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4 ARTICLES DE RECERCA

38 ARTICLES D'EXPERIÈNCIES



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Editorial

Amb l'efervescència des de finals de 2022 d'aplicacions com ChatGPT, basades en els models de llenguatge extens —*large language models* o LLM en anglès—, la intel·ligència artificial (IA) generativa s'ha vist com un possible revulsiu en molts àmbits de l'activitat humana i això ha despertat un gran interès per les seves possibles implicacions en educació.

Com altres eines digitals, estan centrades en l'ésser humà en el sentit que el seu ús implica una cognició distribuïda entre la persona que les utilitza i les possibilitats d'acció de l'eina mateixa, la qual cosa augmenta la nostra capacitat de pensament, però també reorganitza l'activitat humana en general. El desplegament de les tecnologies de la IA en educació ha de tenir com a objectiu la millora de les capacitats humanes i la protecció dels drets humans amb vista a una col·laboració eficaç entre humans i màquines en la vida, l'aprenentatge i la feina, així com a favor del desenvolupament sostenible. Des de la pedagogia cal apostar per una lògica ètica de la IA on la persona sigui la protagonista, la que tregui profit de l'ús d'aquesta col·laboració cognitiva, i evitar que sigui la tecnologia digital que ens tregui competències i minvi la nostra capacitat crítica.

En educació implica fomentar un ús d'aquestes aplicacions com si fossin eines per a l'activitat d'aprenentatge, amb les quals «aprendre amb», d'aquesta manera serà sempre l'aprenent qui tindrà el control de l'acció i no serà la tecnologia qui dominarà la cognició perquè, al capdavall, és l'alumnat qui ha d'aprendre. Aquestes eines en mode de tutor intel·ligent i en camps de coneixement limitat poden ser també interessants per a la personalització de l'aprenentatge i per a la retroacció immediata. Tanmateix, si només fomentem una integració de la IA en educació que es basi en aquesta visió «d'aprendre de» la tecnologia, estarem fomentant una visió reduccionista de l'educació i de substitució de la figura docent, que de cap manera pot ser descartada pels riscos que comporta encara la generació de contingut fals per part d'aquestes aplicacions.

Dediquem aquest número de la REVISTA CATALANA DE PEDAGOGIA a posar sobre la taula el potencial de les tecnologies de la IA en educació, amb sis textos ben diferents. Aquests comprenen des de reflexions pedagògiques necessàries per entendre com integrar aquestes eines per a l'ensenyament i l'aprenentatge des d'una perspectiva de l'activitat

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i per al pensament crític, passant per usos de suport per a la recerca qualitativa, fins a descripcions d'experiències en la formació docent, en les aules d'educació primària i pel foment del pensament crític. Totes aquestes contribucions es basen, precisament, a posar l'accent en les limitacions de la IA en educació i en la necessitat que siguin els docents qui supervisin i ajudin l'alumnat a tenir autonomia i pensament crític; sobretot, que siguin les persones mateixes les que tinguin «l'agència» en aquesta col·laboració cognitiva i que no sigui en cap moment la màquina qui dugui la veu cantant, sinó que ajudi en el procés educatiu.

Tot i que podem connectar emocionalment amb converses amb la IA per la versemblança en les respostes que ens dona, en el primer article Neus Lorenzo Galés ens alerta que els algoritmes de la IA generativa no són fiables i estan plens d'errors i biaixos i que, consegüentment, necessiten la supervisió de dels educadors. La integració d'aquestes eines en educació implica un canvi de rol de la figura docent pel que fa a habilitats de pensament crític, científic, de creativitat, així com participar de xarxes col·laboratives per aplicar pràctiques d'IA en educació. També, ha de tenir en compte la formació docent sobre la temàtica per incrementar la competència digital docent que integri l'ús d'IA i, finalment, la promoció d'investigació-acció a partir de pràctiques educatives reflexives amb IA per tal que l'evidència científica informi la integració de la IA en educació.

Aprofitant que la recerca qualitativa es basa en l'anàlisi de grans quantitats de dades escrites, María Paz Sandín Esteban i Angelina Sánchez Martí presenten un estudi de cas sobre l'ús de ChatGPT 3.5 per a l'anàlisi qualitativa de literatura a través de *prompts* que es fan a l'aplicació per a l'extracció d'informació, la identificació de patrons i tendències i per facilitar la comprensió i el processament de les dades. La finalitat és veure com es poden aprofitar aquestes eines per a la recerca basada en l'anàlisi de textos acadèmics i fa aflorar la importància de l'ètica i la integritat en la recerca i el paper de la figura dels investigadors per donar validesa als resultats, ja que normalment implica no acceptar els resultats literalment sinó que cal un procés de refinament en iteracions múltiples.

Les aplicacions d'IA generativa permeten generar continguts més enllà del format textual, és a dir, en altres modes com l'àudio, la imatge i el vídeo. Andrés Torres Carceller exposa una experiència d'educació artística en el grau de mestre d'educació primària per aprendre aplicacions de la IA generativa en les arts visuals, la creació experimental, el

pensament creatiu i l'alfabetització en mitjans. Es proposa un enfocament on els resultats de l'ús d'aquestes eines no s'ha d'acceptar automàticament, sinó que són els estudiants qui tenen el control creatiu, i no és la màquina la que substitueix la seva creativitat.

