https://doi.org/10.17163/soph.n39.2025.05

Challenges of Learning in the Age of Artificial Heuristics

Retos del aprendizaje en la era de las heurísticas artificiales

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Suggested citation: Zambrano-González, Néstor Alexander, & Vallverdú Segura, Jordi. (2025). Challenges of Learning in the Age of Artificial Heuristics. *Sophia, Colección de Filosofía de la Educación*, (39), pp. 159-193.

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Abstract

This study examines, from a philosophical-educational perspective, the fundamental keys to developing a comprehensive model of human cognition. It considers a wide range of essential variables, including the multimodality of knowledge, which highlights how different ways of understanding and processing information contribute to a more complete understanding of reality. The complementary role of languages is also addressed, recognizing that each language offers a unique perspective in the construction of knowledge. Additionally, the imitative sensorimotor foundation is explored, emphasizing the central role of imitation in learning and cognitive development, particularly in the early stages of life. Alongside this, cognitive biases are analyzed, as they influence how we perceive and process information, along with the social influence on perception, which is crucial for understanding how context and social interactions shape our cognitive experiences. The study focuses particularly on the impacts of AI-based educational chatbots, using ChatGPT as a representative case study. It emphasizes how heuristics, combined with these emerging technologies, contribute to a more adaptive and flexible learning environment, preparing individuals to face the complex challenges of the 21st century in the educational sphere.

Keywords

Cognition, Learning, Digital Technologies, Artificial Intelligence, Education, Philosophy.

Resumen

Este estudio examina, desde una perspectiva filosófico-educativa, las claves fundamentales para desarrollar un modelo integral de la cognición humana. Se considera una amplia gama de variables esenciales, entre ellas la multimodalidad del conocimiento, que destaca cómo diferentes formas de entender y procesar información contribuyen para una comprensión más completa de la realidad. También se aborda el rol complementario de los lenguajes, reconociendo que cada uno aporta una perspectiva única en la construcción del conocimiento. Además, se explora el fundamento sensomotriz imitativo, que enfatiza el papel central que tiene la imitación en el aprendizaje y el desarrollo cognitivo, en especial en las primeras etapas de la vida. Junto a esto, se analizan los sesgos cognitivos, que influyen en la manera en que percibimos y procesamos la información, así como la influencia social en la percepción, lo cual es fundamental para entender cómo el contexto y las interacciones sociales moldean nuestras experiencias cognitivas. El estudio se centra, particularmente, en los impactos de los *chatbots* educativos basados en inteligencia artificial, utilizando ChatGPT como un caso de estudio representativo. Se destaca de qué modo las heurísticas, combinadas con estas tecnologías emergentes, contribuyen a un aprendizaje más adaptativo y flexible, preparando a los individuos para enfrentar los desafíos complejos del siglo XXI en el ámbito educativo.

Palabras clave

Cognición, aprendizaje, digitalización, inteligencia artificial, educación, filosofía.

Introduction

Understanding learning processes from the cognitive sciences places this interdisciplinary field in a crucial place to reevaluate the dimension of the subject in the educational environment (Cepeda, 2021). When considering current technological advances, it is essential not only to analyze the technical aspects, but also to reflect on their philosophical and epistemological implications. In particular, the multimodality of knowledge and develop-

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Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 159-193.

ments in artificial intelligence (AI), such as generative artificial intelligence (GAI) systems, significantly influence how students process and acquire information in an increasingly digitized world. This insight is crucial when considering current dynamics, where computational advances and trained models seek to emulate the complex processes of human reasoning.

Delving deeper into this field, there are challenges that go beyond simple memorization or replication of specialized information. To move toward the successful development of models that simulate human reasoning, it is critical to understand the intricate mechanisms of cognitive processing, neural networks, and decision-making processes (Rahgooy *et al.*, 2022). These models, however, remain limited in their ability to emulate key aspects of human thinking, such as creative reasoning and contextual judgment, posing significant challenges in their educational implementation.

In this context, the aim of this paper is to investigate, from a philosophical-educational perspective, several keys that may contribute to the development of an adequate model of human cognition. This implies considering the multiheuristic nature of human thought, without neglecting the biological, psychological and social variables that influence the act of knowing. Therefore, a series of variables must be integrated, such as individual differences, social and cultural context, as well as learning environments, which influence how teaching and learning take place. These factors play a fundamental role in the way knowledge is assimilated and in the ability to apply it in real and diverse situation.

This study argues that aspects such as the multimodality of knowledge, the complementary role of languages, the imitative sensory-motor foundation, cognitive biases, social influence on perception and cognition, and the importance of multiple heuristics in the learning process are essential for designing learning systems that are functional, efficient, and satisfying for individuals, preparing them to face the educational challenges in the transformative dynamics of the 21st century. Exploring the intersection of these factors allows to advance in the creation of more adaptive educational models, capable of responding to the challenges of the digital and AI era. One example is the use of machine learning algorithms that personalize educational content for each student, such as intelligent tutoring systems. These models, which combine traditional approaches with technological innovations, are transforming education by making it more accessible and personalized.

It is worth noting that the relevance of this topic is not restricted to the fact that it is a current or fashionable discussion in contemporary times, but transcends into a complex and urgent discussion, which de-

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mands finding mechanisms that make it possible to achieve a balance between tradition and innovation and between humanity and technology. Recent developments in AI have generated new opportunities to improve educational processes, especially in access to information and in the personalization of learning. However, these technological advances also present significant limitations. Often, AI systems fail to replicate critical reasoning and human creativity, which are essential in the educational process. In addition, these systems can reinforce pre-existing biases in the data they use, posing significant challenges in the evaluation and ethical use of technologies in the classroom. A balanced approach that integrates traditional educational methods with technological innovations is critical. While technological tools can facilitate teaching, they should not replace essential human skills such as creativity, critical judgment and empathy. In this sense, technology should be seen as a complement, not a replacement, in the teaching-learning process.

Education in the 21st century must evolve to focus on the development of critical skills, creative thinking and socioemotional competencies. Educational systems must adapt to hybrid environments where technology and biology are integrated, and where advances in AI and biotechnology impact both learning and human development. This merging of technology and biology raises fundamental questions about the nature of cognition, embodiment, and human experience. For example, the use of brain-computer interfaces in the classroom suggests new forms of interaction between students and technology, which require rethinking traditional pedagogical approaches.

The article is structured in five key sections. The first provides a historical framework on the development of computer science, connecting the invention of the first algorithm with the evolution of AI up to the development of ChatGPT. The second section discusses how philosophy and education have changed since the late 19th century, with a focus on the transition to a pedagogy that incorporates digital technologies. The third section examines cognition through four key issues. The fourth section presents methodology and develops an integrated approach to learning, essential for designing effective systems that respond to the needs of the individual in an interconnected world. Finally, the last section reflects on the case of ChatGPT, highlighting its contributions and challenges in the era of artificial heuristics.

