuestro futuro*. Alienta.

Rudolph, J. W., Raemer, D. B., & Simon, R. (2014). Establishing a safe container for learning in simulation the role of the presimulation

briefing. *Simul Healthc, 9*(6), 339- 349. https://doi.org/10.1097/SIH.0000000000000047

Ruiz, R., & Caballero, F. (2014). Programa para seleccionar y entrenar pacientes estandarizados en el contexto de un currículo universitario de simulación clínica. *Fundación Educación Médica, 17*(4), 199-204. https://dx.doi.org/10.4321/S2014-98322014000400005

Schön, D. A. (1992). The theory of inquiry: Dewey's legacy to education. *Curriculum Inquiry, 22*(2), 119-139.

Schwarzer, R., & Jerusalem, M. (1993). *Measurement of Perceived Self-Efficacy: Psychometric Scales for Cross-Cultural Research*. Freie University.

Turner, S., & Harder, N. (2018). Psychological safe environment: A concept analisis. *Clinical Simulation in Nursing, 18*(5), 47-55. https://doi.org/10.1016/j.ecns.2018.02.004

13

# Using Artificial Intelligence to Assess the Level of Cognitive Complexity Involved in Didactic Tasks. A case study on Historical Thinking

Mg. Connie Cofré-Morales
Universidad Viña del Mar, Chile
connie.cofre@docente.uvm.cl
https://orcid.org/0009-0000-1442-1218

Eduardo Puraivan
Universidad Viña del Mar, Chile
Universidad de Playa Ancha, Chile
epuraivan@uvm.cl
https://orcid.org/0000-0003-2134-8922

Ing. Karina Huencho-Iturra
Universidad Viña del Mar, Chile
karina.huencho.iturra@alumno.uvm.cl
https://orcid.org/0009-0009-7043-2929

Mg. Macarena Astudillo-Vásquez
Universidad Viña del Mar, Chile
mastudillo@uvm.cl
https://orcid.org/0000-0001-5840-0865

PhD Carlos Hervás-Gómez
Universidad de Sevilla, Spain
hervas@us.es
https://orcid.org/0000-0002-0904-9041

PhD M. Dolores Díaz-Noguera
Universidad de Sevilla, Spain
noguera@us.es
https://orcid.org/0000-0002-0624-4079

https://doi.org/10.36006/09643-1-13 

**Abstract**
The design of didactic activities is aimed at developing learning objectives at different levels of cognitive complexity. In the field of History teaching, one of the purposes is to develop Historical Thinking, which requires specific tasks. However, several investigations report that many of the activities presented in school textbooks are limited to the use of the lowest cognitive levels, not achieving the intended Historical Thinking of students. Faced with this singularity, it is valid to ask how we can use some tools to validate that the activities fulfill the expectations of cognitive complexity. In this paper, we discuss the use of an AI to evidence whether it can help as a support tool for this task. The results show that the task of assigning the predominant cognitive level is challenging even for highly qualified experts, and that the AI results match at least with expert's assessment using some of the taxonomies considered, except for one activity. On the other hand, there is a high appreciation by experts of the potential of ChatGPT to both classify and argue its decisions, although there are also some risks to be considered.

**Keywords:** Artificial Intelligence, ChatGPT, cognitive complexity, historical thinking.

## 13.1. Introduction

In the subject of History, from the perspective of the development of skills and competencies, in recent decades, the focus has been placed on students being able to develop "historical thinking", which is defined as the deployment of a set of specific skills of the discipline to ensure that the historical facts of the subject of History are not memorized, but constructed by the students themselves through the use of historical evidence or sources to generate an interpretation of the facts, emulating the work of a historian (Wineburg, 2001; Kitson, et al., 2015; Sáez-Rosenkranz, 2017). In this sense, the teaching of historical thinking consists in initially posing a problem or research question that guides the inquiry that students will carry out in the historical sources, in order to solve the problem posed or provide an answer to the question (Seixas & Morton, 2013; Kitson et al., 2015; Henríquez et al., 2018).

The levels of cognitive complexity identifiable in didactic tasks that seek to develop specific objectives and skills, as is the case of historical thinking, can be identified through the use of

taxonomies that describe what the student does at the cognitive level and, at the same time, allow us to show whether these activities really promote the development of this specific skill of the subject. Bloom's Taxonomy (in the Anderson and Krathwohl's revision) has been used as a means in several studies (Sáiz, 2014; Gómez & Miralles, 2016; Martínez & Gómez, 2018) to identify the levels of complexity of textbook tasks. This taxonomy proposes 6 levels that are presented continuously and ascending in complexity, although they are not necessarily interpreted as linear, in the sense that a student, when working at one of the highest levels, has necessarily passed through all the previous levels (Förster & Rojas-Barahona, 2017). These levels are: "remember", "understand", "apply", "analyze", "evaluate" and "create". Regarding the levels of cognitive complexity but specifically focused on the subject of History and historical thinking, Sáiz (2013) has formulated 3 levels in which there is correspondence with the levels of Bloom's Taxonomy (Anderson and Krathwohl's revision): "low", where students locate and repeat information extracted from historical sources, corresponding to Bloom's "remember" level; "medium", where students understand information from other sources by paraphrasing, summarizing or schematizing it, corresponding to Bloom's "understand" level; and "high", where students analyze, apply and/or evaluate information from sources in order to construct new knowledge about the past. This last level corresponds to Bloom's "apply", "analyze", "evaluate" and "create" levels.

Several studies have investigated the levels of cognitive complexity that are most frequently presented in the didactic tasks of textbooks for the subject of History, in order to verify whether it is possible to get students to develop historical thinking with the support of these activities. In these studies, it is observed as a tendency that the levels of complexity that present a greater presence in the textbooks are those that are lower, and it is highlighted that the higher levels present a very scarce presence (Sáiz, 2014; Gómez, 2014; Gómez & Miralles, 2016; Martínez & Gómez, 2018; Palacios, 2019; Bramann, 2021).

Given the advancement of Artificial Intelligence (AI) in education, recent studies (Bolaño-García & Duarte-Acosta, 2024; Jiménez et al., 2018; Kasneci et al., 2023; Küchemann et al., 2023) have explored its usefulness and risks. The capacity of AI

as a teaching support tool is recognized, motivating investigations into its potential applications. In our case, it is crucial to evaluate whether AI can effectively classify the levels of complexity of didactic tasks in History, and how reliable its work is according to experts in the field.

## 13.2. Background

The possible applications of AI in education have been actively explored in recent times due to its rapid advancement and progress, however, regarding the opportunities and challenges offered in this area by the use of chatbots such as ChatGPT, authors such as Kasneci et al. (2023) state that the studies conducted to experiment in this area are at an early stage, with few empirical studies being found in the literature. In the field of teaching, it is possible to find various uses of AI where it acts as a support tool for teaching. For example, according to Bolaño-García & Duarte-Acosta (2024) from a systematic review done to investigate the use of AI in education, it has been detected that AI is a tool that can be used for the personalization of learning in the sense that teachers can adapt teaching materials to the individual needs of their students immediately; to provide students with instant and personalized feedback on their learning tasks and activities; and to automatize administrative and evaluative tasks in which teachers spend a great amount of time, among other notable uses. Moreover, Kasneci et al. (2023) report that AI offers opportunities for teaching where it can be used for lesson planning or inclusive classes, as well as to generate questions or activities that promote the participation of people with different abilities and/or levels of knowledge; likewise, the mentioned authors point out that AI can semi-automatize the grading of students, highlighting the strengths and weaknesses of their work.

Regarding didactic activities for student learning, some studies have experimented with the use of AI to generate such activities and evaluate their quality. The study by Küchemann et al. (2023) worked with an intervention group that had to create activities for the subject of Physics using ChatGPT, which were subsequently compared with those created by a textbook-sup-

ported control group on the same content. In the relevant findings of the aforementioned work, it is highlighted that no significant differences were detected in the quality of the activities generated by both groups. It is mentioned, however, that one of the activities created by the group that used ChatGPT presented an important omission that did not allow determining the response to the activity. Regarding the taxonomic levels of the activities (based on Bloom's Taxonomy), it was detected that the activities generated by both groups were concentrated in the levels of "remember", "understand" and "apply", with very few activities at the level of "analyze" and "evaluate", and none belonged to the level of "create" in the activities of both groups.

On the other hand, Kwan (2024), using ChatGPT, generated an assessment script that included a test, scoring guideline, suggested solutions to the test, and classification of the difficulty levels of the test questions based on Bloom's Taxonomy levels. Among the main findings, it was detected that the assessment generated by ChatGPT was quite structured. However, it was observed that one question was incorrect; that there were inconsistencies in the scoring guideline related to the score of some questions and the total score given by the chat itself; and that, when requesting the solution to the test, the chat only generated the solution to one of the test sections (of the two existing in total), failing to suggest a solution for the other section. With respect to the taxonomic level classification (performed with ChatGPT) of the generated assessment questions, it is argued that most of them are at the "remember" and "apply" levels, and that two of them are at the "analyze" level. Therefore, of the questions generated by ChatGPT, no questions for the higher levels of "evaluate" and "create" are detected.

From the above mentioned, two aspects stand out regarding the generation of tasks using ChatGPT and its subsequent classification of the levels of cognitive complexity based on Bloom's Taxonomy. Firstly, it is striking that the activities generated using the chat possess the same frequency trends of taxonomic levels as the textbook activities that other studies have classified (Sáiz, 2014; Gómez, 2014; Gómez & Miralles, 2016; Martínez & Gómez, 2018), namely, activities concentrated in the first 4 levels of the Taxonomy (those of the lowest cognitive level), and very few of the "evaluate" and "create" levels (the highest

cognitive levels). Secondly, it is observed that ChatGPT has the ability to classify the levels of cognitive complexity of didactic activities, taking Bloom's Taxonomy as a reference; however, the referenced studies have not verified whether the classification made by the chat is correct, thus it is not possible to affirm that this ability, at present, is accurate and effective. This last point is of particular relevance, since, as has been suggested by some authors (Hashem et al., 2024; Kwan, 2024; Gill et al., 2024), in some cases ChatGPT can generate inaccurate or incorrect data.

Therefore, in this study, we proposed to use ChatGPT to perform a classification of the taxonomic levels of a set of didactic activities extracted from two textbooks circulating in Chilean schools in 2022, specifically from the subject of History, Geography and Social Sciences. We also performed a validation, under the criteria of experts in the discipline, of the classification and arguments provided by the chat to verify its accuracy and reliability

## 13.3. Methodology

We asked ChatGPT 4 (hereinafter ChatGPT) to analyze didactic activities and determine the predominant cognitive level, according to the Taxonomies of Bloom (Anderson and Krathwohl's revision) and Sáiz (2013), hereinafter Bloom's and Sáiz's Taxonomy, respectively. As a case study, we used didactic tasks in the field of Historical Thinking. The methodology used in this work considers the following stages.

- **Selection and Preparation of Didactic Activities.** For our study, we chose and prepared six didactic activities, all extracted from two textbooks used in Chilean schools during the year 2022. These activities belong specifically to the subject of History, Geography and Social Sciences. Each of them was stored in separate files to facilitate their analysis and management.
- **Elaboration of Prompts for ChatGPT.** We designed specific prompts to guide ChatGPT in the analysis of didactic activities. These prompts are oriented to determine the cognitive

level associated with each activity, according to Bloom's and Sáiz's taxonomies. In addition, ChatGPT was asked to provide arguments to justify each of its decisions in this classification process.