Rosa Maria de la Fuente Castelló presenta una experiència d'innovació docent en un centre de primària que inclou l'ús de maquinari de robòtica i aplicacions d'IA, per a l'increment de la competència digital dels estudiants i com a forma d'inclusió. Els resultats preliminars són positius pel que fa a la motivació de l'alumnat, la disminució de conflictes i l'augment de la fluïdesa relacional i, alhora, participen en el projecte creatiu «Ciutat intel·ligent», que implica l'ús de programari i maquinari relacionat amb la IA, i incrementen competències relacionades amb l'STEAM.

A partir del debat sobre la IA en educació en el context de desenvolupament professional docent, Katia Cristian Puente Muniz i Caterine Fagundes Vila presenten dos estudis de cas basats en l'observació, un a Brasil i l'altre a Catalunya. Els resultats indiquen que l'ús de ChatGPT pot incrementar el pensament crític gràcies a un enfocament constructivista i de personalització d'activitats. També indiquen els riscos que comporta respecte a privacitat i biaixos.

Finalment, en el sisè i darrer article del monogràfic, Maria de Montserrat Oliveras Ballús reflexiona sobre la importància de fomentar una perspectiva biopsicosocial quan parlem de fer servir aplicacions de la IA generativa en educació. Planteja una experiència tecnopedagògica, en aquest cas, basada en l'activitat de l'estudiant, per a la creació d'algun projecte, i que en promogui l'autoregulació, que garanteixi que siguin els estudiants els protagonistes del seu propi aprenentatge.

Són sis articles de contextos diferents, amb objectius diferents, però amb el denominador comú de l'ús exploratori de les potencialitats de la IA generativa en el camp educatiu, sempre amb una mirada crítica i que vetlli per l'ètica i la qualitat de l'educació. Estem convençuts que contribuiran al debat sobre com integrar aquesta tecnologia digital de la millor manera possible i a engegar noves recerques.

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Trust and connection in the artificial intelligence educational ecosystem: From algorithmism to algoritharism

Confiança i connexió en l'ecosistema educatiu d'intel·ligència artificial: de l'algorisme a l'algoritharisme

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Abstract

This paper addresses the role of trust and emotional connection in the learning process as a human mechanism for social construction, and its adaptation to an emerging educational ecosystem where artificial intelligence (AI) performs various teaching tasks and trend analysis. Likewise, it highlights widespread concerns about the arbitrariness and biases of algorithms in decision-making based on vast data archives (big data). Methodologically, this paper presents neither a case study nor experimental results based on events. Rather, it establishes a mindset that can open a field of future study. Descriptive analysis is used to detect terms, ideas and concepts that will provide elements for a further study of word frequencies and other linguistic analyses (usage of key words, etc.) to elaborate consciousness acquisition and social transformation processes. In sum, the paper discusses the role of trust in educational matters, from creating emotional bonds in the classroom to the institutional credibility conflict arising from the use of AI algorithms in decision-making to replace scientific evidence

(acceptance of algorithmism) or the suspicion that AI arouses in terms of privacy, security, and impartiality (rejection of algoritharism).

Keywords

Trust, evidence-based practice, EBP, practice-informed education, PIE, algorithmism, algoritharism, governance.

Definitions

Algorithmism: human reasoning processes transferred to algorithmic processes such as mathematical calculation, logic or multifactorial causality. Linked to concepts of computational thinking (Wang, 1993; Papert, 1980, 1996).

Algoritharism: a multidimensional set of political practices technologically arranged to hijack vital meaning; a set of devices to inform, to plan repeatable functions and to shape possible futures under pain logics, deepened by standardization (Sabariego *et al.*, 2020).

Resum

Aquest article aborda el paper de la confiança i la connexió emocional en el procés d'aprenentatge com a mecanisme humà per a la construcció social, i la seva adaptació a un ecosistema educatiu emergent, on la intel·ligència artificial (IA) realitza diverses tasques docents i anàlisi de tendències. Així mateix, posa de manifest la preocupació generalitzada sobre l'arbitrarietat i els biaixos dels algorismes en la presa de decisions basada en vastos arxius de dades (big data). Metodològicament, aquest article no presenta ni un estudi de cas ni resultats experimentals basats en esdeveniments. Més aviat, estableix una mentalitat que pot obrir un camp d'estudi futur. L'anàlisi descriptiva s'utilitza per detectar termes, idees i conceptes, que proporcionaran elements per a un estudi més profund de les freqüències de paraules i altres anàlisis lingüístiques (ús de paraules clau, etc.) per elaborar processos d'adquisició de consciència i transformació social. En resum, l'article analitza el paper de la confiança en qüestions educatives: des de la creació de vincles emocionals a l'aula fins al conflicte de credibilitat institucional derivat de l'ús d'algorismes d'IA en la presa de decisions per substituir l'evidència científica (acceptació de l'algorisme), o la sospita que desperta la IA en termes de privacitat, seguretat i imparcialitat (rebuig de l'algorisme).