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Historical framework

In 1843, Augusta Ada Byron King, Countess of Lovelace, better known as Ada Lovelace, an English mathematician, writer and computer pioneer, developed the first algorithm intended to be processed by a machine. This groundbreaking work detailed methods for calculating Bernoulli numbers using the principles of the analytical machine of Charles Babbage, who is credited with the concept of the programmable computer.

Although Ada never saw her development in operation due to the technical limitations of the time, later studies confirmed that her algorithm would have worked correctly had it been implemented. This fact did not go unnoticed, as documented by Hammerman and Russell (2015) in an interdisciplinary work dedicated to the commemoration of the bicentennial of the birth of this inventor, highlighting her impact on computing from the Victorian era to the digital age.

Without going into every event that shapes the timeline of computer science and programming, it is worth noting that approximately one hundred years after Ada's death, AI emerged by consensus as a formal field of study. This occurred during a conference at Dartmouth College in 1956 organized by John McCarthy, Marvin Minsky, Claude Shannon, and Nathaniel Rochester.

In 1969 and 1971, respectively, McCarthy and Minsky received the Turing Award-considered «the Nobel Prize of computer science» for their contributions to AI (Abeliuk & Gutiérrez, 2021). McCarthy was recognized for creating the LISP programming language, while Minsky was awarded for his work in characterizing human psychological processes using computational ideas, both of which were fundamental to the advancement of AI.

During the 1960s, the introduction of chatbots[1] marked the emergence of GAI. These computer programs, designed to communicate with users via text or voice, seek to provide an interaction as close as possible to a real conversation[2].

In less than a century, technological advances ceased to be purely technical and began to influence various areas of human life. In 1974, T. A. Dwyer, a researcher at the University of Pittsburgh, published an article in the *International Journal of Man-Machine Studies* on the use of heuristic strategies in teaching and learning, arguing that education should unleash human potential. Although this idea may have seemed contradictory to some conservative thinkers of the time, it evidences the antiquity of the debate on human-machine relations, standing out in cognitive and educational areas.

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Nearly half a century after the formalization of the AI concept, in November 2022, the AI research lab, OpenAI®, launched ChatGPT[3]. This model interacts through a dialogue format that allows answering follow-up questions, admitting errors, questioning incorrect premises, and rejecting inappropriate requests (OpenAI®, 2022). Although ChatGPT was not created for essentially educational purposes, its impact on teaching-learning processes has been significant, thanks to its open access policies and interaction with diverse educational actors at a global level.

Leading researchers have analyzed the challenges and opportunities presented by GAI in education, considering it a catalyst for change in teaching and learning, especially in higher education (Baidoo-Anu & Ansah, 2023; Cooper, 2023; Bahroun et al., 2023; Alasadi & Baiz, 2023; Mao *et al*., 2024).

In order to continue expanding this historical framework, it is considered necessary to expand research in this regard to all levels of schooling, problematizing issues such as the design of integrative teaching-learning strategies, the strengthening of citizenship competencies, the development of critical thinking, the integration of technological resources in training and curricular configuration, reflection on systems of accompaniment and evaluation, as well as ethical issues and some associated with the socio-affective component.

Philosophy, knowledge and learning

Throughout the history of philosophical traditions, both Western and Asian, there has been a predominant focus on the content of knowledge, while methodological epistemology – i.e., the ways through which knowledge is accessed, validated and transmitted - has often been undervalued (Guba & Lincoln, 2005); in various foundational currents, such as the Socratic-Platonic theory, there was a notable lack of a rigorous methodological approach. According to this perspective, knowledge was conceived as reminiscence (*anamnesis*) of previous experiences of the immortal soul before its incarnation in the sensible world (Plato, *Menon*, 81c-86b).

In this framework, the philosopher exercised a maieutic role, acting as an «obstetrician of ideas,» whose aim was to facilitate the delivery of the latent knowledge within the interlocutor. This methodology, although innovative in its time, was frequently accompanied by narrative myths and ontological interpretations with metaphysical meaning, such as the myth of the winged chariot or the world of Ideas, which coexisted with an apparently rational and idealistic discourse (Nussbaum, 2001).

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Such elements reflect a persistent tension between reason and myth that has traversed much of the history of philosophy.

However, this classical conception presents evident limitations when confronted with contemporary developments in cognitive sciences, pedagogy and neuroscience. On the one hand, the assumption that all subjects reason following the universal laws of Aristotelian logic excludes the cultural, emotional and experiential diversity that shapes human ways of thinking (Kahneman, 2013; Damasio, 2019). On the other hand, the view that language and written texts constitute epistemological obstacles - a position held, for example, in certain passages of the *Phaedrus* - ignores the heuristic potential of language as a cognitive tool of systematization and expansion of knowledge (Bermúdez & García, 2016).

Consequently, an ambiguous methodology was historically consolidated, centered on the teacher-disciple relationship, which varied considerably according to personal dispositions, oral traditions and the sociopolitical conditions of the philosophical contexts. This form of knowledge transmission - highly performative and situated - privileged dialogical experience over pedagogical systematization, giving rise to forms of teaching highly dependent on the *ethos* of the teacher (Freire, 2018).

Therefore, it is paradoxical that despite these apparent methodological shortcomings, philosophy has been able to gestate innovative conceptual developments, many of which continue to nurture current debates on ethics, knowledge, language and education. Authors such as Dewey, Vygotsky and Piaget, by incorporating systematic methodological tools from psychology and pedagogy, were able to articulate more integrative forms of teaching, centered on active, contextualized and socially mediated learning (Bruner, 1996; Vygotsky, 1978). These currents gave rise to a pedagogy more committed to the learning process and not only to the contents learned, and laid the foundations of what is now called educational constructivism.

In this sense, contemporary philosophy of education must recover its methodological dimension not to replicate the old dogmatic schemes, but to articulate complex, transdisciplinary and ethically oriented approaches, capable of dialoguing with the challenges posed by the incorporation of AI and emerging technologies in the formative processes (Floridi, 2019; Vallor, 2016).

At the end of the 19th century -specifically between 1870 and 1900- the field of education began to undergo a profound transformation, marked by new conceptions about learning, the role of the teacher and the place of childhood in society. This evolution responded not only

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to a shift in educational philosophy, but also to social, cultural and technological tensions that challenged traditional teaching models. One of the most significant developments was the emergence of the New School Movement, initiated between 1890 and 1920, with figures such as John Dewey in the United States, Célestin Freinet in France and Ovide Decroly in Belgium. These authors advocated an active education, based on experience, the child's interest and democratic participation (Cambi, 2006; Gutek, 2013; Viñao, 2015).

In contrast to the transmissive approach, focused on memorization, the progressive model proposed a pedagogy of doing, which considered the student as the active protagonist of his or her learning. Dewey, whose central work *Democracy and Education* was published in 1916, insisted that the school should be a social laboratory, where the child was prepared for a democratic life through critical inquiry and problem solving. These ideas found echoes in the proposals of Freinet (1896-1966), who in the 1920s developed cooperative techniques of writing and free expression, and in Maria Montessori (1870-1952), who first presented her method in 1907 (Montessori, 2020; Álvarez Uría, 2019).