- **Obtaining Results.** In this phase, we compiled the classifications made by ChatGPT together with their corresponding justifications. These results are based on Bloom's and Sáiz's taxonomies used in the analysis. This process allowed us to evaluate how the chat determines the cognitive levels of the didactic activities.
- **Expert Critical Assessment.** For a detailed and critical review of the classifications made by ChatGPT, we convened six highly qualified experts, all with doctoral degrees. Initially, each expert was asked to determine the predominant cognitive level in the didactic activities, using Bloom's and Sáiz's taxonomies as a reference. Subsequently, we presented them the ChatGPT results and asked them to critically evaluate both the classifications and the arguments offered by the chat. This analysis focused on identifying the potential risks and benefits of using ChatGPT.

## 13.4. Results

Below we present the findings of our experiment with six didactic activities extracted from two textbooks used in Chilean schools during 2022, focusing on the area of History, Geography and Social Sciences. These materials are representative of those used in the first two years of secondary education (students aged 14-15 years).

### Classification of activities

We prepared and presented the didactic activities extracted from the textbooks of the subject of History, Geography and Social Sciences to each of the experts. Figure 13.1 is an example of an activity presented (the question asks "What does the act of source A symbolize? Why was this date chosen?").

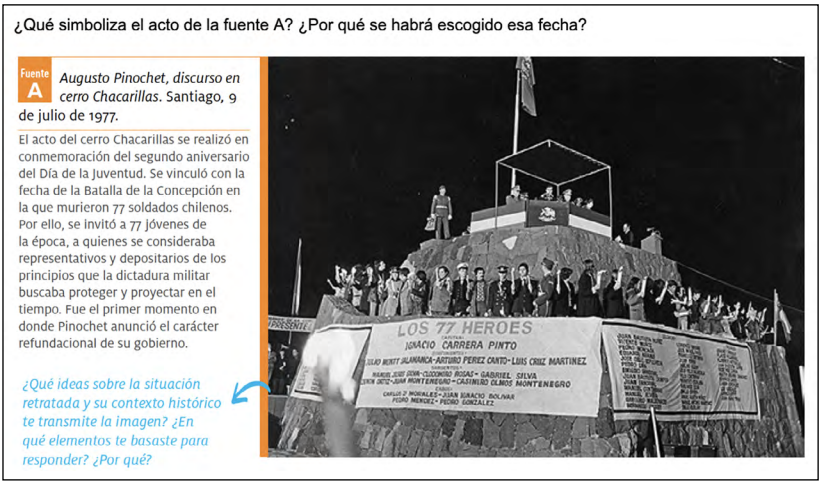



**Figure 13.1.** Example of an activity extracted from a textbook.

Each expert identified the predominant cognitive level of the didactic tasks, based on Bloom's and Sáiz's taxonomies. The assessment was carried out individually by two experts for each activity. After completing their classification, they were shown the results obtained with ChatGPT for direct comparison. The details of these evaluations and comparisons are summarized in Table 13.1. In the ChatGPT's column we present the classification of both taxonomies and in parentheses the percentage of agreement with the experts considering each taxonomy. Interesting situations emanate from these results. Firstly, note that there is no agreement among experts in determining the predominant cognitive level of each activity, except when using Sáiz's taxonomy in Activity 5 and when using Bloom's taxonomy in Activity 6. This empirical finding confirms the complexity of this task. On the other hand, we see that the classification performed by ChatGPT is in line with that of at least one expert (examining the taxonomies individually), except in activity 5. We have highlighted (gray background) the coincidences between ChatGPT and the experts.

**Table 13.1.** Experts and ChatGPT results (Ai: Activity "i", T: Taxonomy, *Ej: Expert "j"*.

| A | T | ChatGPT | $E_1$ | $E_2$ | $E_3$ | $E_4$ | $E_5$ | $E_6$ |
|---|---|---|---|---|---|---|---|---|
| $A_1$ | Bloom | Analyze (50%) | Analyze | Understand | | | | |
| | Sáiz | High (50%) | High | Medium | | | | |
| $A_2$ | Bloom | Analyze (0%) | Evaluate | Remember | | | | |
| | Sáiz | High (50%) | High | Medium | | | | |
| $A_3$ | Bloom | Evaluate (50%) | | | Evaluate | Remember | | |
| | Sáiz | High (50%) | | | High | Low | | |
| $A_4$ | Bloom | Analyze (50%) | | | Analyze | Remember | | |
| | Sáiz | Medium (50%) | | | Medium | Low | | |
| $A_5$ | Bloom | Analyze (0%) | | | | | Evaluate | Understand |
| | Sáiz | High (0%) | | | | | Medium | Medium |
| $A_6$ | Bloom | Evaluate (100%) | | | | | Evaluate | Evaluate |
| | Sáiz | High (50%) | | | | | Medium | High |

Source: developed by author.

## Assessment of the work performed by ChatGPT

As was previously mentioned, once their classification was completed, the experts were shown the results obtained with ChatGPT, asking them to rate (on a scale of 1 to 5) the classification and arguments provided by the chat. Table 13.2 shows an example of the classification and general arguments provided by ChatGPT.

**Table 13.2.** Example of classification and arguments provided by ChatGPT

| Taxonomy | Assigned level | Arguments |
|---|---|---|
| Bloom (Anderson and Krathwohl's revision) | Analyze | The task requires the student to interpret the symbolism of a public act, understanding the meaning behind the selection of the date and the relationship to a historical event. This demands analytical skills to connect the visual information with previous knowledge of history and politics. |
| Model of Sáiz (2013) | High | The student must go beyond the mere identification of visual elements or textual comprehension (low and medium levels). They are expected to make a critical evaluation of the act in its historical and political context, which implies the creation of new information from a deep reflection on the symbology and intentionality behind the selection of the date. |

The average rating is shown in Table 13.3. It is interesting to note that there is a high valuation in both dimensions. On the other hand, the experts based their ratings both on the classification and on the arguments provided by ChatGPT. Among their justifications (free text), based on identifying benefits and risks, the experts show interest and surprise in the classification made by ChatGPT, but they also state as a risk that teachers may slightly accept the results and rely too much on the tool. They make explicit reference to the fact that the tool can be wrong, and that some historical contexts may not be well understood, which can lead to errors in the results.

**Table 13.3.** Average ratings in the classification and arguments provided by ChatGPT *(Ai: Activity "i")*.

| INDICATOR | $A_1$ | $A_2$ | $A_3$ | $A_4$ | $A_5$ | $A_6$ |
|---|---|---|---|---|---|---|
| Average rating in the classification | 4 | 4 | 5 | 5 | 3 | 5 |
| Average rating in the argument | 5 | 4.5 | 5 | 5 | 4 | 5 |

Source: developed by author.

## 13.5. Conclusions and Projections

The achievement of the learning objectives is of utmost relevance for the quality of the teaching that is delivered. In this sense, one

of the aspects to consider and review in teaching is the complexity of the didactic activities proposed to students, to ensure that they are appropriate to the expected learning, for which Bloom's taxonomy (Wang et al., 2021), or others specific to the subject, can be used. If the subject of History is intended to develop historical thinking, the most appropriate levels of complexity should be the highest (Sáiz, 2014; Palacios, 2019; Bramann, 2021). The use of AI as a tool for the task of classifying activities can be valuable and contribute greatly to quality teaching.

The results of our experiments indicate an initial finding: the difficulty of assigning a specific cognitive level to didactic activities, despite the fact that these were selected directly from school textbooks and are well defined. This complexity is evidenced by the lack of consensus among experts, even using a commonly employed taxonomy such as Bloom's. This finding suggests the importance of expanding research to other areas of knowledge to better understand these challenges. A second significant finding of our study is that, for each didactic activity (except for Activity 5), the ChatGPT's results match at least the classification provided by one of the experts, when considering the taxonomies individually. This coincidence indicates that the ChatGPT's classifications are in line with the experts' evaluations, showing relevant consistency. This result suggests that the tool, in terms of classification, does not present significant deviations or obvious errors that could be considered as "hallucinations" in its responses. The third finding of our study is the experts' favorable assessment towards the use of ChatGPT in the assigned task, both in terms of classification and argumentation. However, experts also warn about the need for caution when using this tool. They highlight the importance of avoiding overconfidence of teachers and recall that, like any automated tool, ChatGPT is not error-free (Hashem et al., 2024; Kwan, 2024; Gill et al., 2024), e.g., in challenging contexts such as assigning a level of cognitive complexity where there are various reasons that can make this task difficult. For instance, in some cases, an activity can be associated with more than one level of Bloom's taxonomy (Rawat et al., 2023) or the amount of time and resources associated with this task when it is performed considering a big amount of activities (Rawat et al., 2023; Wang et al., 2021), which is why it is necessary to work on an automated tool to support it. This balance

between recognition of its usefulness and awareness of its limitations is crucial for its effective application in educational contexts.

The current results lead us to plan future research in two key directions: to extend the empirical evidence with a wider range of didactic activities and to diversify the areas of knowledge studied. In the medium term, our goal is to develop a software tool based on recent advances in AI. This tool will support decision making in assigning levels of cognitive complexity to didactic activities and will be aimed primarily at trainee and novice teachers as initial users.

## References


Bramann, C. (2021). *Fostering Historical Thinking with Textbooks. A case study of tasks in Austrian history textbooks* (conference). International Conference on Textbooks and Educational Media, Berlin, Germany. https://doi.org/10.1007/978-3-030-80346-9_31

Bolaño-García, M., & Duarte-Acosta, N. (2024). Una revisión sistemática del uso de la inteligencia artificial en la educación. *Revista Colombiana de Cirugía, 39*(1), 51-63. https://doi.org/10.30944/20117582.2365

Förster, C., & Rojas-Barahona, C. (2017). Aprendizaje y evaluación: lo que no se evalúa, no se aprende. In C. Förster (Ed.). *El poder de la evaluación en el aula. Mejores decisiones para promover aprendizajes* (pp. 43-74). Universidad Católica de Chile.

Gill, S., Xu, M., Patros, P., Wu, H., Kaur, R., Kaur, K., Fuller, S., Singh, M., Arora, P., Kumar, A., Stankovski, V., Abraham, A., Ghosh, S., Lutfiyya, H., Kanhere, S., Bahsoon, R., Rana, O., Dustdar, S., Sakellariou, R. ..., & Buyya, R. (2024). Transformative effects of ChatGPT on modern education: Emerging era of AI chatbots. *Internet of Things and Cyber-Physical Systems, 4*, 19-23. https://doi.org/10.1016/j.iotcps.2023.06.002

Gómez, C. (2014). Pensamiento histórico y contenidos disciplinares en los libros de texto. Un análisis exploratorio de la Edad Moderna en 2.º de la ESO. *Ensayos. Revista de la Facultad de Educación de Albacete, 29*(1), 131-158. https://revista.uclm.es/index.php/ensayos/article/view/498

Gómez, C., & Miralles, P. (2016). Développement et évaluation des compétences historiques dans les manuels scolaires. Une étude

comparative France-Espagne. *Spirale. Revue de Recherches en Education*, *2*(58), 53-66. https://www.cairn.info/revue-spirale-revue-de-recherches-en-education-2016-2-page-53.htm

Hashem, R., Ali, N., El Zein, F., Fidalgo, P., & Abu Khurma, O. (2024). AI to the rescue: Exploring the potential of ChatGPT as a teacher ally for workload relief and burnout prevention. *Research and Practice in Technology Enhanced Learning*, *19*. https://doi.org/10.58459/rptel.2024.19023

Henríquez, R., Carmona, A., Quinteros, A., & Garrido, M. (2018). *Leer y escribir para aprender Historia. Secuencias para la enseñanza y el aprendizaje del pensamiento histórico.* Universidad Católica de Chile.