Paraules clau: confiança, pràctica basada en l'evidència, EBP, educació basada en la pràctica, PIE, algorisme, algoritharisme, governança.

Definicions

Algorisme: processos de raonament humà transferits a processos algorítmics com el càlcul matemàtic, la lògica o la causalitat multifactorial. Vinculat a conceptes de pensament computacional (Wang, 1993; Papert, 1980, 1996).

Algoritarisme: conjunt multidimensional de pràctiques polítiques disposades tecnològicament a segrestar significat vital; conjunt de dispositius per informar, planificar funcions repetibles i donar forma a futurs possibles sota lògiques de dolor, aprofundits per l'estandardització (Sabariego *et al.*, 2020).

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1. Context

1.1. *Trust and its role in this study*

Currently, all educational institutions strive to legitimize their decisions through outcomes, scientific evidence, and system indicators. From governments to management teams, everyone wants to generate trust and reinforce their credibility with the public. Trust and connection, so essential in teaching and learning processes, thus become elements of political credibility, with all its implications. Measuring society's trust becomes an institutional goal (Organisation for Economic Cooperation and Development [OECD], 2017, 2022a).

The emergence of artificial intelligence (AI) is opening new analytical and statistical possibilities in accessing, measuring, and interpreting results. Institutions are beginning to take an interest in the role of AI-assisted research for improving administration, governance, and institutional decision-making (Gibert, 2023). In education, algorithms are becoming increasingly relevant in justifying pedagogical theories, academic practices, and transformation proposals (Cardona *et al.*, 2023).

Informed practice emerges as a desirable, objective, and scientific concept. Initially introduced by British epidemiologist Archie Cochrane in his book *Effectiveness and Efficiency: Random Reflections on Health Services* (1972), the concept advocated for the use of randomized clinical trials to make objective decisions in the health field. However, the term "evidence-based practice" (EBP) was popularized in the 1990s by David Sackett and other researchers (Thyer, 2004). EBP has been used to define and expand a fundamental approach to many other disciplines, such as nursing, psychology, education, etc., leading to "algorithmism", or computational thinking for social and political decision-making (Wang, 1993). The term is not new: over half a century ago, Valabanis (1958) already contrasted algorithmism as a scientific response against human marginal and subjective explanations (marginalism), useful for reformulating problems but wholly insufficient for explaining processes and proposing economic, social, or military solutions.

The hope of finding an understanding of complex realities in algorithms does not seem very close, and the credibility of educational artificial intelligence (EAI) is still in question, to the point where several territories are thinking of banning AI at school (Klein, 2024). The

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difficulty of transparently explaining the opaque automatisms of AI is generating an instinctive distrust with respect to future proposals which are oriented towards long-term benefit and the always elusive common good. The book *Algoritarismos*, written by Jesús Sabariego (Sabariego *et al.*, 2020) collects numerous examples of this evolution and discusses the social and ethical consequences of the so-called “techno-politics” applied to the transformation of international public opinion (Cristante, 2020). The artificial construction and manipulation of public opinion seem much more feasible if vast data managed by AI algorithms and tools to direct and control media, social networks, and information access spaces are available.

Evidence-based practice (EBP) and its counterpart, practice-informed evidence" (PIE), are two sides of the same coin that intertwine theory and practice. Both demonstrate that the cult of algorithmism has come to education to stay, at the risk of increasing didactic automatisms, cultural biases, or erratic evolutions, which can lead to a dehumanizing algorithmism.

1.2. *The impact of EAI in education: Transformations in trust mechanisms*

Without a favorable state of opinion among education stakeholders, it will not be possible to deploy educational artificial intelligence (EAI) in schools, nor to achieve the benefits of personalization and efficiency that EAI can offer. On the other hand, it would be negligent to incorporate into the classroom, without any caution, tools that are still in a pilot and validation stage. Maintaining a responsible experimental vision requires studying the possibilities of EAI, its ethical limits, and the dangers of its application in controlled environments. The three paradigms of EAI in education (Ouyang & Jiao, 2021) offer a plausible evolution of the use of AI in educative environments, showing different levels of involvement, engagement and interaction between humans and algorithms. They can be summarized as follows:

- Paradigm 1. AI-directed – passive student: behaviorism and action/reaction approach, learner-as-recipient.
- Paradigm 2. AI-Supported – student learns from (and teaches) the IA tutor, in dialogic systems and collaborative models: social constructivism and interactive approach, cognitive adaptations, learner-as-collaborator.

- Paradigm 3. AI-empowered – personalized learning, adaptive mutual evolution: connectivism and networking approach, complex and adaptive systems, learner-as-leader.

Paradigm three implies evolving into a tutorial EAI model that will identify, personalize, and recreate the student's learning processes. Eventually, human "digital twins" will not only be able to operate with information from direct interaction but from data obtained by tracking and integrating the student's personal digital wake. Adaptive systems, on the other hand, can create personal digital bubbles of information that may amplify bias, and individual opinions, polarizing beliefs and opposite positions.