The expansion of compulsory education, between the 1870s and 1930s in Western Europe and North America, represented a major break with previous elitist education[4]. In France, for example, the Ferry laws (1881-1882) established free, secular and compulsory education. This process consolidated the idea that education was a social right and a tool for national development. At the same time, the advance of the Industrial Revolution (1760-1914) introduced techno-scientific pressure on school systems, which began to include technical and vocational content. Education came to play a key role in building human capital, especially after the Second Industrial Revolution (1870-1914) (Tröhler, 2011; Álvarez Uría, 1992; Depaepe, 1993).

Also the feminist movement, which gained strength during the second half of the nineteenth century, was instrumental in transforming the educational landscape. Writers such as Mary Wollstonecraft and later Simone de Beauvoir and bell hooks denounced the systematic exclusion of women from formal knowledge and demanded an education that recognized their intellectual and political agency (Hooks, 1994; Biesta, 2022; Navarro, 2004). These struggles achieved important advances in women's access to secondary and higher education, especially between the 1910s and 1930s.

Between 1880 and 1930 educational psychology was also consolidated as a scientific discipline. William James (1842-1910) published *Talks*

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to Teachers (1899), Edward Thorndike introduced principles of empirical learning from 1903 and Jean Piaget developed his theory of cognitive development between 1920 and 1950. This model was complemented by the contributions of Luria and Vygotsky, who emphasized the role of cultural and linguistic mediation in the formation of higher psychological functions (Luria, 1976; Vygotsky, 1978; Piaget, 1972; Hernández Díaz, 2011).

During the interwar period (1918-1939), innovative pedagogical proposals emerged, such as those of Edouard Claparède, Gisèle de Failly (CÉMEA) and Rudolf Steiner with Waldorf pedagogy (1919). These currents rejected mechanistic behaviorism in favor of an education centered on the integrality of the subject, including aesthetic, ethical and spiritual dimensions (Cambi, 2006; Kuhn, 2018; Escolano Benito, 2000).

Despite their theoretical impact, many of these proposals were marginally applied, facing institutional and political resistance. However, their legacy lives in current debates on inclusive curricula, critical education and holistic approaches. Finally, Paulo Freire's 1968 work *Pedagogy of the Oppressed* consolidated an emancipatory perspective of learning, based on dialogue, critical consciousness and social transformation. Freire (2018) questioned banking pedagogies, proposing an education that articulates knowledge, power and social justice (Mignolo, 2011; Viñao, 2015).

Lessons from cognition studies

From contemporary philosophy, understood not only as a speculative discipline, but as an active component of the cognitive sciences (Varela *et al.*, 1991; Vallverdú, 2011), it is possible to approach the phenomenon of learning from a holistic and integrative perspective. This approach overcomes the dichotomy between mind and body, reason and emotion, or theory and practice, to situate knowledge as an embodied, situated and socially mediated process.

While Socrates' maieutic method has been historically influential -considered one of the first systematic attempts to activate critical thinking through dialogue- it is important to recognize that much of the Western philosophical tradition has focused on the nature of knowledge (*episteme*) and its justifications, leaving in the background the strategies for its teaching and transmission (Biesta, 2022; Bruner, 1996). Consequently, although powerful theories on truth, reason or mind have been developed, there has been lacking a philosophy of education articulated with the cognitive sciences, capable of offering effective and ethically responsible models of human formation.

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The rise of cognitive sciences since the mid-twentieth century - in dialogue with neuroscience, psychology and AI - has made it possible to reconfigure learning as a complex phenomenon, involving multiple levels: biological, cultural, linguistic and affective. Within this framework, philosophy can play a key role as a meta-reflective discipline, in charge of analyzing the ontological, epistemological and axiological assumptions of educational practices (Floridi, 2019; Vallor, 2016; Menary, 2010).

This situation raises, from an ethical, social and rights perspective, the urgency of an educational revolution. As Freire (2018) argues, education cannot be neutral: either it reproduces structures of oppression, or it contributes to emancipation. To achieve the latter, it is necessary to overcome technical or instructional approaches to learning, and incorporate a critical, dialogical and transformative gaze, where the subject is seen as an epistemic and political agent. This vision coincides with what Biesta (2022) calls a «world-centered education», as opposed to an education focused on results or competencies.

Likewise, proposals such as extended cognition (Clark & Chalmers, 1998), enaction (Varela *et al*., 1991) and *blended cognition* (Vallverdú, 2019) invite us to think about learning beyond the individual brain, in constant interaction with symbolic tools, technologies, and sociocultural environments. This paradigm questions traditional forms of schooling and forces us to rethink pedagogical mediations in the era of AI, educational algorithms, and digital recommender systems (Selwyn, 2019; Luckin & Holmes, 2016).

Thus, the convergence between philosophy, cognitive sciences and critical pedagogy not only allows us to enrich our conceptions of learning, but also opens the possibility of reconstructing education as a right, as an ethical-political project and as a transformative cultural practice. A philosophically informed education is not one that simply transmits conceptual content, but one that questions the conditions of possibility of knowing, teaching and emancipating.

To this end, it is essential to consider four key questions about cognition:

1. *Why the cognitive?* The fundamental question about cognition is to understand its purpose and role in evolution. Cognition is the most crucial adaptive feature, as it allows to design responses to environmental information, minimizing exposure to negative events and maximizing positive ones (Damasio, 2019).

In humans, this adaptation is reflected in our high rate of encephalization, socialization, neoteny, and use of symbolic thinking. An essential

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component of this process is the mirror neuron mechanism, which facilitates learning through constant imitation. This mechanism is not only crucial for motor learning, but also for socialization and empathy. Furthermore, contemporary neuroscience suggests that the brain functions as a predictive system, constantly adjusting its models of reality and the actions to be performed (Seth, 2021). This conception of the brain as a predictive system is relevant for educational adaptations, especially in schoolchildren with autism (Vermeulen, 2022).

2. *Language as a place where the human cognitive is solitary.* The second fundamental key to understanding human cognition is symbolic language, as already intuited by Aristotle, who defined human beings as political animals (*zoon politikon*) and animals with *logos* (*zoon logon echon*) in his *Politics* (1253a), suggesting that language not only communicates, but also underlies rationality and community life. This conception is taken up and complexified in the twentieth century, which was, as Richard Rorty (1967) pointed out, «the century of the linguistic turn», where multiple philosophical currents placed language as a constitutive structure of thought, subjectivity and shared reality.

From the analytic tradition, Ludwig Wittgenstein was the key author of this turn. In the *Tractatus Logico-Philosophicus* (1921), he proposed that «the limits of my language are the limits of my world» (TLP 5.6), showing a representational conception of language. But in his second stage, with *Philosophical Investigations* (1953), he argued that «the meaning of a word is its use in language», shifting the focus towards a pragmatic, situated and communitarian understanding of meaning. Thus, language does not passively describe the world, but actively shapes it through its social uses (Baker & Hacker, 2009).