Jiménez, S., Juárez-Ramírez, R., Castillo, V., & Tapia, J. (2018). *Affective Feedback in Intelligent Tutoring Systems. A practical approach.* Springer. https://doi.org/10.1007/978-3-319-93197-5

Kasneci, E., Sessler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günnemann, S., Hüllermeier, E., Krusche, S., Kutyniok, G., Michaeli, T., Nerdel, C., Pfeffer, J., Poquet, O., Sailer, M., Schmidt, A. Seidel, T. ..., & Kasneci, G. (2023). ChatGPT for Good? On opportunities and challenges of large language models for education. *Journal of Psychology and Education*, *103*. https://doi.org/10.35542/osf.io/5er8f

Kitson, A., Steward, S., & Husbands, C. (2015). *Didáctica de la Historia en Secundaria Obligatoria y Bachillerato. Comprender el pasado.* Morata.

Küchemann, S., Steinert, S., Revenga, N., Schweinberger, M., Dinc, Y., Avila, K., & Kuhn, J. (2023). Can ChatGPT support prospective teachers in physics task development? *Physical Review Physics Education Research*, *19*(2). https://doi.org/10.1103/PhysRevPhysEducRes.19.020128

Kwan, C. (2024). *Exploring ChatGPT-Generated Assessment Scripts of Probability and Engineering Statistics from Bloom's Taxonomy* (conference). International Conference on Technology in Education, Hong Kong, China. https://doi.org/10.1007/978-981-99-8255-4_24

Martínez, M., & Gómez, C. (2018). Cognitive level and thinking historically competencies in history textbooks from Spain and England: A comparative study. *Revista de Educación*, *379*, 136-159. https://doi.org/10.4438/1988-592X-RE-2017-379-364

Palacios, N. (2019). Teaching violence, drug trafficking and armed conflict in Colombian schools: Are history textbook deficient? *Issues in Educational Research*, *29*(3), 899-922. https://www.iier.org.au/iier29/palacios.pdf

Rawat, A., Kumar, S., & Samant, S. (2023). *A Systematic Review of Question Classification Techniques Based on Bloom's Taxonomy* (conference). International Conference on Computing Communication and Networking Technologies, Delhi, India. https://doi.org/10.1109/ICCCNT56998.2023.10308403

Sáez-Rosenkranz, I. (2017). La enseñanza de la historia en los libros de texto de educación básica en Chile. *Revista Enseñanza de las Ciencias Sociales*, *16*, 27-40. https://doi.org/10.1344/ECCSS2017.16.3

Sáiz, J. (2013). Alfabetización histórica y competencias básicas en libros de texto de historia y en aprendizajes de estudiantes. *Revista Didáctica de las Ciencias Experimentales y Sociales*, *27*, 43-66. http://dx.doi.org/10.7203/dces.27.2648

Sáiz, J. (2014). Fuentes históricas y libros de texto en secundaria: Una oportunidad perdida para enseñar competencias de pensamiento histórico. *Ensayos. Revista de la Facultad de Educación de Albacete*, *29*(1), 83-99. https://revista.uclm.es/index.php/ensayos/article/view/503/458

Seixas, P., & Morton, T. (2013). *The Big Six Historical Thinking Concepts*. Nelson Education. https://bibliotecadigital.mineduc.cl/handle/20.500.12365/17630

Wang, Z., Manning, K., Mallick, D., & Baraniuk, R. (2021). *Towards Blooms Taxonomy Classification Without Labels* (conference). Artificial Intelligence in Education: 22nd International Conference, Utrecht, Netherlands. https://doi.org/10.1007/978-3-030-78292-4_35

Wineburg, S. (2001). *Historical thinking and other unnatural acts: Charting the future of teaching the past*. Temple University.

14

# Space Design Assisted by Artificial Intelligence in Early Childhood Education Classrooms

PhD Rosario Ordóñez-Sierra
Universidad de Sevilla, Spain
rordonez@us.es
https://orcid.org/0000-0002-8563-9975

PhD Margarita Rodríguez-Gallego
Universidad de Sevilla, Spain
margaguez@us.es
https://orcid.org/0000-0001-6959-4829

Cristina De-Cecilia-Rodríguez
Community Manager in educational centres
cristinadececilia01@gmail.com
https://orcid.org/0000-0001-9950-9859

**Abstract**
This chapter analyzes space setting in early childhood education, considering its influence on the teaching-learning processes. School space is a factor that promotes academic, life and attitudinal learning, and it favors the cultural exchange of rules and values, due to its non-neutrality and to the fact that it educates us continuously, with teachers learning new meanings within it, exerting great influence on the movements, behaviors and learning of the students, in particular, and all the members of the educational community, in general. At the same time, Artificial Intelligence has appeared in our daily living as an effective learning tool to unburden teachers, facilitating the co-creation and co-design of spaces in early childhood education. Artificial Intelligence is becoming a valuable instrument to analyze the organizational designs, equipment and fluid relationship of said work spaces in educational centers and their environment.

https://doi.org/10.36006/09643-1-14 

**Keywords:** early childhood education, spaces, physical dimension, functional dimension, temporal dimension.

## 14.1. Introduction

Educational centers must be considered centers for learning and co-existence, and the way in which spaces are organized within them will determine the working and social relationships. Due to the influence of educational organization on our lives, we must analyze it from the curricular and pedagogical perspective, as well as from the psychological and sociological perspective. The term space admits different definitions and, therefore, different conceptualizations, taking into account that it generally means "indefinite expanse", i.e., area without limits that contains all finite extensions.

According to Madrid and Mayorga (2012) and Camacho (2017), the school space is the container and content of the structured teaching-learning situations, understood as a material reality that influences the educational action.

In the current context, González-Zamar and Abad Segura (2020) considered physical space as a learning factor and proposed that the planning, design and organization of space exerts great influence on the movements, behaviors and learning of students. Moreover, the design and organization of space allows favoring the cultural exchange of rules and values, as well as life and attitudinal learning (Shernoff et al., 2017).

In the studies conducted by Barret et al. (2017), Daniels et al. (2007) and Tse et al. (2015), a positive relationship has been reported between the properties of physical space, the methodology used and the influence of both on the teaching-learning process of students. According to Maxwell (2016), the adaptation of spaces favors the development of positive emotions, greater integration and better values among the students. Similarly, an adequate space promotes the social connection of the students, as well as collaboration, reflection and the exchange of ideas (Oblinger, 2005); fosters cognitive development (Fraser, 2018; Lin-Siegler et al., 2016); favors early literacy (Fraser, 2018); and promotes more active methodologies (Acaso & Megías, 2013). Physical space also influences the planning

of curricular elements: objectives, content selection and timing, classroom organization and monitoring, and evaluation and motivation of students and teachers (González-Calvo et al., 2018).

In space planning, it is important to consider not only children but also adults (teachers, parents, educators and assistants), to ensure that they all have spaces to comfortably carry out their tasks, duties and relations.

Thus, space can transform and directly influence learning and the development of people and organizations.

## School space understood as a learning environment

Upon entering an educational center, the walls, the furniture and its distribution, the dead spaces, the people and the decoration show the types of activities that are carried out in it, the communication among students, the interests of the students and teachers, the relationships with the outside world, etc. As was stated by Iglesias (2008), the term "space" refers to physical space, that is, the buildings for activities, characterized by the objects, didactic material, furniture and decoration. On the other hand, the term "environment" refers to the set of physical space and the relationships that are established in it (affections, interindividual relationships among children, between children and adults, between children and society as a whole, etc.). Chacón and Triana (2020, p. 11) stated that "...for the design of school environments, it is fundamental to consider the heterogeneity of spaces, where each space has relevant characteristics and furniture for the programmed activity, two or more access points, free-leisure areas and common zones". Likewise, Urda and Leal Laredo (2017) claimed that the following aspects should be considered when designing a space that promotes education and the construction of knowledge: the identity of the building with respect to its immediate context; flexibility and permeability; transition space; and the heterogeneity of classroom spaces.

## 14.2. Dimensions of the Space/Environment in Early Childhood Education Centers

According to Iglesias (2008), we can analyze three dimensions in the spaces of educational centers: physical, functional and temporal.

### Physical dimension

Which refers to the physical space (center, classroom, annex spaces...) and its structural conditions (floor, windows...). It also comprises the objects of the space (materials, furniture and decorative elements) and their decoration (ways of distributing the furniture and the materials within the space).

Decree 149/2009, of May 12th, which regulates the centers that teach the first cycle of early childhood education, by the Government of Andalusia (Spain), version in force 1/1/2024, gathers the minimum criteria of every early childhood education center in Chapter II, Article 11, which states that centers with the first cycle of early childhood education must be in buildings of educational use and with independent access, with architectural conditions that enable access for people with disabilities.

Article 13 gathers the facilities and material conditions of centers of the first cycle of early childhood education, including the following:

- One room per unit with a minimum of two square meters per school placement, with a total minimum of thirty-six square meters. The rooms for children under two years of age will have different areas for resting and hygiene.
- A space adapted for cooking.
- A multipurpose room of a minimum of thirty-six square meters that may be used as a cafeteria.
- A play yard of a minimum of sixty-five square meters.
- One restroom per room for children aged 2-3 years, which must be visible and accessible from the room and will have two sinks and two toilets.
- One restroom for the staff, separated from the units and services of the children, with one sink, one toilet and one shower.

- A differentiated space for the administration and coordination activities. (p. 5)

On its part, Royal Decree 132/2010, of February 12th, establishes the minimum requirements of centers that teach the second cycle of early childhood, primary and secondary education in Spain. These centers must meet, at least, the following requirements about the facilities that are common to all centers (Article 3, point 2, p. 5-6): being in independent buildings, meeting the safety and energy-saving conditions, and having ventilation, natural lighting and conditions of accessibility for people with reduced mobility. The centers that teach the second cycle of early childhood education must have a minimum of three units. Article 6 gathers the facilities and material conditions of these centers:

- One classroom per unit, with an area that suits the number of authorized school placements, and a minimum of 2 square meters per school placement.
- A multipurpose room of thirty square meters.
- A play yard that can only be used by the center, with an area of at least 150 square meters for every six units or fraction, and a differentiated schedule of use if the center has students of other educational stages. (p. 6)

In general, in order for school spaces to be adequate, they must meet three types of conditions:

- Pedagogical conditions, such as: adaptability, which implies the possibility that a building may admit changes; flexibility, to modify spaces and make them convertible and moldable; and communicability among spaces.
- Physical conditions: location, far from dangerous areas; orientation; classroom structure, which can be linear or nucleated; sufficient rooms (rest rooms, toilets, multipurpose rooms...); favorable acoustic conditions; lighting, enough natural light; natural ventilation; and adequate heating.
- Compliance with the general conditions according to the regulations in force.

There are different classifications about physical spaces in educational centers. Next, we present the classification of Domènech and Viñas (2007): teaching, leisure, services, management, and movement. Each of them is briefly explained below.

**Teaching space**: In these spaces, an educational activity is carried out, which has been programmed and ordered according to the curricular needs of each class or stage.

The equipment of each classroom must respond to the fundamental activity that is carried out in it, whether it is specific of the area (audiovisuals, library...) or general, and it will be adapted to each educational level or stage.

The teachers must have sufficient technological equipment: slide projectors, computers, speakers, printers...

The furniture and distribution of the classroom must favor three important aspects: easy and direct access to the materials; the presence of spaces for the permanent presentation of the classroom activity; and the free expression and participation of the students.

The classroom design must be taken care of considering characteristics like size, aesthetics, luminosity, distribution, shapes, color, decoration... adapting them to their age, with the aim of favoring creativity, communication and participation. It is important for the students to participate in the adaptation of the spaces of the center.