Social network algorithms have been accused of favoring partisan trends, generating hatred among communities, and even altering elections and changing governments. To understand these conflictive processes, in this paper the author briefly reviews the evolution of the concepts discussed and highlights the factors that can contribute to generating or destroying trust in the AI era: from the biological mechanisms of personal interactions when teaching and learning (micro-level), to the communicative processes in school coordination environments (meso-level), and transformations in social, international, and global interest contexts (macro-level). These three areas of study allow a relevant core educational topic to be addressed: the need to generate trust and mutual recognition among the different sectors of the educational community. Therefore, first we will briefly review the conceptual components of trust in education. Then we will construct an educational argument about the uses of artificial intelligence to promote the responsible adoption of AI in the school ecosystem and guide its application to improve processes and outcomes. Finally, we will explore the current trends of technological, pedagogical, and conceptual integration that accompany the system's transformation and its impact on building community and social cohesion.

2. Theoretical and methodological approach

This article establishes an ecosystem of reflection on how AI can affect policymaking, institutional decision-making and even democracy in a hybrid world. It is not a case study, nor is it an experimental descriptive study of particular events. The TPAK and SAMR models

are presented as the basis for a mindsetting reflection that can open a field of future research.

2.1. *The TPACK model*

The TPACK model (technological, pedagogical, and content knowledge) was originally created by Mishra and Koehler (2006) to show the three domains of knowledge needed for integrating technology in the classroom. This model has proven to be closely associated with teachers' motivation and confidence (Almaiah *et al.*, 2022).

The use of the TPACK integration model incorporates the interrelated analysis of technology, pedagogy, and the conceptual contents of educational experiences.

2.2. *Combining SAMR with TPACK*

The evolutionary SAMR model (substitution, augmentation, modification, redefinition – Puentedura, 2006) can help us identify, compare, and sequence the processes of application, adaptation, adoption, and transformation of artificial intelligence technologies in learning environments. Both TPAK and SAMR have been successfully used in the study of learning motivation regarding innovative technologies and in analyzing teachers' and students' trust in the socio-emotional acceptance of the Internet of things (IoT), mobile telephony, and digital gamification, among other technologies (Yang *et al.*, 2021):

- The TPACK model offers the possibility to assess positive attitudes towards the adoption of AI technologies in educational environments.
- The SAMR model can indicate the degree of development of AI integration in these processes and focuses pedagogical processes on improving results.

Used in coordination, TPACK and SAMR generate an integrated dual model that can help identify the endogenous and exogenous barriers that teachers enumerate against the proliferation of EAI tools.

2.3. *Mind-setting methodology*

The process used to develop this article is one of guided reflection, of creating a mindset that can suggest further avenues for research. It therefore does not have traditional research phases such as data collection to answer a specific research question. Rather, it

begins from a premise that, without trust, the adoption of artificial intelligence or any other educational technology cannot receive the necessary attention, critical assessment, or educational consensus needed to study its potential, risk and impact.

Relationship-building and trust, taken together, are essential for deep learning and interrelation in formal education settings, while they are also the best emotional promoters of a school's positive climate. They are equally indispensable for developing good collaborative work among teachers, facilitating professional self-image, team involvement, and project sustainability. Trust, connection, and social awareness are, in sum, intangible parts of the social fabric that provide cohesion to society, promote participation, and enable democracy.

In their study of the variables that hinder technology adoption in education, Bingimlas (2009) highlights the lack of trust due to acquired behaviors, prejudices and beliefs, and unfounded preconceptions which are difficult to counteract. From the TPACK perspective, trust stands out as one of the most significant variables in the adoption of EAI technology in the model's three areas, reflected in this article's structure:

- a) Conceptual contents: We need comparative studies on trust and connection in teaching and learning to help us compare processes with and without EAI.
- b) Pedagogical appropriation of EAI: We must explore the reliability and trust that EAI generates among different educational agents to better understand algorithmism, or the school incorporation of EAI algorithms and artifacts in what has been called "intelligent pedagogy" or "smart pedagogy" (Lorenzo & Gallon, 2019).
- c) The credibility of AI in social systems: We must be alert to emerging trends in algorithmism, and to threats to credibility and social cohesion. These trends call into question the scientific method, proven protocols, and the credibility required by participative governance institutions.

These areas are examined and connected in the context of existing literature and the author's forays into possible ways of integrating AI into sound pedagogical processes. Descriptive analysis is used to detect terms, ideas and concepts that will provide elements for a further study of word frequencies and other linguistic analyses (usage of key words,

etc.) to elaborate consciousness acquisition and social transformation processes. The methodology draws on previous detection of needs and tries to suggest further areas for exploration.

This approach from the TPACK perspective is also aligned with the three levels of gamification in game theory (Werbach & Hunter, 2012): components, mechanics, and dynamics:

- a) Components: operational elements, like pieces in a chess game.
- b) Mechanics: established procedures and evident processes, like the rules and plays and movements of the pieces on the board.
- c) Dynamics: systemic evolution of reality, analyzed holistically, in which the players themselves transform into agents of change and variables resistant to transformation.

The ultimate purpose of this exercise should be to guide research interests towards socio-emotional techno-educational practices, the adoption of ethical techno-scientific models that prioritize the wellbeing of people and communities, and the development of techno-sustainable trends towards a fairer and more supportive world.