In continental philosophy, Heidegger argued that «language is the house of being» (*die Sprache ist das Haus des Seins*), a central assertion in *Letter on Humanism* (1947), where he stresses that language is not a mere communicative instrument, but the way in which human beings access being and interpret themselves. For Derrida (1967), language is a network of differences and displacements (*différance*) that destabilizes any claim to stable meaning. And Foucault demonstrated in *Words and Things* (1966) that language and discourse do not reflect reality, but produce regimes of truth in the service of power relations.

However, Marx had already warned that «philosophers have done nothing more than interpret the world... it is a matter of transforming it» (1845), which leads us to insist: language cannot be reduced to an end in itself, but must be understood as a tool for collective action and in-

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tersubjective coordination. From this perspective, Hannah Arendt (1958) stresses that language is the privileged medium of political action, since «acting and speaking are so closely related that they could almost be considered the same thing».

This approach is deepened by enactivist cognition, represented by Francisco Varela *et al*. (1991), who assert that knowledge «emerges through the dialogue between the body and the world». Here, language emerges as a coordination of behavioral coordinations, as Humberto Maturana would say, i.e., as an adaptive symbolic system that allows dynamic and recursive social couplings (Maturana & Varela, 1984).

Contemporary cognitive sciences validate this vision. Studies by Lera Boroditsky (2011) show how language shapes our perception of time, space and causal relationships. From sociocultural psychology, Lev Vygotsky (1978) showed that inner language forms the basis of reflective thinking and that symbolic mediation is a condition of higher cognitive development. Piaget, although from another framework, also recognized that language allows for more complex mental operations in the formal operative stage (Piaget, 1972).

In the field of education, this transformative understanding of language is taken up again in critical pedagogy. For Paulo Freire, «language does not describe reality, but creates it with and for the other» (Freire, 2018), and that is why critical literacy is an act of liberation and not mere technical learning. In this line, Gert Biesta (2022) argues that language should not be reduced to a vehicle of content, but be thought of as a space of subjectivation, of appearance in the world, of ethical relationship.

Therefore, a philosophical and cognitive understanding of language as a symbolic instrument for action, subjectivation and social coordination makes it possible to build educational practices that recognize its political, creative and formative power. This vision is crucial in a present where human language coexists and competes with the algorithmic language of automated AI systems that also produce meaning and decisions, often without critical reflection.

Language must be understood as a means to explore and model experience, which is the true goal of the cognitive process. Language is therefore not an end in itself, but an optimized vehicle for resolving foundational elements that precede and order it. It creates a metasense from the individual, and in turn connects with the sum of organized corporealities, i.e., the social. Symbolic language, in spite of its success, is nothing more than a nuance of the felt experience. As such, it should be considered in the learning process, as a means to explore and model experience,

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which is really the essential purpose of the cognitive process. Applied to the school environment, Bermúdez and García (2016) emphasize that the problematization of language is fundamental in the systematization of experiences and in the theoretical reflection of socio-educational scientific research.

3. *When does it occur?* This question addresses the optimal temporality for learning from a cognitive perspective (Zull, 2020). Human beings, with their neoteny, show a perennial willingness towards learning. Neoteny, understood as the retention of juvenile characteristics into adulthood, has been pointed out as an evolutionary key that extends cognitive plasticity and adaptive capacity, facilitating continuous learning (Björklund & Ekdahl, 2021). This distinctive property, related to the late development of the prefrontal cortex and prolonged social dependence, allows humans to modify their mental schemas according to new experiences even in adulthood.

Although childhood and adolescence are crucial stages for the development of cognitive structures, learning can continue throughout life under certain conditions. Studies in neuroscience have confirmed that synaptic plasticity, while decreasing with age, does not disappear, and can be stimulated by meaningful experiences, novelty, and emotionally relevant context (Merzenich, 2013; Morrison & Baxter, 2012).

The anecdote of Socrates learning a new melody on his deathbed - recounted by Plutarch and reinterpreted by contemporary philosophers such as Hadot (1995) - symbolizes this constant willingness to learn as an existential feature of philosophizing. Beyond its anecdotal value, this image has been recovered in philosophical pedagogy as a metaphor of «knowing in order to die», i.e., of a formative willingness that transcends utility and is based on the exercise of thought as a continuous openness (Hadot, 1995; Nussbaum, 1997).

However, adults tend to be more reluctant to change and innovation, due to factors such as cognitive crystallization, emotional resistance to error, and cultural dynamics that discourage late learning (Illeris, 2018). Despite this, adult education programs have shown that when intrinsic motivation is fostered and individual rhythms are respected, it is possible to generate profound cognitive transformations (Jarvis, 2006). Consequently, learning should be considered a transversal capacity at all ages, as long as there are conditions that stimulate interest, contextual relevance and active participation of the subject.

Understanding this phenomenon allows us to conceive learning as an innate characteristic of human beings. Considered as a decisi-

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ve stage in the life of human beings, Chávez (2019) examines in child development the anatomical and neurophysiological bases of learning, highlighting that the combination of genetic and biological condition, together with the interaction in a historical-social context, allows human beings to build and modify their knowledge and behavior. These premises synthesize the complex process of learning generation, which constitutes an essential component for the development of what this study has called: integrated learning systems.

4. *How is knowledge for action generated?* The last key question focuses on how knowledge for action is produced, also considering the fundamental role of emotions. Cognitive processes are a sum of shortcuts, strategies and heuristics based on functional biases. These biases allow us to react in situations with little data or time, which implies a selection and manipulation of reality (Kahneman & Tversky, 1979). In fact, we are incredible beings capable of combining many reasoning heuristics throughout the same day, what Vallverdú (2019) has called *blended cognition*, an element that, in the perspective of this study, is essential to face a revolution in learning processes according to current cognitive evidence. Although we have known for decades that we are emotional and heuristic beings, the multiheuristic nature of our cognition is an area yet to be explored. Interestingly, the study of these mechanisms has been driven by research in AI and robotics, leading us to reconsider our own human cognition.

In this order of ideas, it is proposed that these questions and their answers support a more science- and learner-centered education, opening new opportunities to improve educational methods and the process of knowledge acquisition.

Methodology

To address the challenges of learning in the age of artificial heuristics from a philosophical-educational perspective, this study adopts a qualitative interpretive-reflexive methodology, aimed at exploring complex phenomena linked to human cognition and its interactions with emerging technologies, such as GAI systems. This methodology is framed within a constructivist and critical paradigm that values contextual understanding, actors' subjectivity and philosophical reflection as legitimate dimensions of knowledge (Guba & Lincoln, 2005; Flick, 2018).

The research was developed under an inductive-analytical approach, supported by the triangulation of theoretical sources, previous

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empirical studies and philosophical categories, which allowed articulating findings from multiple epistemic traditions. This methodological strategy makes it possible not only to identify common patterns, but also to reveal tensions, discontinuities and emerging dilemmas in the discourses on education, cognition and technology (Tracy, 2010).

To establish the state of the art, a systematic literature review was conducted (Booth *et al.*, 2016), focusing on the educational impact of GAI, especially *chatbots* such as ChatGPT. The literature search was conducted between January 2024 and May 2024, and covered academic publications between 2018 and 2024. The databases consulted included Scopus, Web of Science, ERIC, JSTOR, and Google Scholar.