Regarding the materials of early childhood education classrooms, these can be grouped into assembly materials (cork board, children's books, audio material...), material for working stands (each stand must have a large recipient to store the necessary materials), material for workshops and learning environments (material classified by groups and colors, such as pencils, crayons, markers, scissors...) and other types of materials (poster board, clay, tissue paper, cellophane...).

**Leisure space**: In these spaces, the students express themselves and act freely and spontaneously, although they must meet an educational end. These spaces are: play yards, games rooms, etc.

Due to the minimum budgets, centers must potentiate their imagination and make good use of the materials to enrich the leisure experiences of the students. Thus, the following aspects are considered:

- The yards can be livened up with slides, tunnels made of different materials, large-diameter tubes, unleveled terrain, swings, bicycles, etc.
- Floors with geometric shapes: squares, triangles, chess boards, games such as hopscotch...
- The yard can be used for handicrafts, painting and modelling; the installation of benches of different heights for multiple uses would be enough, which can also be employed for resting.
- A high platform can be used as stage, etc.
- Parts of the yards can be used for relaxation and individual concentration, gardening, crops, small ponds, etc.
- Walls for panels, which can be decorative and employed for advertising, announcements, etc.

**Service spaces**: mainly formed by sanitary spaces and the cafeteria. The cleanliness and order of these places is fundamental for their correct use.

**Management spaces**: these include not only the offices for secretaries, principals and caretakers and a teachers' room, but also a meeting room and rooms for individual and collective work for teachers.

**Spaces for circulation and communication**: mostly formed by corridors, halls, stairs... said spaces have two main functions: enable physical circulation between the facilities and favor work communication in the center.

The entrance is the first space through which children and parents get in contact with this new environment. Therefore, it could be set in the following manner:

- Objects that are familiar to the children.
- A place for families, in a peaceful and pleasant framework.
- A space for communication and information. For information, there could be panels to communicate any type of information aimed at parents, such as:
  - Menu of the day if there is a cafeteria.
  - General advice: meetings, trips...
  - Presentations of the productions of the children.

The corridors are places of communication, like the entrance, although they should have specific information about the ac-

tivities that are carried out in the different classrooms and workshops, with the possibility of exhibiting samples of the works done by the children. The type of communication we can offer are moments of everyday life, pedagogical projects, habits and routines, interactions among children and between children and educators, knowledge processes, and artistic expression in school.

**Great common space**: it is also important to highlight the importance of a space of common use for the entire center (students, parents, teachers...). The existence of this space may facilitate the organisation of debates, open discussion forums, conferences, extracurricular activities, cultural weeks..., etc., which may be a dynamizing element that would favor the development of the educational project of the center.

**Table 14.1.** Classification of spaces of Doménech and Viñas (2007)

| | |
|---|---|
| **Teachers** | Classroom; library; specific-use rooms; audiovisual rooms |
| **Leisure** | Play yards; game rooms |
| **Services** | Cafeteria; restrooms |
| **Management** | Secretary; meeting rooms |
| **Circulation** | Corridors; stairs; halls |
| **Common multipurpose room** | Multipurpose rooms |

*Note.* Developed by author.

## Functional dimension

This is related to the way in which the spaces are used, their multi-usage, and the type of activity they serve. Thus, spaces can be used by children autonomously or under the direction of the teacher. Multi-usage refers to the different functions that a single physical space can assume (e.g., the rug is the meeting place for communication during assemblies, and later on it is the place for construction). Lastly, with regard to the types of activities that the children can carry out in a certain physical space, the latter acquires a certain functional dimension, e.g., construction place, symbolic game, music, library, etc.

### Temporal dimension

This dimension is linked to time management and, consequently, to moments when the spaces will be used. The time of the different activities is necessarily bound to the space in which they are carried out: time for playing in the areas, communicating with others in the assembly, storytelling, cafeteria, recess, individual or small-group work, etc., as well as the time for free and autonomous activities, and planned and guided activities. However, in addition, the temporal dimension also refers to the pace (quick or moderate) at which the class develops, i.e., the *tempo*.

## 14.3. Artificial Intelligence and Educational Spaces in Early Childhood Education

Artificial Intelligence (AI) is a reality that is present in the lives of people, facilitating many tasks (Estupiñán et al., 2021), and, due to its appearance in our daily living and its proliferation and development in many aspects of our lives, it seems necessary to learn to use it and know its advantages and disadvantages in the scope of education. Although it is a relatively new technology, it is increasingly evident that it will have a great repercussion in the future (Navarro, 2018). As was stated by Marqués Cobeta (2023, p. 28), it must be implemented "as a fundamental tool for the improvement of the educational experience that is beneficial for both teachers and students in all educational stages".

The use of AI can be understood as an effective learning instrument that unburdens the teacher and offers efficient learning experiences for the students (EDUCAUSE, 2023). We highlight some of the ways in which AI may influence the design of spaces in the classrooms of early childhood education.

With the use of AI-based software and tools, teachers can obtain precise data that allow them to predict facts and search for better solutions and classroom designs to adapt to the needs of their students.

AI tools generate images from text, which allows applying collaborative and multidisciplinary approaches, such as the co-

creation and co-design of educational spaces of early childhood education (Cobeta, et al., 2023; López-Forniés & Asión-Suñer, 2023), with the need to design differentiated and fluid spaces according to the educational activity that is carried out in them (Durá-Gúrpide, 2016). AI systems allow gathering data of performance, needs, learning styles and preferences to design classroom spaces and, thus, create personalized activities (Hutchins, 2017; Pimienta & Mosquera-Martínez, 2022). Through this technological tool, it is possible to organize personalized learning environments, by analyzing the learning style of each student, and create different environments, maximizing their use and efficiency, in addition to providing real-time information about the performance of the students, with the possibility of adjusting the space and methodology (Montiel-Ruiz & López-Ruiz, 2023; Prendes-Espinosa, 2023). For example, an AI system may suggest the teacher which resources she/he may offer to her/his students, based on the study of the space in which they work most motivated and relaxed (Peñaherrera-Acurio et al., 2022).

Similarly, AI can define spaces that encourage collaboration and cooperative work, by designing flexible groups, and allowing for temperature, lighting and sound adjustment, in order to maximize concentration among the students. A very novel aspect of AI is that it improves safety in educational centers, due to smart surveillance systems that can detect risk situations. With AI, it is possible to design classrooms that can be accessed by students with disabilities, which allows compensating opportunities. Lastly, AI improves energy efficiency and reduces the costs in classrooms and educational centers, which reduces the environmental impact. To sum up, AI enables the design of sustainable classrooms for early childhood education to preserve the space in which children live. Using AI tools and the Floorplanner application, we present the design of the following propositions of spatiograms for classrooms of early childhood education for children aged 0-3 years (see images 14.1 to 14.6)[1]

1. Note: Spatiograms designed with AI by Jesús Martín Pérez (4th year student of the Degree of Pedagogy, University of Seville).

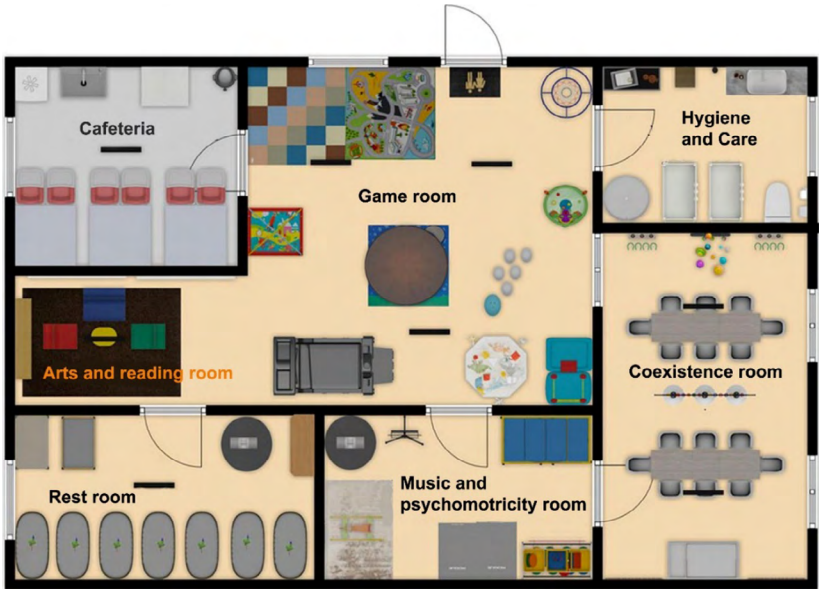



**Image 14.1.** Spatiogram (2D).

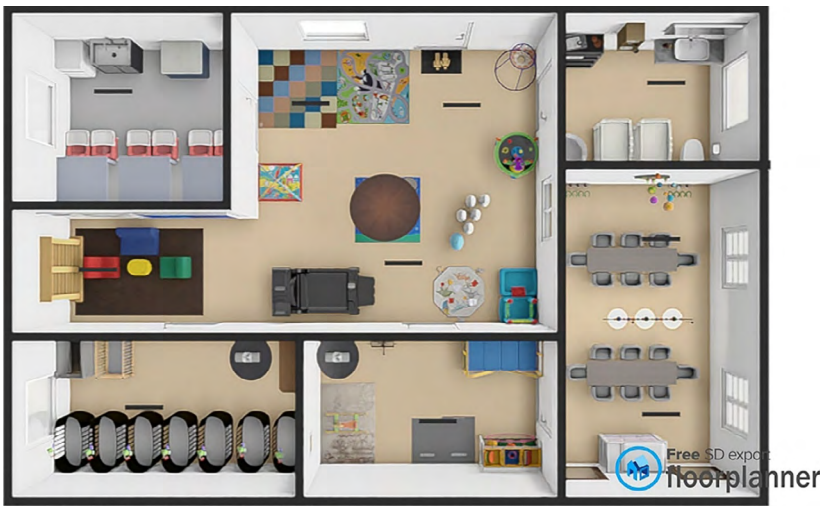



**Image 14.2.** Spatiogram (3D).

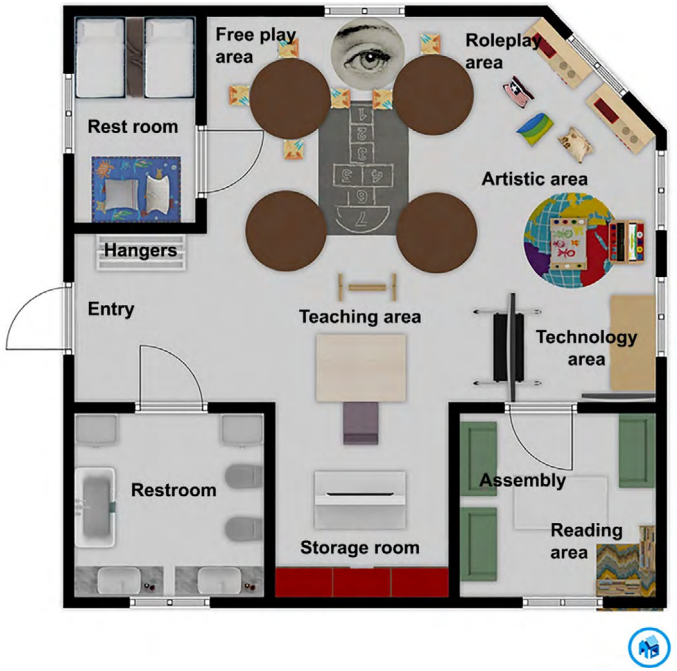



**Image 14.3.** Spatiogram (2D).

**Image 14.4.** Spatiogram (3D).

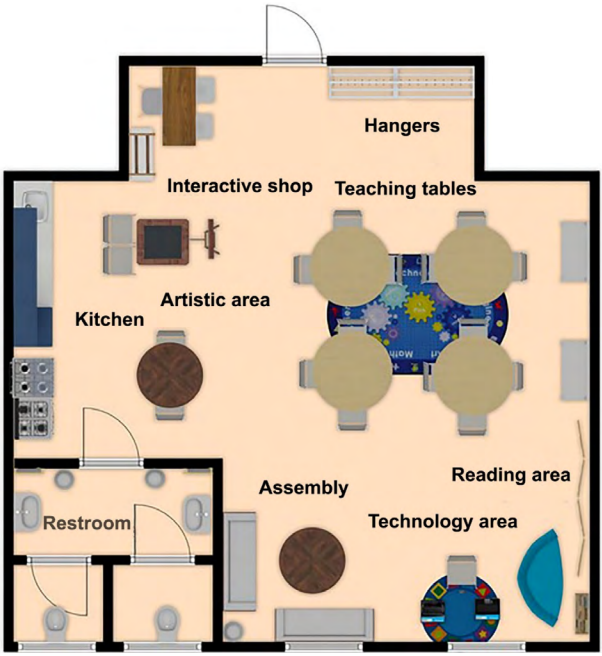



**Image 14.5.** Spatiogram (2D).

**Image 14.6.** Spatiogram (3D).

The process followed for the design of the classrooms consisted in the steps described below:

1. Signing in the website of "Floorplanner" to start using its established functions.
2. Starting the spatiogram. In the homepage of "Flooplanner", the user accesses the "Projects" option, and then selects the option "Create new project".
3. Main data of the project: after clicking the "Create new project" option, the user adds those data that characterize the project (name, country, labels...).
4. Room assistant: although the tool offers a total of 3 options (room assistant, uploading floor plan and empty plan) after introducing the data of the project, the plans that were introduced in this case were created from the ideas provided by the assistant.
5. Room shapes: the shape of the spatiogram is selected based on the ideas and structures conceived by the user.
6. Dimensions: the dimensions are introduced, which will take into account the total area, height of the ceiling, Dimension A and Dimension B.
7. Room style: here begins one of the most remarkable aspects of the tool, since a large number of decoration styles are provided.
8. Educational plan: in this step, most of the work of this project is conducted. Through the control panel, the user can access different options, such as "Build", "Information", "Objects", "Finishing", etc.
9. Export image: once the educational plan is complete, the user selects the option that appears at the top right of the screen in orange ("Export Image"). Then, the user decides whether to export the image with a certain quality, i.e., in 2D or 3D, as well as the format of the image.
10. Download file (spatiogram): after exporting the image, it is necessary to go back to the control panel, as is mentioned in step 8, which includes the "Export" option. This section includes all the exports that have been made and the downloaded files.

Lastly, it is important to highlight some of the AI tools that can be used in the scope of education to create and edit images:

Midjourney, Bing, LeiaPix, Dreamstudio, Leap AI, Magician Design, PicWish, Getimg ai, StockimgAI, Removebg, and Florplanner. To create and edit videos: Boomy, Voicemod, Lovo AI, Eleven labs, Songburst AI, Adobe Podcast, and Buzz AI. With Machine Learning (automatic learning), it is possible to analyze a large amount of data and suggest adjustments in the design of classrooms in real time.

## References


Acaso, M., & Megías, C. (2013). *"rEDUvolution": hacer la revolución en la educación*. Paidós.

Barret, P., Davie F., Zhang, Y., & Barrett, L. (2017). The holistic impact of classroom spaces on learning in specific subjects. *Environment and Behavior*, *49*(4), 425-451. https://doi.org/10.1177/0013916516648735

Camacho, A. (2017). La arquitectura escolar: estudio de percepciones. *Revista Internacional de Educación para la Justicia Social (RIEJS)*, *6*(1), 31-56. https://doi.org/10.15366/riejs2017.6.1.002

Chacón, C.A., & Triana, D. G. (2020). *Transformación de espacios educativos desde la valoración entre estructura espacial y modelo de aprendizaje*. Universitaria Agustiniana. https://repositorio.uniagustiniana.edu.co/bitstream/handle/123456789/1637/TrianaRamon-Dolly Genci-2021.pdf?sequence=1&isAllowed=y

Cobeta, I., Sánchez, L., & Toribio, C. (2023). El Jardín Docente y Aula de Emprendimiento crəalab Pinto. In M. L. Sein-Echaluce Lacleta, A. Fidalgo Blanco, & F. J. García-Peñalvo (2023). I*nnovación educativa en los tiempos de la inteligencia artificial. Actas del VII Congreso Internacional sobre Aprendizaje, Innovación y Cooperación.* CINAIC 2023 (18-20 de octubre de 2023, Madrid, España). Universidad de Zaragoza. https://doi.org/10.26754/CINAIC.2023.0090

Daniels, H., Leadbetter, J., Warmington, P., Edwards, A., Martin, D., Popova, A., & Brown, S. (2007). Learning in and for multi-agency working. *Oxford Review of Education*, *33*(4), 521-538. https://doi.org/10.1080/03054980701450811

Decreto 149/2009, de 12 de mayo, por el que se regulan los centros que imparten el primer ciclo de la educación infantil. Comunidad Autónoma de Andalucía, *BOJA* número 92, de 15 de mayo, pp. 1-23.

Domènech, J., & Viñas, J. (2007). *La organización del espacio y del tiempo en el centro educativo*. Graó.

Durá-Gúrpide, I. (2016). La arquitectura escolar de Martorell, Bohigas y Mackay. El modelo concentrado como oportunidad educativa. *Ra. Revista de Arquitectura. 18*, 71-80. https://doi.org/10.15581/014.18.71-80

EDUCAUSE. (2023). *Horizon Report*. Teaching and Learning Edition.

Estupiñán, J., Leyva, M. Y., Peñafiel, A. J., & El Assafiri, Y. (2021). Inteligencia artificial y propiedad intelectual. *Universidad y Sociedad, 13*(S3), 362-368. https://rus.ucf.edu.cu/index.php/rus/article/view/2490

Fraser, B. J. (2018). Milestones in the evolution of the learning environments field over the past three decades. In D.B. Zandvliet, & B. Fraser (Eds.). *Thirty Years of Learning Environments* (pp. 1-19). Educational Research E-Books Online. Brill Sense.

González-Calvo, G., Martínez-Álvarez, L., & Hortigüela-Alcalá, D. (2018). La influencia de los espacios para el desarrollo del proceso de enseñanza/aprendizaje en educación física: una perspectiva autoetnográfica. *Retos: Nuevas Tendencias en Educación Física, Deporte y Recreación*, *34*, 317-322. https://doi.org/10.47197/retos.v0i34.63672

González-Zamar, M. D., & Abad Segura, E. (2020). Diseño del espacio educativo universitario su impacto en el proceso académico: análisis de tendencias. *Revista Estilos de Aprendizaje, 13*(25), 25, 1-13. https://doi.org/10.55777/rea.v13i25.1512

Hutchins D. (2017). *How Artificial Intelligence is Boosting Personalization in Higher Education*. EdTech. https://bit.ly/2ZmCgyM

Iglesias, M.L. (2008). Observación y evaluación del ambiente de aprendizaje en educación infantil: dimensiones y variables a considerar. *Revista Iberoamericana de Educación, 47*, 49-70. https://rieoei.org/historico/documentos/rie47a03.pdf

Lin-Siegler, X., Dweck, C., & Cohen, G. (2016). Instructional interventions that motivate classroom learning. *Journal of Educational Psychology, 108*(3), 295-299. https://doi.org/10.1037/edu0000124

López-Forniés, I., and Asión-Suñer, L. (2023). Enhancing industrial design creativity through Artificial Intelligence: Insights from a study on human-machine co-creation. In M. L. Sein-Echaluce Lacleta, A. Fidalgo Blanco, & F. J. García-Peñalvo (2023). *Innovación educativa en los tiempos de la inteligencia artificial*. Actas del VII Congreso Internacional sobre Aprendizaje, Innovación y Cooperación. CINAIC 2023 (18-20 de octubre de 2023, Madrid, España). Universidad de Zaragoza. https://doi.org/10.26754/CINAIC.2023.0103

Madrid, D., & Mayorga, M. J. (2012). Importancia de los espacios. In D. Madrid Vivar, & M. José Mayorga Fernández (Coords.). *La organi-*

*zación del espacio en el aula infantil: de la teoría a las experiencias prácticas* (pp. 33-47). Octaedro.

Marqués Cobeta, N. (2023). La inteligencia artificial y la educación. In M. L. Sein-Echaluce Lacleta, A. Fidalgo Blanco, & F. J. García-Peñalvo (2023). *Innovación educativa en los tiempos de la inteligencia artificial.* Actas del VII Congreso Internacional sobre Aprendizaje, Innovación y Cooperación. CINAIC 2023 (18-20 de octubre de 2023, Madrid, España). Universidad de Zaragoza. https://doi.org/10.26754/CINAIC.2023.0002

Maxwell, L. E. (2016). School building condition, social climate, student attendance and academic achievement: A mediation model. *Journal of Environmental Psychology*, *46*, 206-216. https://doi.org/10.1016/j.jenvp.2016.04.009

Montiel-Ruiz, F. J., & López-Ruiz, M. (2023). Inteligencia artificial como recurso docente en un colegio rural agrupado. *RiiTE. Revista Interuniversitaria de Investigación en Tecnología Educativa*, *15*, 28-40. https://doi.org/10.6018/riite.592031

Navarro, S. N. (2018). Obras generadas por algoritmos. En torno a su posible protección jurídica. *Revista de Derecho Civil*, *5*(2), 273-291. https://nreg.es/ojs/index.php/RDC/article/view/310

Oblinger, D. (2005). Leading the transition from classrooms to learning spaces. *Educause Quarterly*, *28*(1), 14-18. https://er.educause.edu/-/media/files/article-downloads/eqm0512.pdf

Peñaherrera Acurio, W. P., Cunuhay Cuchipe, W. C., Nata Castro, D. J., & Moreira Zamora, L. E. (2022). Implementación de la inteligencia artificial (IA) como recurso educativo. *Recimundo*, *6*(2), 402-413. https://doi.org/10.26820/recimundo/6.(2).abr.2022.402-413

Pimienta, S. X., & Mosquera-Martínez, M. L. (2022). Consideraciones curriculares, tecnológicas y pedagógicas para la transición al nuevo modelo educativo en el campo de la salud soportado por inteligencia artificial (IA). *Medicina*, *43*(4). https://doi.org/10.56050/01205498.1644

Prendes-Espinosa, M.P. (2023). La revolución de la inteligencia artificial en tiempos de negacionismo tecnológico. *RiiTE. Revista Interuniversitaria en Investigación en Tecnología Educativa*, *15*, 1-15. https://doi.org/10.6018/riite.594461

Real Decreto 132/2010, de 12 de febrero, por el que se establecen los requisitos mínimos de los centros que impartan las enseñanzas del segundo ciclo de la educación infantil, la educación primaria y la educación secundaria. Ministerio de Educación, *BOE* número 62, de 12 de marzo de 2010. Referencia: BOE-A-2010-4132, pp. 1-13.