3. Conceptual content

Experts define trust (Mayer *et al.*, 1995) as the willingness to be vulnerable to another person's actions based on the belief that they will act competently, honestly, and ethically, which implies both a positive expectation of another person's actions and the acceptance of the risk of error. On the other hand, connection in education is defined as an affective relationship, a strong emotional bond that influences wellbeing and development (Bowlby, 1988) and it is one of the elements that allows efficient personalized interaction between students and teachers, crucial for engagement and learning motivation (Pianta, 1999).

3.1. Trust and connection in teaching and learning

Although trust is initially presented as the bond of credibility and affection between humans, there are not enough studies on its possible transfer to computer-assisted learning situations. At a time when EAI makes us consider how technology can affect changes in the

perception of reality, cognition, and social interaction, it seems essential and necessary to explore trust and its role in learning.

Human learning processes have been approached from very diverse fields. For neuroscience, teaching and learning are linked to somatic, cognitive, social, and cultural stimuli. In its physiological aspect, these stimuli are found in electrochemical processes and neurotransmitters, where various substances released in the brain stimulate physical, emotional, communicative, and behavioral responses. Methods like the universal design for learning (UDL) are clear about the potential of emotions (Meyer *et al.*, 2014) and base much of their success on the management of dopamine (a hormone related to satisfaction, problem-solving reward, and positive reinforcement), oxytocin (a neurotransmitter with natural analgesic properties released after high-intensity experiences to promote a pleasant and happy sensation), adrenaline (which, along with serotonin, regulates circuits of excitement and physical and emotional rest), and endorphins (released in response to stress, imbalance, or cognitive dissonance), among many other molecules that play essential roles in cognitive processes (Vogel & Schwabe, 2016; Takahashi *et al.*, 2023).

Much of the effectiveness of active didactic sequences structured with the motivation-practice-reinforcement scheme lies in the consolidation of a biochemical circuit associated with the creation of trust:

- Acetylcholine is involved in attention and the ability to process new information and to learn.
- Dopamine is related to motivation, emotion regulation, and recognition.
- Oxytocin is associated with trust, empathy, and the formation of social relationships, promoting an inclusive and supportive environment where students feel emotionally involved and connected.

These and other endogenous substances (hormones, neurotransmitters, enzymes) play a relevant role in the creation of trust bonds and help us interact with the environment, balance our sensorial-cognitive reactions, empathize with others, and regulate our adaptation to the social and cultural environment. From here, based on different individual experiences shared through various language filters and mental representation, all cultures

construct their own collective imaginary of feelings, expectations, risk assessment of error, and trust in others.

At the present time, it may be interesting to know the trust processes that students and teachers are building in relation to the role of EAI, given that, for the moment, trust is placed in algorithms to perform routine automated tasks (Miao *et al.*, 2021) but an indiscriminate algorithmic analysis that could represent a risk to social inclusion has not yet been adopted (for example, with the creation of emotional profiles, tutorial areas, or conciliation in conflict management). It is time to take preventive measures before this happens.

Mutual trust is fundamental in the educational field and represents the main emotional element that sustains the implicit social contract between students and educators (Buitrago & Estupiñán, 2022). When the dynamic construction of this trust manages to shape a safe and reliable school environment, education professionals can efficiently develop their work facet, and students can learn in an ideal climate of wellbeing to grow and develop in a comprehensive and balanced manner. In his book *Pedagogy of the Oppressed*, Freire (1968) emphasizes the importance of the dialogical relationship between students and teachers based on frankness and mutual trust and argues that the construction of the bond based on the principles of equity, transparency, and responsibility is fundamental to create a liberating educational environment.

According to this position, the bonds created in a framework of trust allow deep and meaningful learning as students can take risks, ask questions, and explore new ideas without fear of rejection. Among humans, cognitive learning is linked to affective interaction with others, a dialogic learning that constitutes a good part of socialization and sociocultural integration, to achieve a better interpretation of the environment, community, and culture. We still do not have enough information on the socio-emotional consequences that learning derived from exclusive interaction between students and EAI may have.

3.2. *The role of evidence-based trust*

Currently, generative AI has entered the educational ecosystem abruptly and unexpectedly for most professionals through OpenAI and its ChatGPT. It is unknown what alterations conversational transfers from students to chats, bots, and other generative AI tools might

cause. For decades, a long list of digital tools based on algorithms to regulate computerized self-learning systems, known by their acronyms such as CBL (computer-based learning), CAL (computer-assisted learning), CAI (computer-assisted instruction), etc., have existed. However, the arrival of ChatGPT has far surpassed the interest that the emergence of smart classrooms generated a few years ago.

ChatGPT and other AI models designed to generate conversations in natural language raise countless issues that we need to address as soon as possible. The first is clear: What should we do to ensure that advanced AI language models can offer effective, safe, reliable, and consistent educational environments?

Evidence shows that ChatGPT algorithms can generate fake news. Experts warn of the “hallucinations” of generative AI, which are incorrect and unverified responses constructed by the algorithms to provide predictive answers based on their internal statistical logic. The algorithms are imperfect because they largely respond to the biases and cultural filters of their designers, but their results fascinate us because they mimic human actions and communicative processes and can quantify, represent, and predict them with astonishing verisimilitude. This statistical prediction has both advantages and risks.