The keywords used were: "artificial intelligence in education", "chatbots in learning", "heuristics and cognition", "blended cognition", "philosophy of technology", "epistemology of education", "ChatGPT AND education", "cognitive heuristics AND learning", among others. Inclusion criteria were applied such as: peer-reviewed articles, studies with a theoretical or empirical focus, and relevance to the fields of philosophy, pedagogy or cognitive science.

After a rigorous purging process, which included the removal of duplicates and the exclusion of marginal or redundant studies, 72 articles were selected that met the criteria for quality and scholarly relevance (Nowell *et al.*, 2017).

The main technique employed was qualitative documentary analysis, which allows extracting meanings from academic texts through thematic coding and contextual interpretation (Yin, 2015). A data extraction form was designed with the following variables: authorship, year, geographic region, objective of the study, type of methodology used, main findings and links with the conceptual categories of this study.

The analysis was supported by digital tools such as Zotero for reference management and NVivo 14, which facilitated the open, axial and selective coding of the textual corpus (Saldaña, 2021). The information was organized according to six key axes:

- Multimodality of knowledge
- Complementary languages
- Imitative sensory-motor foundation
- Cognitive biases
- Social influence
- Learning heuristics

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The analytical process was articulated in three sequential phases, inspired by Braun and Clarke's thematic analysis model:

- *Initial theoretical coding*. Relevant categories were identified from key conceptual frameworks, such as *blended cognition* (Vallverdú, 2019), sensorimotor cognition (Damasio, 2019) and functional cognitive heuristics (Kahneman & Tversky, 1979).
- *Clustering and contrasting*. The findings of the reviewed studies were compared with the categories of the theoretical model. For example, we analyzed how the works of Baidoo-Anu and Ansah (2023) or Albadarin *et al*. (2024) address (or not) the affective and bodily dimension of AI-mediated learning.
- *Reflective interpretation*. A hermeneutic-critical analysis was developed from the dialogue with thinkers such as Freire (2018), Biesta (2010) and Korol (2017), who stress the need for a liberating, situated and ethical education in contexts marked by digital inequality (Brunner, 2013; Selwyn, 2019).

The choice of this approach is justified by the complex, situated and multiscale nature of the phenomenon under study. Understanding how learning occurs in hybridized human-machine scenarios cannot be reduced to performance or efficiency metrics. It requires, on the contrary, a critical look that integrates ontological, epistemological and ethical aspects of knowledge (Floridi, 2019; Vallor, 2016).

From this perspective, AI is not approached as a neutral instrument, but as an epistemic and political actor, whose influence on education must be interrogated in terms of cognitive justice, critical literacy and human agency. Thus, this methodology does not aim to generalize, but to deepen the understanding of meaning, revealing how new forms of subjectivity, mediation and knowledge emerge in the age of artificial heuristics.

An integrated approach to learning

An integrated approach to learning is essential for designing effective systems that meet the needs of individuals. In the previous sections, several keys were stated that, in the opinion of the authors of this study, help to develop an adequate model of human cognition. These keys include the multimodality of knowledge, the complementary role of languages, the imitative sensory-motor foundation, cognitive biases, the social influence on perception and cognition, and the importance of multiple heuristics

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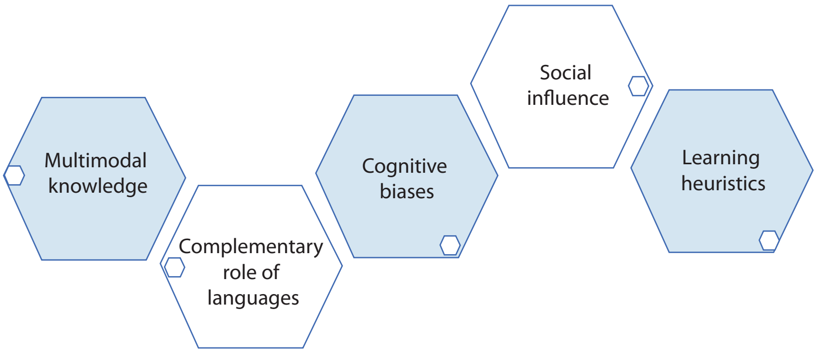
in the learning process. This section will delve deeper into each of these keys, seeking to propose the development of a comprehensive model, the backbone of which is summarized in Figure 1.

Figure 1
Keys to the integrated approach to learning



It may seem overwhelming to consider all these elements together, but this complexity reflects the true nature of human cognition. Our minds do not operate in watertight compartments, but instead work in an integrated way, using multiple sources of information and resources to process knowledge and make decisions. Therefore, a holistic approach is necessary to design systems that accurately reflect how we learn and how we can improve our learning.

Multimodality of knowledge

This aspect holds that human learning is not a unidimensional phenomenon, but involves the dynamic integration of diverse sensory and symbolic channels. This idea has been validated by both cognitive neuroscience and contemporary pedagogy, which have shown that sensory systems do not function in isolation, but in constant interaction (Shams & Seitz, 2008). Thus, sight, hearing, touch, and even smell and taste can act as complementary routes for the encoding and retrieval of information.

In education, this implies designing materials that take advantage of this sensory integration, using resources such as infographics, videos, podcasts, manipulative models and interactive activities. This proposal goes beyond a mere superficial inclusion of «multiple channels»: it is about conceiving knowledge as an embodied and distributed experience (Clark, 2011). In this way, learning becomes more robust, especially when

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it is adapted to the dominant sensory styles of the learners, favoring memory consolidation and deep understanding.

The complementary role of languages

Human learning is mediated by multiple languages, understood not only in linguistic terms, but also in semiotic, visual, symbolic and digital terms. Each language offers a particular access to reality, structuring the way we think, feel and act. According to Kress (2010), contemporary learning environments must assume a multimodal approach, where different representation systems coexist and articulate, from written text to digital animation or symbolic coding.

This conception implies recognizing the cognitive value of concept maps, visual schemes, dramatizations, music and simulations. It is not a matter of translating information from one code to another, but of allowing languages to dialogue with each other to construct complex meanings. In this sense, language is not only a means of transmitting information, but a space where the very experience of knowledge is shaped (Bakhtin, 1981). Adopting this perspective in curriculum design allows the integration of cognitive, affective and cultural dimensions of learning.

Imitative sensory-motor foundation

Learning by imitation is a foundational mechanism in human cognitive evolution. From the first weeks of life, human beings learn by observing and replicating gestures, sounds and actions of others. This phenomenon is mediated by mirror neurons, discovered by Rizzolatti *et al.* (1996), which activate motor patterns both by performing an action and by observing it performed by others. This suggests that human learning is deeply rooted in the body, motor skills and socialization.

In educational contexts, this sensory-motor dimension must be translated into practices that privilege active experimentation, manipulation, modeling, dramatization, and problem solving in real or simulated environments. The pedagogy of active learning, in this sense, is aligned with what Piaget and Vygotsky proposed as the basis for cognitive development: situated action in meaningful contexts (Tomasello, 1999).