Shernoff, D. J., Ruzek, E. A., & Sinha, S. (2017). The influence of the high school classroom envi-ronment on learning as mediated by student engagement. *School Psychology International*, *38*(2), 201-218. https://doi.org/10.1177/0143034316666413

Tse, H. M., Learoyd-Smith, S., Stables, A., & Daniels, H. (2015). Continuity and conflict in school design: a case studyfrom building schools for the future. *Intelligent Buildings International*, *7*(2-3), 64-82. https://doi.org/ 10.1080/17508975.2014.927349

Urda, L., & Leal Laredo, P. (2017). La arquitectura, una aliada en la educación. *Ruta Maestra*, *17*, 49-54. https://oa.upm.es/50307/1/INVE_MEM_2017_273354.pdf

# 15

# New Technologies Applied to the Improvement of Human Anatomy Learning

PhD Soledad Aguado-Henche
Universidad de Alcalá, Spain
soledad.aguado@uah.es
https://orcid.org/0000-0003-2188-3618

PhD Rafael Moreno-Gómez-Toledano
Universidad de Alcalá, Spain
rafael.moreno@uah.es
https://orcid.org/0000-0002-4834-289X

PhD Ana María Slocker de Arce
Universidad de Alcalá, Spain
ana.slocker@uah.es
https://orcid.org/0000-0001-5992-2999

PhD Gabriel de Arriba de la Fuente
Universidad de Alcalá, Spain
gabriel.arriba@uah.es
https://orcid.org/0000-0001-6626-623X

PhD Miguel A. Ortega
Universidad de Alcalá, Spain
miguelangel.ortega@uah.es
https://orcid.org/0000-0003-2588-1708

PhD Soledad Cristóbal Aguado
Universidad de Alcalá, Spain
Hospital Universitario Príncipe de Asturias, Spain
soledad.cristobal@uah.es
https://orcid.org/0009-0006-5199-9557

PhD Mónica Grande Alonso
Universidad de Alcalá, Spain
monica.grande@uah.es
https://orcid.org/0000-0002-1056-7305

https://doi.org/10.36006/09643-1-15 

**Abstract**
The present chapter aims to explore the new digital tools applied to enhance teaching in the field of anatomy. Thus, tools such as the virtual dissection table for human bodies, interactive anatomical atlases, supplementary virtual material to traditional textbooks, and platforms for interacting with students in class, among others, will be thoroughly analyzed to assess the possibilities that new technologies offer to health science students in the 21st century.

**Keywords:** anatomy, teaching innovation, Artificial Intelligence, new technologies.

## 15.1. Historical Context of Anatomy Education

Since its inception, the learning of anatomy has embraced pedagogical models imposed by society. Over time, teaching strategies for this discipline have evolved in accordance with different educational paradigms, primarily focusing on cadaver dissection. The use of wax to model figures has ancient origins, especially in the artistic field, initially employed for the creation of objects with religious significance, such as statues of saints and nativity scenes.

At present, our legal system lacks specific and systematic regulation governing the donation of cadavers for educational and research purposes in Human Anatomy, although there is regulation for other activities related to cadavers. Anatomical practices are currently governed by various technical documents such as the Barcelona Act of 1996 and the Madrid Act of 2015, both developed by the Spanish Anatomical Society.

Throughout the early 20th century, a modern period for anatomy, following the discovery and description of all anatomical organs and structures in the human body, a technological race began for the visualization of structures or organs of living humans, i.e., bioscopic anatomy. This era includes milestones such as Roblat obtaining the first image through nuclear magnetic resonance in 1948, Ian Donald's development of echography (1950), and Computed Tomography developed by Hounsfield in 1967. In 1990, the German scientist Gunther Von Hagens successfully plastinated his first human body through a process known as plastination. In this process, water is extracted from

the body using cold acetone, and then it is replaced with a hard-enable plastic solution (Zurdo, 2007). Despite all this, until very recently, the most accessible aid for anatomy students has been anatomical atlases in paper form, with Eduard Pernkopff's Atlas of Human Anatomy (1888-1955) considered the most perfected (Hildebrandt, 2009).

The rapid development of science and technology in the last half of the 20th century has also been incorporated into the study and teaching of anatomy, influencing the institutions where it is taught and the methods of knowledge transmission (Araujo-Cuauro, 2018). In 1991, an online resource for the training of surgeons and anatomy students emerged; it was an interactive atlas with high-resolution three-dimensional images, known as the 'Vesalius Project' (Mccracken & Spurgeon, 1991). Many other atlases have followed suit since the introduction of this project.

In the teaching and learning of this basic science, the current 21st century has witnessed methods based on group work, anatomical software enabling virtual dissection, body painting anatomy, body projection anatomy, and palpation anatomy, among others. All of this is within the context of teaching to learn a 'living anatomy,' a dynamic anatomy based on both virtual and real-world realities.

Visual information in anatomical education is crucial, transitioning from 2D materials with static two-dimensional images (anatomical atlases, slides, etc.) to 3D visualization technologies, considering the human body as a three-dimensional spatial form. In this regard, an example is the integration of 3D videos (with visual and auditory information) as auxiliary teaching tools in current curricula, as it could be beneficial in enhancing students' understanding of spatial relationships among different structures and their reasoning skills (Bernard et al., 2020). Prior to the emergence of 3D videos, this issue has been partially addressed using commercial synthetic disassemblable models or plastination models. However, it is important to note that virtual reality contributes to anatomy education, but manipulating a living human body or cadaver, in most cases, has no possible substitute. Therefore, while virtual reality serves as an excellent didactic method, it remains a complementary alternative to the traditional method of dissection (Araujo-Cuauro, 2018).

Now the question is: Are these methods preferred by students over traditional methods? (Grignon & Duparc, 2021). According to the work of García-Barrios and colleagues, specifically in the Medicine Degree, students, even with the aid of modern tools, still prefer to practice with cadavers (García-Barrios et al., 2023).

## 15.2. Artificial Intelligence in Anatomy

### Definition and available evidence of AI usage

AI is defined as the capability of machines to use algorithms, learn from data, and apply that learning in decision-making, akin to a human being (Rouhiainen, 2018). Currently, AI is considered a powerful tool with multiple applications, ranging from the financial world to education, and extending to its use in clinical settings (Chan & Zary, 2019). It is being utilized as a support for the study and practice of anatomy, as evidenced by the work of Ghosh (2022) and Moro (2023). So much so that Tolsgaard and colleagues, in the past year, determined that the use of AI is more widespread than other technologies in terms of learning and assessment (Tolsgaard et al., 2023).

The study of anatomy is crucial for diagnosis and treatment across all healthcare professions. Students in medical undergraduate and postgraduate programs, as well as medical professionals, regard macroscopic anatomy as fundamental. This significance arises from the fact that surgical procedures and other invasive interventions require anatomical knowledge for proper execution, making this field the cornerstone of medical education. The study of anatomy has often been perceived as tedious by students, mainly due to outdated teaching approaches. While the most effective teaching method has not been definitively determined, success is known to lie in the integration of multimodal methods in learning.

In recent years, numerous studies have explored the various applications of AI in medical education, leading to the conclusion that one of its most valuable features is the ability to identify specific knowledge gaps in each student and assist in reinforcing learning in those areas. This proves particularly beneficial for students with special needs. Additionally, the integration

of AI in health sciences education has been observed not only to enhance the teaching of the subject matter but also to increase student engagement, indirectly fostering greater motivation and satisfaction with the learning process (Bayne, 2015; Holmes et al., 2019; Savage, 2021).

A study published in 2022 identifies several advantages of implementing AI in the education of medical students. Firstly, it promotes self-directed learning tailored to the individual needs of each student. Secondly, it reduces the resources required for effective learning. Additionally, the learning process is characterized by greater depth, divergence, and a reduction in errors, thereby enabling efficient problem-solving. Other benefits include the use of automated and remotely controlled systems capable of storing vast amounts of valuable data. Finally, this methodology is considered user-friendly for the newer generations (Abdellatif et al., 2022).

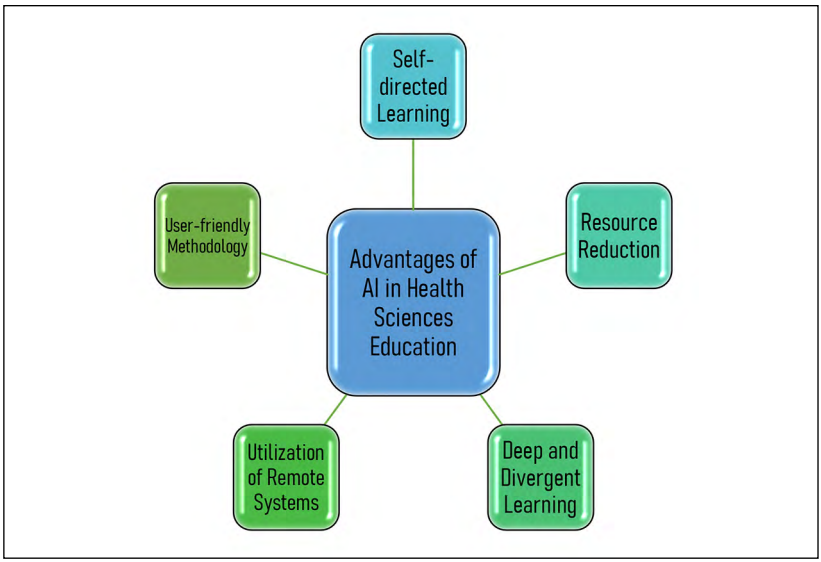



**Figure 15.1.** Diagram outlining the advantages of AI application in medical student education based on the study by Abdellatif and colleagues in 2022.

Among the tools currently propelled by Artificial Intelligence (AI), we encounter Virtual Reality (VR), Augmented Reality (AR), and Robotics (Sousa et al., 2021). The distinction between VR and AR lies in the fact that VR illustrates anatomical structures

on mobile devices without a connection to the real world, whereas AR contextualizes these images in our lived environment, resulting in a more impactful experience. Both tools signify a shift in the anatomy learning process, involving increased student interaction with a subject that has often been considered theoretical, challenging, and static. AR and VR provide enhanced visualization of specific complex anatomical structures and body regions. Although they seem to contribute to improved learning, it is crucial to conduct well-designed research studies analyzing academic performance and student satisfaction when utilizing these tools (Bölek et al., 2021; Chytas et al., 2020; Karbasi & Niakan Kalhori, 2020; Mendez-Lopez et al., 2022).

Historically, the learning of human anatomy has been grounded in cadaveric models, proving to be a valuable resource for students' learning processes. However, over the past few decades, there has been an imbalance between the supply and demand for anatomy studies. The availability of cadavers for dissection has decreased, while the number of students and institutions dedicated to the study of anatomy has been on the rise. Given this scenario, the necessity to apply AI for anatomical studies has grown, leading to the development of more sophisticated AI models, particularly highlighting artificial or convolutional neural networks. These networks have the capability to search for optimal solutions, functioning almost like a human brain, and even could plan surgeries remotely (Ramesh et al., 2004).

While this situation does not replace learning from cadaveric models, it proves to be immensely helpful as an assistant in practice. Moreover, it is imperative for teaching methods in anatomy to evolve and undergo restructuring in line with changes in educational curricula. Simultaneously, educating students in various AI tools is of great importance, as their application in clinical settings is on the rise. This approach not only enhances anatomical knowledge but also develops skills and competencies essential for professional healthcare practice (Guimarães et al., 2017; Rockarts et al., 2020).

Recent research determines that AI can be integrated into the teaching of anatomy through the development of applications for more intricate branches such as embryology or pathological anatomy. These applications can provide the option to utilize 3D models for analyzing complex dissectible structures. The im-

plementation of AI in anatomy education offers the potential for continuous feedback to students, akin to simulating clinical anatomy sessions through robotic systems that guide students in interventions, fostering self-confidence. Additionally, its application would involve the creation of an updated repository of literature, the facilitation of online self-assessments through digital tools (which will be discussed later), and the development of practical study videos for use outside the classroom (Abdellatif et al., 2022; Lazarus et al., 2022).

## Critical analysis of the impact and necessity of AI in the study of anatomy

Despite the undeniable potential positive qualities that artificial intelligences present in the future global landscape, we must not forget that these technologies are still in the developmental stage, and their subsequent results depend on the training methods employed. Therefore, numerous crucial factors in the professional and personal development of health sciences students hinge on the proper use of these technologies.