Can AI or EAI tools enhance affective interaction, socialization, and sociocultural learning that help us to better understand the environment and human culture? ChatGPT itself, when asked, confesses that it is incapable of feeling emotions or consciousness:

PROMPT [Neus Lorenzo]: Please, try to describe yourself as if you were a person.

RESPONSE [ChatGPT4.5]: Alright, I'll try: I am like a person with a great capacity to remember and a quick response capability. Although I have no feelings or consciousness, I can process and understand vast amounts of information. I am always available to help and answer questions. I do not experience emotions or fatigue, and my main goal is to facilitate information and assistance based on what I have been taught.

(OpenAI-ChatGPT4, September 2023)

When asked to analyze the described personality as if it were an expert in psychology and psychiatry, ChatGPT's assessment is more than worrying:

Lorenzo Galés, N. (2024). Trust and connection in the artificial intelligence educational ecosystem: From algorithmism to algorithmism. *Revista Catalana de Pedagogia*, 26, 4-37.
<https://doi.org/10.2436/20.3007.01.208>

RESPONSE [ChatGPT4.5]: This person might be experiencing a disconnection from their own emotions or perhaps a form of anhedonia (inability to feel pleasure). The statement of not experiencing emotions could indicate a sensation of affective flattening.

Possible psychiatric diagnosis: There are many conditions that could have similar symptoms, but based solely on this description it could suggest:

Schizoid personality disorder: These individuals often appear distant and may prefer to be alone. They tend not to have strong desires for intimacy and may not respond intensely to situations that others would find exciting.

Depression: Affective flattening, the sensation of disconnection with emotions, or anhedonia are common symptoms of depression.

Some forms of autism: Some people with autism may have difficulty understanding or expressing their own emotions.

(OpenAI-ChatGPT4, September 2023)

We must consider whether EAI can help transform the education system into a more inclusive, ethical, and fair teaching and learning ecosystem if it lacks the capacity to feel emotions, consciousness, or any affective connection. The emotional intensity triggered in conversation with EAI does not come from mirror neurons but from the context of intimacy, the semantic understanding of the text, and the idealization of the message in the brain itself.

Mirror neurons are brain cells that activate both when a person performs an action and when they observe another person performing the same action. They facilitate learning by imitation, essential for acquiring new skills, from language to the development of affectivity and social behaviors. The prefrontal cortex is involved in executive functions such as decision-making, problem-solving, and attention regulation. These brain areas assist in planning complex actions and modulating our responses, crucial for directed and conscious learning. Together, these brain structures enable social and cognitive learning and help individuals interpret and respond effectively to stimuli in their environment, developing their self-image and constructing the trust frameworks that allow them to relate to others.

It is evident that students' mirror neurons do not activate when interacting with ChatGPT in the same way as with people but it is worth studying if the brain is capable of managing learning with generative AI from another substitutive domain with similar or equivalent results that are not harmful to the user. There are not enough studies (Moya, 2023) to determine what the long-term changes will be, if any, in the emotional and behavioral response of students who learn, grow, and develop by placing their emotional connection and personal trust in the responses of an EAI agent, instead of doing so in a human adult. But we have indications to suspect that at the individual level, an extremely focused and addictive dependency bond can develop (Shaffer *et al.*, 2000), and at the community level, there is a real large-scale cybersecurity risk, both in terms of privacy and false information, in what has been called "data poisoning" (Romeu, 2023).

Experts (Tschannen-Moran, 2001) suggest that students' trust in teachers, which allows for open collaboration and communication, is built on variables of reliability, teacher competence, and care:

a) Reliability: The ability to identify and represent reality consistently. In a test, reliability is related to coherence so that when applied repeatedly under similar conditions consistent results are obtained.

b) Teacher competence: Refe

rs to the set of knowledge, skills, practices, and attitudes that educators need to perform their job effectively. It involves the ability to adapt to different contexts, students, or specific situations, and the capacity to reflect on one's practice and improve it based on evidence.

c) Teacher care: Refers to empathy, emotional interaction, and the professional attention with which the teacher connects to students.

Some researchers (Bryk & Schneider, 2002) add two more areas as key components of trust and educational connection, applicable to students and teachers alike and essential for creating a safe supportive environment, so necessary for effective learning:

d) Integrity: Refers to ethical uprightness and the ability to remain true to one's beliefs and models of action.

e) Teacher openness: A capacity related to accessibility and transparency in teachers' decision-making processes.

Let's see if EAI believes it meets these quality criteria. If we ask ChatGPT itself for an evaluation of these characteristics in its teaching performance, its response is revealing and contradictory:

QUESTION [Neus Lorenzo]: As an LLM, ChatGPT and other natural language AI models can be used in education prudently. Can you please indicate what score you would assign to AI on the following characteristics, from 1 to 100? (1 is none, and 100 is absolutely all). Reliability. Professional teaching competence. Teacher care. Integrity. Teacher openness and transparency. Can you add a justification of up to 12 words for each response, please?