Cognitive biases

Cognitive biases constitute mental shortcuts with an obvious adaptive function, as they allow quick responses in contexts of uncertainty; howe-

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ver, they distort perception, memory and judgment, generating systematic errors that can limit learning (Kahneman, 2011). In light of the above, training environments must incorporate specific mechanisms aimed at mitigating such distortions. This implies, on the one hand, providing objective information and, on the other, assisting students in identifying and overcoming their own biases through metacognitive strategies. Specifically, it is recommended to make biases visible through the contrasting presentation of examples and counter-examples; encourage critical reasoning through argumentative debate and dialogic feedback; and resort to explainable AI systems capable of detecting biased patterns in learners' responses and offering personalized corrections (Rahwan *et al*., 2019).

Social influence

Social influence must be considered because individual cognition is shaped, to a large extent, by interaction with others. Beliefs and knowledge emerge, are validated, or are transformed within the framework of such interactions. Consequently, learning systems must favor structured collaboration, regulated debate and participation in communities of practice, strategies that, if well managed, enrich the collective construction of knowledge. However, these same dynamics can lead to the emergence of networks of weak rhetoric or uncritical conformity; hence the desirability of establishing explicit rules of discussion and moderation to avoid *ad populum* fallacies and group pressures (Frankfurt, 2005).

Learning heuristics

Learning heuristics -understood as empirical rules of thumb that simplify decision making and reduce cognitive load- play a relevant role in structuring formative experiences (Thaler & Sunstein, 2009). The deliberate integration of such heuristics enables efficient learning without reducing conceptual depth. Relevant applications include:

- The decomposition of complex tasks into manageable subtasks.
- The introduction of prototypical examples as an initial anchor for theory.
- The provision of immediate feedback that reinforces appropriate heuristics and corrects inappropriate ones.

This orientation is congruent with the constructivist approach, according to which knowledge is actively constructed through experien-

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ce, reflection and social interaction (Ortiz Granja, 2015; Fosnot, 2013; Vygotsky, 1978).

Based on the above, it can be stated that an integrated approach to learning should reflect the adaptive, distributed, multimodal and heuristic nature of human cognition (Anderson, 2010). Overcoming linear models of transmission requires articulating sensory perception, symbolic reasoning, social interaction and contextual decision making. Jointly recognizing the multimodality of knowledge, the imitative sensory-motor foundation, cognitive biases, social influence and learning heuristics allows to design more functional and subject-centered educational environments. Moreover, this perspective is consistent with findings from neuroscience, pedagogy and philosophy of mind (Immordino-Yang and Damasio, 2007; Clark, 2011; Sawyer, 2014) and responds to the contemporary need to educate individuals capable of acting in complex, uncertain and changing contexts. In short, educating in the understanding of one's own cognitive limits, as well as in the strategic use of available heuristics, enables learners to develop mental flexibility, ethical judgment and creativity, necessary requirements in the dynamics of the 21st century.

The challenges of learning in the age of artificial heuristics based on ChatGPT

One last crucial point remains to be considered in the integration of cognitive learning, which is directly related to the hybrid human-machine informational contexts that we are currently experiencing. In the information age, we are immersed in a tsunami of data, an avalanche of information that complicates the learning process. At the same time, AI is being integrated into the educational and work systems of millions of people.

What should a human really know, and does it make sense to insist on memorization and use of limited practices that are, in fact, no longer used in real competitive environments? Hybrid epistemic environments, assisted by computational systems, challenge many elements of previous educational paradigms (Papert, 2020). The competencies must be reconsidered under the reality of current knowledge production systems. We must remember that they start from the physical and sensory-motor experience of a being that labels the world from its shared needs, fears and dreams. Paleolithic minds for a present of technological gods, to paraphrase E. O. Wilson. Trying to overcome these challenges, it is necessary to reconsider what members of the human species should learn, not forgetting the educational challenges of the transhumanist revolution that

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will radically transform our understanding of cognition, embodiment, experience and knowledge.

The increasing incorporation of AI in contemporary educational systems raises a number of philosophical challenges that require deep reflection. According to Floridi (2019), AI is transforming not only access to knowledge, but also the very nature of knowledge, raising questions about how we define and validate what students learn. In a context where digital technologies reshape the educational experience, Selwyn (2019) cautions that we must carefully assess the extent to which machines can replace teachers without compromising the fundamental human relationship in teaching.

Likewise, Vallor (2016) proposes that the adoption of AI in education should be guided by an ethical reflection on human virtues, ensuring that these technologies promote the holistic well-being of students, rather than reducing education to a simple transfer of information. In this sense, AI should not only be seen as a tool to improve learning efficiency, but also as a means to develop ethical and reflective skills, crucial in the 21st century.

Today, humanity is facing unprecedented educational challenges, especially with regard to the integration of AI and technology in the learning process. These challenges not only affect traditional teaching methods, but also raise fundamental questions about the very purpose and nature of education in the era of machine learning systems such as ChatGPT, as evidenced by findings derived from recent systematic literature reviews (Labadze *et al*., 2023).

The impact of ChatGPT and similar technologies on educational processes is significant and presents both benefits and challenges (Baidoo-Anu & Ansah, 2023). Some of these are discussed below, grouped as pros and cons.

On the one hand, the benefits include immediate access to a wealth of information and online resources, facilitating research and efficient learning on a wide variety of topics. In addition, AI-based educational *chatbots*, such as ChatGPT, can provide tutorials and personalized responses to student questions, enabling individualized attention that is difficult to achieve in a traditional classroom setting. These *chatbots* also provide interactive, hands-on learning experiences, such as simulating science experiments or performing math exercises, increasing engagement and understanding. In addition, ChatGPT facilitates self-directed learning, allowing students to search for answers and learn independently outside the classroom, fostering autonomy and responsibility in learning.

However, the integration of AI should not be detached from broader philosophical problematics about knowledge and subjectivity in La-

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tin American contexts. Brunner (2013) stresses that globalization and digitization are transforming education in Latin America, requiring critical reflection on how emerging technologies interact with local educational systems. Along these lines, Korol (2017) and Mignolo (2011) emphasize the importance of critical thinking and emancipatory education to prevent technology from reinforcing colonial power structures. Biesta (2010) warns that, in an era marked by measurement and automation, education must focus on the development of autonomy and ethical judgment, aspects that cannot be replaced by AI. These philosophical perspectives underscore the need for AI to complement, rather than replace, human interactions and critical thinking in the educational process.

On the other hand, there are challenges to this approach. An over-reliance on ChatGPT for answers may limit the development of critical thinking skills and the ability to solve problems independently, which could lead to shallow learning (Baidoo-Anu & Ansah, 2023). The automation of teaching through *chatbots* raises questions about the future role of teachers. If teachers become less necessary due to technology, this could negatively affect the quality of education in terms of human interaction and emotional support (Selwyn, 2019).