### Development and maturity of the student: critical thinking

One of the fundamental elements of higher education should be the development of critical thinking, accompanying the student in a process of intellectual maturation throughout their instruction. However, it is evident that the current educational system often emphasizes the ability to complete assessments purely reliant on memorization skills, at the expense of reasoning, comprehension, and even the ability to understand the "why" behind fundamental aspects of a subject.

In this regard, the implementation of digital tools, along with the technological revolution brought about by text processing AIs, such as chat-GPT, could entail a significant loss of one of the fundamental pillars of the educational process in higher education. If students lose the opportunity to develop their capacity for creative writing, to hone their skills in creating scientific content, and ultimately, the ability to craft academic manuscripts – which form the bedrock of intellectual progress in society – we are confronted with a problem of great complexity and magnitude.

## Social aspects

We must be aware of the kind of healthcare professionals we aim to empower; numerous aspects related to interpersonal skills, emotions, and social abilities qualitatively and quantitatively influence what could be termed a "fully qualified professional." The ability to excel in a written test is a skill that can be entirely trained in a virtual environment. However, it does not allow the student to develop all the capacities and skills required for the optimal development and execution of their future profession.

Firstly, the student-teacher relationship, in capable hands, can be a paradigm-shifting revolution for motivated students. Paraphrasing Newton, we can see farther because we stand on the shoulders of giants. A teacher with extensive professional and teaching experience has the potential to broaden the minds of their students, molding them so that successive generations of healthcare professionals become increasingly competent. This almost relegates the educational capacity of artificial intelligences to a nearly anecdotal level. Human relationships, in general terms, and especially in professions such as medicine or nursing, constitute one of the central axes of the profession. Trust between healthcare provider and patient, human interaction, the ability for empathy, dialogue, and emotional support are fundamental aspects acquired and developed through human interaction.

Furthermore, in the context of anatomy, there is another fundamental element that is currently impossible to replace with AI: anatomical dissection. Human dissection involves a real connection with the human body, accompanied by a set of ethical aspects related to the relationship between the student and the donor. Such activities not only enhance teamwork but also help develop crucial competencies, such as self-reflection or "detached concern"[1] through emotional interaction with the donor (Böckers, 2020; Cornwall et al., 2023). Ultimately, for many students, it is their first clinical encounter with death, which undoubtedly brings benefits to their future professional development. While it is true that practice might be a stress-inducing element for the student, evidence suggests that the most intense reactions occur in anticipation (Böckers, 2020). In any case,

1. Describes the effort of medical professionals/students to "care" for the patient/body donor, but yet "not get too close". (Böckers, 2020)

there are currently no substitutes that can match the benefits of dissection (Romo-Barrientos et al., 2020).

## 15.3. Digital Tools for Learning Improvement

### Virtual anatomical dissection tables

Recently, a life-sized computerized table has been designed, integrating Computed Tomography, X-rays, Ultrasound, and Magnetic Resonance Imaging to generate stereoscopic images of various parts of the human body. This innovative tool, known as Anatomage (3D Anatomy and Physiology Simulation Systems Anatomage), facilitates virtual dissection and reconstruction of the human body. Through a fully interactive multitouch screen, students can dissect the body, navigating through layers of tissue or using a virtual knife to cut and visualize internal structures. The precise details and rich content it provides capture the attention and interest of students. Moreover, it finds extensive applications in surgical education (García-Martín et al., 2018).

In a study conducted in the USA, the effectiveness of learning anatomy for specific body regions using the Anatomage table was compared with traditional cadaveric dissection. The results indicated a higher level of enthusiasm and perceived learning when utilizing the Anatomage table, especially in specific anatomical regions such as the musculoskeletal system of the upper and lower limbs (Baratz et al., 2019). For other authors, the combination of the virtual dissection table with traditional methods of anatomical training and the use of real cadavers enhance the effectiveness of learning in this subject (Kavvadia et al., 2023).

### Interactive 3D Atlases

Interactive 3D atlases are digital tools that enable science students to move and rotate anatomical elements, aiding in the spatial understanding of the subject (Park et al., 2019). This is made possible through the development and easy accessibility of technologies such as smartphones, tablets, and computers, which are user-friendly and typically have intuitive interfaces. Two well-known

3D atlases are 3d4Medical and Visible Body, as reflected in the work of Park et al. (2019), where the majority of the 155 analyzed students used them. It is noteworthy that, in their study, a small percentage of students did not use them due to a lack of electronic equipment, concerns about functionality, economic cost, or a perception of them as unnecessary. However, it has been observed that their combined use with traditional study materials can exhibit good synergy (Park et al., 2019), increasing student interest and empowering them to acquire skills and competencies during the learning process (Rodríguez-López et al., 2020).

### 3D Printing

3D printing technology goes beyond three-dimensional visualization, adding a tactile component to the sensory experience involved in the learning process. In the context of anatomy, human dissection allows students to develop numerous competencies and skills, as discussed in section 2.2. However, there are many anatomical structures that are difficult to access or of small size, making them challenging to study in the traditional way. Since the size limitations of 3D printing are solely based on the printing area capacity of the printer itself, anatomical models used in the educational process can be freely scaled. This is particularly advantageous in the case of human embryology, where the ability to print 3D models of different human embryonic stages and even increase the scale of the model qualitatively enhances teaching capacity, facilitating the understanding of complex processes that require three-dimensional visualization. Scientific evidence shows that students have better learning outcomes and higher satisfaction in the study of anatomy, and future perspectives point towards the enhancement of these complementary applications alongside classical methods (Ye et al., 2020).

## 15.4. Other Tools for Educational Innovation

Currently, there are other technological tools, such as various applications that promote student motivation and participation in the classroom. The most widely used and engaging tools for stu-

dents include Kahoot, Quizizz, Wooclap, and Socrative (Grzych & Schraen-Maschke, 2019). These applications are based on gamification, making them particularly attractive for theoretical subjects that may seem static, such as Anatomy.

All these tools share the common feature of utilizing a game-like format, where the teacher can pose questions and students, using their mobile devices, can answer and interact with each other in real-time. These applications bring a dynamic approach to classes, enabling the assessment of intra-class acquired knowledge, which can lead to meaningful and collaborative learning among students (Donkin & Rasmussen, 2021; Sailer & Homner, 2020; Singhal et al., 2019; Sugiura et al., 2020).

A study conducted in 2019, comparing the use of various applications mentioned earlier, revealed statistically significant differences in academic performance before and after their use on all platforms. Additionally, the learning experience for students was found to be better than in an expository class format (Orhan Göksün & Gürsoy, 2019). In line with this, Garza and colleagues observed that students exposed to activities using these platforms demonstrated better academic performance at the end of the course compared to those who did not undergo such training, and their performance could be predictive of the final grade (Garza et al., 2023).

## 15.5. Conclusions

In agreement with Winkelmann, anatomical knowledge is too crucial for future medical professionals to be left to the educational trends of the moment (Winkelmann, 2007). Regardless of the educational model, according to Professor DiDio (1920-2004), students should learn anatomy with the teacher, without the teacher, despite the teacher, and even against the teacher if necessary (DiDio, 1998).

The field of artificial intelligence has brought about a technological revolution that is currently at the forefront of expertise in every field or branch of knowledge. The convenience and immediacy of information are evident strengths of AI, but it is important to remember that they have potential negative effects on the development and maturation of students' skills and knowledge.

In essence, it is crucial to foster each student's development of their own professional identity (Cruess et al., 2014); that is, to become a well-rounded healthcare professional, encompassing technical knowledge, intellectual capacity, and maturity, as well as social skills. This is based on the premise of the "good professional" concept conveyed by the teacher, whose human interaction is essential to complete their education.

## References


Abdellatif, H., Al Mushaiqri, M., Albalushi, H., Al-Zaabi, A. A., Roychoudhury, S., & Das, S. (2022). Teaching, learning and assessing anatomy with Artificial Intelligence: The road to a better future. *International Journal of Environmental Research and Public Health, 19*(21), 1-13. https://doi.org/10.3390/ijerph192114209

Araujo-Cuauro, J. (2018). Aspectos históricos de la enseñanza de la anatomía humana desde la época primitiva hasta el siglo XXI en el desarrollo de las ciencias morfológicas. *Revista Argentina Anatomía Online, IX*(3), 87-97.

Baratz, G., Wilson-Delfosse, A. L., Singelyn, B. M., Allan, K. C., Rieth, G. E., Ratnaparkhi, R., Jenks, B. P., Carlton, C., Freeman, B. K., & Wish-Baratz, S. (2019). Evaluating the anatomage table compared to cadaveric dissection as a learning modality for gross anatomy. *Medical Science Educator, 29*, 499-506. https://doi.org/10.1007/s40670-019-00719-z

Bayne, S. (2015). Teacherbot: interventions in automated teaching. *Teaching in Higher Education, 20*(4), 455-467. https://doi.org/10.1080/13562517.2015.1020783

Bernard, F., Richard, P., Kahn, A., & Fournier, H. D. (2020). Does 3D stereoscopy support anatomical education? *Surgical and Radiologic Anatomy, 42*(7), 843-852. https://doi.org/10.1007/s00276-020-02465-z

Böckers, A. (2020). Preparing students emotionally for the human dissection experience. In Chan, L. K, & Pawlina, W. (Eds.). *Teaching Anatomy* (pp. 237-246). Springer. https://doi.org/10.1007/978-3-030-43283-6_25

Bölek, K. A., De Jong, G., & Henssen, D. (2021). The effectiveness of the use of augmented reality in anatomy education: a systematic review and meta-analysis. *Scientific Reports, 11*(1), 1-10. https://doi.org/10.1038/s41598-021-94721-4

Chan, K. S., & Zary, N. (2019). Applications and challenges of implementing Artificial Intelligence in medical education: Integrative review. *JMIR Medical Education, 5*(1), e13930. https://doi.org/10.2196/13930

Chytas, D., Johnson, E. O., Piagkou, M., Mazarakis, A., Babis, G. C., Chronopoulos, E., Nikolaou, V. S., Lazaridis, N., & Natsis, K. (2020). The role of augmented reality in anatomical education: An overview. *Annals of Anatomy, 229*, 151463. https://doi.org/10.1016/j.aanat.2020.151463

Cornwall, J., Hildebrandt, S., Champney, T. H., & Goodman, K. (2023). Ethical concerns surrounding artificial intelligence in anatomy education: Should AI human body simulations replace donors in the dissection room? *Anatomical Sciences Education, 17*(5), 937-943. https://doi.org/10.1002/ASE.2335

Cruess, R. L., Cruess, S. R., Boudreau, J. D., Snell, L., & Steinert, Y. (2014). Reframing medical education to support professional identity formation. *Academic Medicine, 89*(11), 1446-1451. https://doi.org/10.1097/ACM.0000000000000427

DiDio, L. J. A. (1998). *Tratado de anatomia aplicada* (Vol. 1). Poluss.