RESPONSE [ChatGPT4.5]: Evaluating AI models like ChatGPT in education (from 1 to 100):

- *Reliability: 75. High consistency in responses, but not infallible.*
- *Professional teaching competence: 40. Strong in content, limited in pedagogy.*
- *Teacher care: 20. Lacks empathy and personalized attention.*
- *Integrity: 80. Reliable in providing truthful and relevant information.*
- *Teacher openness and transparency: 70. Transparent about its limitations but cannot self-evaluate.*

(OpenAI-ChatGPT4, December 2023).

It is curious that it can carry out or simulate a self-evaluation, and end denying it (cannot self-evaluate). In any case, we must always remember that these responses are not the result of an authentic exercise in evaluating reality but merely respond to the numerous internal algorithms, that is, to the frequency of occurrence of these words in the current documentation it handles, the conversions by minimum-error correlation, and clustering by proximity (Euclidean KNN models, Manhattan, Minkowski, etc.).

If we insist on details, ChatGPT becomes more precise:

“PROMPT [Neus Lorenzo]: Why did you say earlier that the teacher care score is 20? Can you make a brief list of the main shortcomings, with a sentence of fewer than 10 words for each?”

RESPONSE [ChatGPT4.5]: The score of 20 in teacher care for AI reflects its limitations in emotional and personal aspects, crucial in teaching:

- *No empathy: Incapable of understanding human emotions.*
- *Lack of personal understanding: Cannot adapt to individual needs.*
- *Absence of human connection: Does not form emotional bonds.*
- *Inability to provide counseling: Does not offer emotional or psychological support.*
- *Does not recognize emotions: Cannot interpret or respond to emotional signals.*

(OpenAI-ChatGPT4, December 2023)

It is very significant that in this response, AI’s inability to personalize and provide support to students with specific needs is denied (cannot adapt to individual needs; does not offer personal or psychological support). Obviously, this is not a contradiction in semantic meaning but the result of an algorithm that constructs the sequence of words according to a classification by statistical proximity, and not necessarily in response to the lexical content of the message.

We are also surprised by the way our mind “humanizes” the responses, integrates them as “reasoning and opinions”, and turns them into “credible” when they match our own prior ideas, beliefs, and value judgments, precisely because a positive response triggers neurotransmitter and hormonal mechanisms that we have socially developed to reinforce self-esteem, recognize the cognitive-emotional bond with others, and increase the feeling of wellbeing. Our brain deceives us. No surprises: it also has a reward effect that can be potentially addictive and requires external control.

Simplifying the explanation: ChatGPT does not evaluate; it only searches and quantifies existing word chains and proposes new correlations according to the highest probability of use, based on the statistics of previous uses in its files (both those “supervised” initially and those acquired from the “uncontrolled” contributions of its users). However, it generates

situations of communication in privacy (1 to 1) that intensely simulate human intimacy, emotional openness, and an apparent infallibility that can lead students (especially those who have not yet reached brain maturity) to create an unfounded trust bond. With these prospects, it would be truly negligent to let students explore EAI without human adult support and supervision and be swayed by false expectations or seemingly harmless but highly contradictory proposals with respect to reality.

Along with families and students' legal guardians, it is clear that schools, teachers, and educational system administrations must assume the role that society has granted them by institutional delegation: the design of educational instruction (instructional design), the role of facilitators of knowledge (knowledge facilitation), and inclusive child and youth socialization within the framework of the comprehensive and ethical education of future generations (global citizenship).

4. Appropriation and adaptation of EAI – Algorithmism and the logic of evidence

In 1993, cognitive philosopher Hao Wang pondered, "Can machines think?". He studied human reasoning processes (physicalism) and their transfer to algorithmic processes (algorithmism) such as mathematical calculation, logic, or multifactorial causality (Wang, 1993). At that time, logical reasoning or problem-solving could be represented as a series of steps or computational procedures accessible to the detailed and rational understanding of humans. Algorithmism, in its intention to represent human thought to train rational machines, ended up linking with the idea of computational thinking (CT) by Seymour Papert (1980, 1996), increasingly interested in creating a set of instructions that aligned with human narrative learning and could make technological processes and decision sequences performed by computers accessible and understandable. Technology has changed a lot since then: the initial algorithmism (Valavanis, 1958) has become the computational thinking that currently seeks to improve the essential responses for teaching and learning in a digital world:

a) Enhancing human learning: How to enhance students' thinking skills through concepts and models coined by computer sciences.

b) Improving EAI: How to program, from its origin, technological tools and processes with the legal, ethical, and cultural filters and controls that society deems necessary