In addition, the information provided by ChatGPT is not always accurate or reliable. Several studies have documented errors called «hallucinations»-plausible but incorrect responses generated by language models-as a significant limitation to its rigorous educational use (Bender *et al*., 2021). This could impair students' comprehension and knowledge by receiving incorrect answers or biased information. Finally, interaction with *chatbots* does not contribute to the development of social and emotional skills that students gain through human interaction, this being especially important in early education and in teaching social-emotional skills (Holmes *et al*., 2019).

To the above, it is worth adding intrinsic problems of large-scale language models (LLMs), such as the aforementioned hallucination and data cannibalism, the phenomenon in which the model recycles training content without generating new knowledge, which limits its capacity for conceptual innovation (Bommasani *et al*., 2021).

The impact of ChatGPT on education has the potential to improve access to information, personalize teaching, and foster autonomous learning (Mao *et al*., 2024). However, it also presents challenges related to over-reliance, information credibility, teacher-student relationship, and social skills development. The key is to use these technologies in a balanced way and consider how they complement, rather than replace, traditional education (Vallor, 2016).

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In response to these tensions between the benefits and risks of using AI in education, in March 2023, a consortium of leading UK universities, including Oxford, Cambridge, and Imperial College London, established five guiding principles for the ethical use of GAI. These principles seek to promote the responsible use of AI while ensuring academic integrity. They include supporting students and staff to become AI literate, adapting teaching and assessment methods, and ensuring equal access to AI technology. The agreement represents a change in attitude towards AI, recognizing its potential impact on education.

However, it is worth remembering that prior to the establishment of these principles, some universities had banned the use of AI due to concerns about plagiarism and academic fraud (THE, 2023). In a turbulent context, this initiative came just four months after, in March 2023, several UK universities - including some associated with the Russell Group - completely banned the use of AI, warning that students caught using it would be expelled. Moreover, in April of the same year, some of these universities stated their intention not to use Turnitin, claiming that its new AI-based plagiarism detection system could emit false positives (*The Guardian*, 2023). With the new agreement, UK universities committed to incorporate the ethical use of AI in teaching and assessment as an opportunity, not a threat.

Another notable challenge is the information overload to which students are exposed. We live in an era of data abundance, where the constant flow of information available online can be as harmful as it is useful. This «infoxication» can lead to cognitive fatigue and difficulty in discerning relevant and reliable sources (Bawden & Robinson, 2009). Educators face the task of teaching students to critically navigate through this flood of data, evaluate the credibility of sources, and develop digital critical thinking (McGrew *et al*., 2018).

The incorporation of AI and automation in education raises questions about the future role of teachers. How does the teacher-student dynamic change when AI takes on active roles in teaching and assessment? How are essential human qualities, such as empathy and personalized guidance, preserved in environments increasingly mediated by algorithms (Holmes *et al*., 2019; Selwyn, 2019)?

The question of what a human should actually know in the age of AI is fundamental. If much of factual knowledge is at the click of a button, education must focus on the development of higher skills: critical thinking, problem solving, creativity, and socioemotional skills, difficult to replicate by machines (Brynjolfsson & McAfee, 2014; Nussbaum, 1997).

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Moreover, the transhumanist revolution, looming on the horizon, raises even deeper questions. How will the merger between technology and biology affect our understanding of cognition and embodiment? How will the human experience change as the boundaries between the biological and the artificial become blurred (Bostrom, 2014)?

Considering the above, this study reaffirms that education in the age of AI and the technological revolution is not only about acquiring information, but also about cultivating adaptive capacity, critical thinking, and deep understanding about complex phenomena. Educators and institutions must be willing to evolve and reinvent themselves to prepare future generations for an ever-changing world. The task of balancing tradition with innovation, and humanity with technology will be one of the great challenges -and also opportunities- for education in the 21st century (Vallor, 2016; Floridi, 2019).

Ultimately, in the era of ChatGPT it is expected that assessment will cease to be synonymous with verifying the ability to retain information, and become a process focused on the development of higher intellectual capacities: processing, appropriating, refuting, adapting and applying knowledge in real and diverse contexts.

Reflections from the educational perspective regarding the design of integrated learning systems

From the educational perspective, the transformative dynamics of the 21st century demand a reconceptualization of the design of integrated learning systems, especially in relation to technology. These transformations respond to a combination of factors: accelerating digitization, the emergence of new epistemologies, and the need to prepare learners for complex sociotechnical contexts (Selwyn, 2016; Luckin & Holemes, 2016). For decades, educational technology has been addressed from an instrumental approach, focused on its technical-operational and infrastructural dimensions, without significant integration into pedagogical processes (Cuban, 2001).

Moreover, in many cases, technology has been perceived as a threat to the role of the teacher, especially when associated with automation or disintermediation of traditionally human functions (Holmes *et al*., 2019). This vision has defended a hierarchical structure in which the teacher remains an authority figure and possessor of knowledge and truth, heir to a banking model of education (Freire, 2018).

However, it is necessary to move towards a horizontal and dialogic perspective, in which the participants of the educational act interact with the available information, mediated and enriched by the professional

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knowledge of the teacher. This reconfiguration is aligned with pedagogical approaches focused on dialogue, co-construction of meanings and critical citizenship (Biesta, 2010; Freire, 2018). Such active participation allows improving the ability to interpret, contrast, evaluate and critically position oneself in the face of complex phenomena.

It is important to remember that humans are social beings, and that our capacity for abstract reasoning and symbolic thinking distinguishes us evolutionarily from other species (Tomasello, 1999; Damasio, 2019). Therefore, any results obtained from our interactions with educational chatbots should invite us to reflect on the mechanisms by which algorithms cross-reference data to generate responses in a matter of seconds, including and excluding certain sources and variables: processes that are neither neutral nor opaque by chance, but the result of human decisions encoded in automatic systems (Bender *et al*., 2021; Crawford, 2021).

We must optimize the use of these technological resources by learning to ask questions, cross-examine, triangulate, confirm and discard data. This implies critical digital literacy, not only in technical use, but in the ethical and epistemological understanding of how AI works (George Reyes & Avello Martínez, 2021). It is also crucial to be aware of its computational limitations -such as training biases, algorithmic opacity, or «hallucinations»- as well as its socioemotional implications in the educational relationship (Zhai, 2022).

As teachers and researchers, it should be advocated that the approach towards AI and automation in education should move away from prohibitionism, denialism and reductionism, and promote an interdisciplinary discussion based on the knowledge of these resources. As Zhai (2022) points out, although AI can perform tasks such as writing a coherent and accurate academic paper, it cannot replace creativity and critical thinking, nor can it replace the richness of human social interactions that impact the affective component and the physical and mental health of participants in educational processes.

The challenges of learning in the era of artificial heuristics are not limited to the instrumental mastery of technological resources, but demand, taking up the words of George Reyes and Avello Martínez (2021), «to reconceptualize the term digital literacy from different angles as a way to understand what skills are needed to participate in a hyperconnected world» (p. 1).

Therefore, it is urgent to generate deep reflections on the configuration of integrated learning systems that balance tradition and innovation, and humanity and technology. These reflections must take place in the pro-

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cesses of initial and continuous teacher training and in the collective agreement of educational guidelines since, as Freire (2018) points out, it is essential to practice a humanizing pedagogy that establishes a permanent dialogical relationship with the oppressed, instead of imposing itself on them.