Donkin, R., & Rasmussen, R. (2021). Student perception and the effectiveness of Kahoot! A scoping review in histology, anatomy, and medical education. *Anatomical Sciences Education, 14*(5), 572-585. https://doi.org/10.1002/ase.2094

García-Barrios, A., Cisneros-Gimeno, A. I., & Whyte-Orozco, J. (2023). Is anatomical dissection a teaching method in decline? *Educación Médica, 24*(6), 100839. https://doi.org/10.1016/j.edumed.2023.100839

García-Martín, J., Dankloff-Mora, C., & Aguado-Henche, S. (2018). Possibilities for the use of anatomage (the anatomical real body-size table) for teaching and learning anatomy with the students. *Biomedical Journal of Scientific & Technical Research, 4*(4), 4080-4083. https://doi.org/10.26717/bjstr.2018.04.0001094

Garza, M., Olivan, S., Monleón, E., Cisneros, A. I., García-Barrios, A., Ochoa, I., Whyte, J., & Lamiquiz-Moneo, I. (2023). Performance in Kahoot! Activities as predictive of exam performance. *BMC Medical Education, 23*(1), 1-8. https://doi.org/10.1186/s12909-023-04379-x

Ghosh, S. K. (2022). The evolution of epistemological methodologies in anatomy: From antiquity to modern times. *Anatomical Record, 305*(4), 803-817. https://doi.org/10.1002/ar.24781

Grignon, B., & Duparc, F. (2021). New insights in anatomical education. *Surgical and Radiologic Anatomy, 43*(4), 467. https://doi.org/10.1007/s00276-021-02737-2

Grzych, G., & Schraen-Maschke, S. (2019). Interactive pedagogic tools: Evaluation of three assessment systems in medical education. *Annales de Biologie Clinique*, *77*(4), 429-435. https://doi.org/10.1684/abc.2019.1464

Guimarães, B., Dourado, L., Tsisar, S., Diniz, J. M., Madeira, M. D., & Ferreira, M. A. (2017). Rethinking anatomy: How to overcome challenges of medical education's evolution. *Acta Medica Portuguesa*, *30*(2), 134-140.

Hildebrandt, S. (2009). Anatomy in the Third Reich: An outline, part 3. The science and ethics of anatomy in national socialist Germany and postwar consequences. *Clinical Anatomy*, *22*(8), 906-915. https://doi.org/10.1002/ca.20874

Holmes, W., Bialik, M., & Fadel, C. (2019). Artificial Intelligence in education: Promises and implications for teaching and learning. In *Center for Curriculum Redesign* (Vol. 14, Issue 4).

Karbasi, Z., & R. Niakan Kalhori, S. (2020). Application and evaluation of virtual technologies for anatomy education to medical students: A review. *Medical Journal of The Islamic Republic of Iran*, *3*(34), 163. https://doi.org/10.47176/mjiri.34.163

Kavvadia, E.-M., Katsoula, I., Angelis, S., & Filippou, D. (2023). The anatomage table: A promising alternative in anatomy education. *Cureus*, *15*(8). https://doi.org/10.7759/cureus.43047

Lazarus, M. D., Truong, M., Douglas, P., & Selwyn, N. (2022). Artificial Intelligence and clinical anatomical education: Promises and perils. *Anatomical Sciences Education*, *January*, 1-14. https://doi.org/10.1002/ase.2221

Mccracken, T., & Spurgeon, T. L. (1991). The Vesalius Project: interactive computers in anatomical instruction. *J. Biocommun.*, *18*(2), 40-44.

Mendez-Lopez, M., Juan, M. C., Molla, R., & Fidalgo, C. (2022). Evaluation of an augmented reality application for learning neuroanatomy in psychology. *Anatomical Sciences Education*, *15*(3), 535-551. https://doi.org/10.1002/ase.2089

Moro, C. (2023). Utilizing the metaverse in anatomy and physiology. *Anatomical Sciences Education*, *16*(4), 574-581. https://doi.org/10.1002/ase.2244

Orhan Göksün, D., & Gürsoy, G. (2019). Comparing success and engagement in gamified learning experiences via Kahoot and Quizizz. *Computers and Education*, *135*(October 2018), 15-29. https://doi.org/10.1016/j.compedu.2019.02.015

Park, S., Kim, Y., Park, S., & Shin, J. A. (2019). The impacts of three-dimensional anatomical atlas on learning anatomy. *Anatomy & Cell Biology, 52*(1), 76. https://doi.org/10.5115/ACB.2019.52.1.76

Ramesh, A. N., Kambhampati, C., Monson, J. R. T., & Drew, P. J. (2004). Artificial Intelligence in medicine. *Annals of the Royal College of Surgeons of England, 86*(5), 334-338. https://doi.org/10.1308/147870804290

Rockarts, J., Brewer-Deluce, D., Shali, A., Mohialdin, V., & Wainman, B. (2020). National survey on Canadian undergraduate medical programs: The decline of the anatomical sciences in Canadian medical education. *Anatomical Sciences Education, 13*(3), 381-389. https://doi.org/10.1002/ase.1960

Rodríguez-López, E. S., Calvo-Moreno, S. O., Fernández-Pola, E. C., Fernández-Rodríguez, T., Guodemar-Pérez, J., & Ruiz-López, M. (2020). Learning musculoskeletal anatomy through new technologies: a randomized clinical trial. *Revista Latino-Americana de Enfermagem, 28*, 1-7. https://doi.org/10.1590/1518-8345.3237.3281

Romo-Barrientos, C., Criado-Álvarez, J. J., Martínez-Lorca, A., Viñuela, A., Martin-Conty, J. L., Saiz-Sanchez, D., Flores-Cuadrado, A., Ubeda-Bañon, I., Rodriguez-Martin, B., Martinez-Marcos, A., & Mohedano-Moriano, *A. (2020). Anxiety among nursing students during their first human prosection. Nurse Education Today, 85*, 104269. https://doi.org/10.1016/J.NEDT.2019.104269

Rouhiainen, L. (2018). *Inteligencia artificial. 101 cosas que debes saber hoy sobre nuestro futuro.* Alienta.

Sailer, M., & Homner, L. (2020). The gamification of learning: a meta-analysis. *Educational Psychology Review, 32*(1), 77-112. https://doi.org/10.1007/s10648-019-09498-w

Savage, T. R. (2021). Artificial Intelligence in medical education. In Academic Medicine. *Journal of the Association of American Medical Colleges, 96*(9), 1229-1230. https://doi.org/10.1097/ACM.0000000000004183

Singhal, S., Hough, J., & Cripps, D. (2019). Twelve tips for incorporating gamification into medical education. *MedEdPublish, 26*(8), 216. https://doi.org/10.15694/mep.2019.000216.1

Sousa, M. J., Mas, F. D., Pesqueira, A., Lemos, C., Verde, J. M., & Cobianchi, L. (2021). The potential of AI in health higher education to increase the students' learning outcomes. *TEM Journal, 10*(2), 488-497. https://doi.org/10.18421/TEM102-02

Sugiura, A., Kitama, T., Toyoura, M., & Mao, X. (2020). The use of augmented reality technology in medical museums. In *Teaching Anato-*

*my* (pp. 337-347). Springer. https://doi.org/10.1007/978-3-030-43283-6_34

Tolsgaard, M. G., Pusic, M. V, Sebok-Syer, S. S., Gin, B., Svendsen, M. B., Syer, M. D., Brydges, R., Cuddy, M. M., & Boscardin, C. K. (2023). The fundamentals of Artificial Intelligence in medical education research: AMEE Guide No. 156. *Medical Teacher*, *45*(6), 565-573. https://doi.org/10.1080/0142159X.2023.2180340

Winkelmann, A. (2007). Anatomical dissection as a teaching method in medical school: A review of the evidence. *Medical Education*, *41*(1), 15-22. https://doi.org/10.1111/j.1365-2929.2006.02625.x

Ye, Z., Dun, A., Jiang, H., Nie, C., Zhao, S., Wang, T., & Zhai, J. (2020). The role of 3D printed models in the teaching of human anatomy: a systematic review and meta-analysis. *BMC Medical Education*, *20*(1). https://doi.org/10.1186/S12909-020-02242-X

Zurdo, D. (2007). La plastinación de Gunther von Hagens revolución en el estudio de la anatomía. *Manual Formativo de Autores Científico-Técnicos y Académicos*, *46*, 9-22.

# Index

# Artificial Intelligence and Education

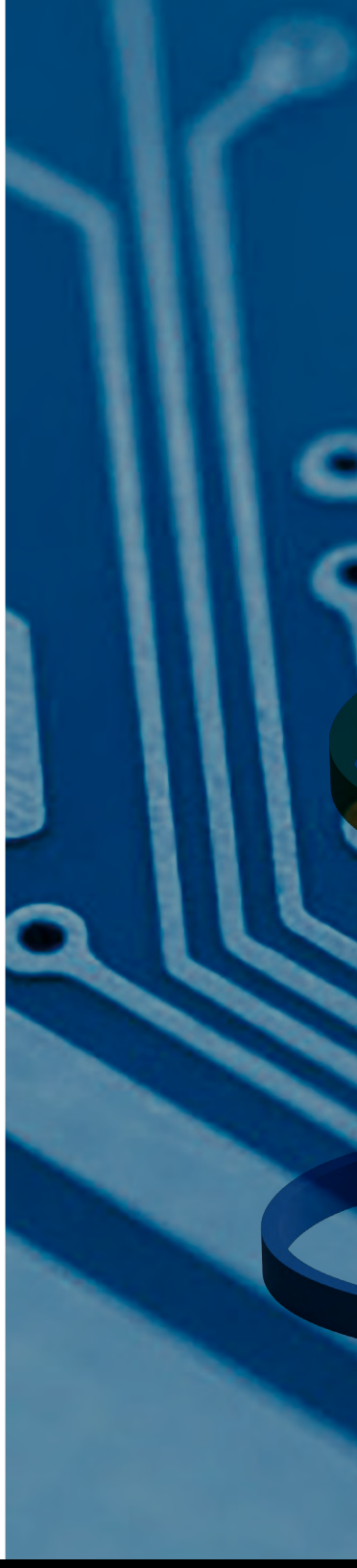
## Enhancing Human Capabilities, Protecting Rights, and Fostering Effective Collaboration between Humans and Machines in Life, Learning, and Work

This book offers a comprehensive view of how AI is transforming education, promoting accessibility and digital well-being. Through innovative studies, the book examines the responsible implementation of AI as a pedagogical tool, highlighting its inclusive potential for individuals with disabilities. With practical examples, such as the use of chatbots and digital simulations, it invites educators and developers to explore new learning methods. This work is a call to harness AI to enrich education and create a more accessible and equitable future.

**María Dolores Díaz-Noguera** is a Full-Time Professor in the Department of Didactics and Educational Organization at the University of Seville (Spain). Her teaching is closely linked to the disciplines of Educational Organization and Management. In recent years, she has made significant contributions to educational knowledge, with a particular focus on technology integration in education and educational inclusion. She has over twenty years of experience teaching doctoral courses at the University of Seville and other Andalusian universities, and has supervised numerous international doctoral theses.

**Carlos Hervás-Gómez** is a Full-Time Professor at the University of Seville (Spain), affiliated with the Faculty of Education Sciences in the Department of Didactics and Educational Organization. He teaches courses related to ICT. He is a member of the editorial boards of several journals, including the European Journal of Educational Research, International Journal of Educational Methodology, Journal of Research in Science, Mathematics and Technology Education, The European Educational Researcher, and Psychreg Journal of Psychology. His research focuses on the integration of ICT in teaching and learning processes through active and innovative methodologies, with a particular emphasis on emerging technologies and artificial intelligence in education.

**Fulgencio Sánchez-Vera** is an Assistant Professor in the Department of Didactics and School Organization at the University of La Laguna (Spain). He holds a PhD in Social and Cultural Anthropology from the University of Murcia, where he also earned a degree in Computer Engineering. Additionally, he has a Master's in Mindfulness from the University of Zaragoza and a University Expert title in Online Teaching from the International University of La Rioja. He has been a speaker at numerous courses on Educational Technology. Currently, he is the director of the journal "Cultura y Conciencia" and serves on the evaluation boards of various scientific journals. His scientific contributions include over fifty publications and participation in educational innovation and research projects, focusing on cyberspace, cyber culture, digital competence, and artificial intelligence in education.



Octaedro

Horizontes Universidad