Furthermore, the discussion on the relationship between GAI and education should not be limited to the detection of plagiarism or concerns about the integrity and quality of academic production. In this sense, it is essential for educators to be protagonists in the critical evaluation of any AI-generated resources, in their adaptation to specific teaching contexts, and in the design, implementation, monitoring, feedback, and reconfiguration of integrated learning systems that reflect the complexity of human cognition.

At the level of educational research, Albadarin *et al*. (2024) recently mapped the relationship between the ChatGPT-education binomial, identifying an emerging field of empirical research that, within the area, requires continuous exploration and proactive dialogue with policy makers, stakeholders and educational practitioners. According to these authors, this approach is essential to stimulate, refine and optimize the use of AI in learning environments, as well as to effectively integrate human interaction and collaboration in educational activities mediated by AI tools.

Finally, it is noteworthy that this study converges around the perspective of Yanes Guzmán (2016), reaffirming that one of the fundamental educational purposes in contemporaneity consists of «configuring a new way of thinking, of training, of educating, a new paradigmatic epistemology that allows us to understand our planetary home through a systemic, holistic, logical, transdisciplinary and complex paradigm» (p. 121). Undoubtedly, in the paradigm referred to technologies, the social and the human acquire a constitutive dimension within the cognitive processes that are undertaken in search of knowing the world and understanding its phenomena through models of integrated learning systems that consider various keys, among them, the six that make up the model presented in this work.

Final considerations

Throughout history, philosophy and education have undergone a remarkable evolution. We have moved from an approach focused mainly on the content of knowledge to a deeper understanding of cognitive and learning processes. This transformation, which has taken place over centuries, has led to more sophisticated pedagogical approaches. The model proposed in this paper rescues some essential elements: Human learning is based on

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cognition, an intricate and multifaceted process, essentially multimodal and rooted in sensory-motor and imitative experience. In addition, symbolic language plays a crucial role in the way humans interact with the world and with each other. It is critical to recognize that human cognition is marked by biases and heuristics that influence the way information is processed and decisions are made. These biases are an inherent part of cognition and must be understood and considered in learning processes.

In the current era of information and AI, there are significant challenges in education. Information overload, increasing reliance on technology, and the potential reduction in the role of teachers are crucial aspects that require careful attention. Education must evolve to focus on the development of critical skills, creative thinking and socioemotional competencies. Education systems must adapt to the reality of hybrid epistemic environments, where technology plays an increasingly important role. However, the future of education is also influenced by the growing fusion between technology and biology. This revolution raises fundamental questions about the nature of cognition, embodiment and human experience. Education systems must be prepared to adapt to these transformations.

Education in the 21st century must strike a balance between tradition and innovation, incorporating technology effectively without losing sight of the importance of human qualities such as empathy, creativity and critical thinking.

Regarding the idea of technology, it is proposed to abandon the conception that associates it merely with the technical-operational and infrastructural domain, which involves machines and sophisticated algorithms. On the basis of holistic theoretical foundations, we stress the need to encourage critical positions in the face of discourses that reduce it to mere support resources with no deep impact on teaching and learning processes. These discourses, with a certain degree of epistemic naivety, consider it as free of opacity, questioning and interests. On the other hand, it is essential to situate an integrative approach in which technology is constituted as an essential element within the complexity of contemporary human school activity.

In this sense, it is important to remember that the incorporation of technological resources into classroom dynamics, within the framework of a modern socio-constructivist perspective and its related approaches, is closely related to planning enriched by dialogical teacher-student interactions. In these interactions, a significant number of variables must be taken into account, among which are: the characteristics inherent to the teaching context, the diversity of learning styles, the concerted pedagogi-

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cal purposes and the development of competencies necessary for recognizing the subjects and their inclusion in the social dynamics.

In short, if education is required to adapt to the challenges of the current era, where technology and information are constantly evolving, such education must focus on the development of skills and competencies that allow people, without idealizations about their cognitive processes, to face a world in constant transformation and to question the traditional boundaries between the biological and the artificial. In this perspective, it is believed that reflection and adaptation are key to address these challenges and to take advantage of the opportunities offered by education in the 21st century.

Notes

1 According to historical records, the first *chatbots* in history, ELIZA, was created in 1966 by Massachusetts Institute of Technology (MIT) professor Joseph Weizenbaum.

2 From a technical point of view, *chatbots* are considered a type of AI capable of generating content not only by imitating, copying or replicating an existing pattern (traditional AI), but also by creating new content based on information that this technology manages to correlate and/or, in the specialized jargon circulating in the field, «learn».

3 On the web page of OPENAI®, the developer of ChatGPT, there is a definition of ChatGPT in the following terms: «A model called ChatGPT which interacts in a conversational way. The dialogue format makes it possible for ChatGPT to answer follow up questions, admit its mistakes, challenge incorrect premises, and reject inappropriate requests".

4 Referring to the global trajectories of compulsory education, Besche-Truthe (2022) adds that compulsory education has been consolidated as an essential component of robust state education systems, particularly since the promulgation of the Universal Declaration of Human Rights in 1948.

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Sources of funding

Entity: Fundação de Amparo à Pesquisa do Estado de São Paulo. Country: Brazil. City: São Paulo. Subsidized project: «Study of Implementation of Curricular Innovations, Pedagogical Strategies and Emerging Technolo-

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Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 159-193.

gies for Quality-Equity in Basic Education». Project code: 2023/16247-7. Grant #2023/16247-7, São Paulo Research Foundation (FAPESP).

Entity: ICREA Academia 2019. Country: Spain. City: Barcelona. Funded project: "Causality and Deep Learning". Project code: ICREA2019.

Authorship Statement - CRediT Taxonomy	
Author(s)	**Contributions**
Néstor Alexander Zambrano-González and Jordi Vallverdú Segura	Both authors shared equally in all phases of the research and writing process. Their contributions include, among others, the following functions according to the CRediT taxonomy: • Conceptualization • Methodology • Research • Original drafting • Proofreading and editing • Supervision • Visualization • Project management • Validation • Data curation The authors declare their integral and joint co-authorship in all stages of the submitted work.

Statement of use of artificial intelligence
We, Néstor Alexander Zambrano-González and Jordi Vallverdú Segura, **DECLARE** that the preparation of the article entitled "Challenges of learning in the era of artificial heuristics" has not involved the direct use of generative artificial intelligence (AI) tools or automated systems for writing, analysis or synthesis of content. Only commonly used academic technologies have been used, systemically integrated in specialized electronic search engines, scientific databases and advanced platforms for editing and reference management, in accordance with the usual standards of academic production. All the contents, arguments, interpretations and essays are the result of the intellectual and reflective work of the authors.

Date of receipt: February 21, 2024
Date of revision: April 20, 2024
Date of approval: April 15, 2025
Date of publication: July 15, 2025

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Print ISSN:1390-3861 / Electronic ISSN: 1390-8626, pp. 159-193.