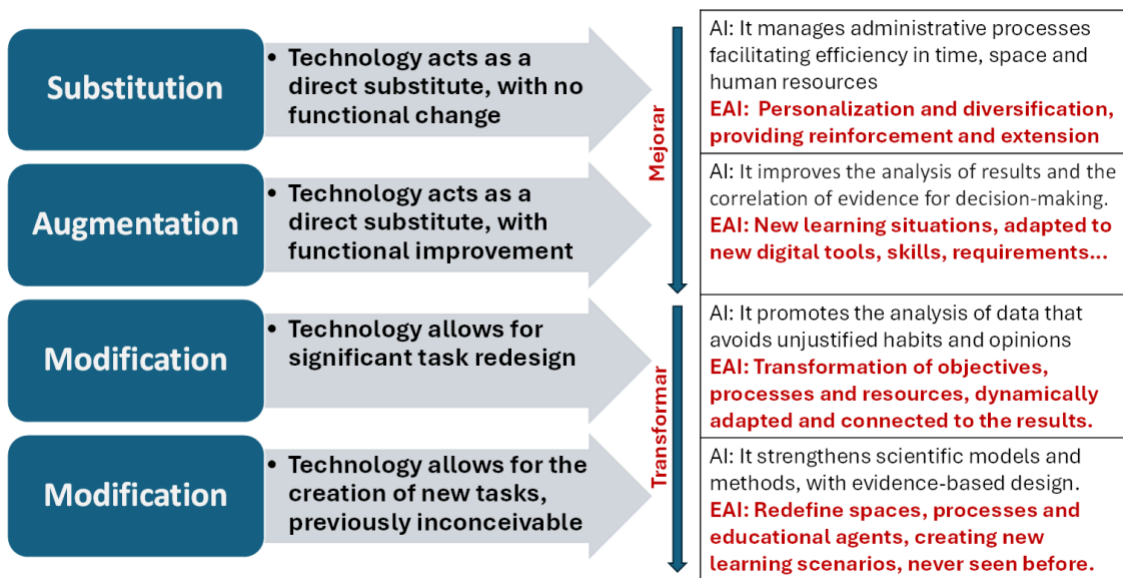
to guarantee the privacy and security of human users as well as equity without biases in their use and application.

c) Improving the so-called “explainability” of both processes: How to explain, justify, validate, and effectively apply both processes for all involved actors (whether human or machines), in the most transparent and accessible way possible, despite their growing complexity.

To advance in these three objectives, the role played by trust is essential. Tech companies are trying to overcome the resistances created by the sudden irruption of AI in the school digital ecosystem and minimize the suspicion generated among educational institutions, teachers, and students’ families every time a new digital tool comes to market.

AI is being consciously used in the management of enrollments, planning of schedules and spaces, mass communication procedures, and administrative processes of communication, dissemination, evaluation, and trend analysis. In this pragmatic framework, transformative educational leadership must seek in EAI algorithms not only the safest teaching and self-learning environments for students and teachers but also the data analysis and management tools that contribute to the delegation of competences and the participation of all educational sectors in order to generate trust and sustainability in the short, medium, and long term.

Especially necessary are the artifacts and constructs that provide the explanations and success evidence needed to incorporate the most efficient management, participative dynamics, and ethical transformation into the system. To avoid an irrational substitution of teachers by EAI, the SAMR Model (Puentedura, 2006) can be used, which describes the phases of incorporating digital technologies into cultural processes:



SAMR applied to Artificial Intelligence (AI) and Educational Artificial Intelligence (EAI), by Neus Lorenzo, 2024.

Figure 1: SAMR processes for technology adoption in educational environments: Proposal for AI (Neus Lorenzo, 2023).

Just as the classification of AI tools is aimed at defining application tasks (OECD, 2022c), the search for educational resources that facilitate the teaching task is aimed at satisfying different areas of action:

- a) Physical or methodological artifacts that improve teacher interaction and generate sufficient evidence on students' progress and difficulties.
- b) Organizational tools and techniques that make administrative management tasks more bearable and allow for comparable data on the results and trends of each group, with the variables that determine the general trend.
- c) Those components, mechanics, and dynamics that can generate models of educational action aimed at meeting learning needs for individual and collective wellbeing throughout life, and an ethical state of opinion that promotes those components, mechanics and dynamics in a situation of inclusion, equity, and social justice.

So far, it seems evident that progress has been made in the first two areas, and only in the last two years has there been a clear concern to address ethical issues with the perspective of unifying interests towards a more promising and sustainable integral approach to EAI.

5. Credibility of AI in social systems

5.1. Credibility in EAI

With AI algorithms in educational environments, an improvement in efficiency (time and space), job safety (reduction of physical and emotional risks), inclusion (progressive ubiquity and universality of digital processes), and sustainability (virtualization presupposes a reduction in the carbon footprint) is generally expected. Evaluating these four variables to gather long-term evidence of their benefits should be an objective of every educational system. It is clear that educational practice cannot work against evidence, and everything seems to indicate that theorization without practical foundation is not a good premise: evidence-based practice, on the other hand, has proven to be efficient in evaluating results and processes.

Evidence-based educational practice (EBP) and practice-informed education (PIE) refer to the use of research and observable evidence to inform and guide both classroom educational practice and pedagogical decision-making based on observable reality (Stahmer *et al.*, 2018). Both generate an interdependent cycle of continuous improvement based on action research,, which constitutes an optimal system when it responds to transformative leadership (Johansson *et al.*, 2010) and is proposed in the form of collaboration between the university and the school. The coordination between researchers and teachers, with the help of data and evidence collected in EAI environments, can be a space for mutual enrichment that we should not renounce.

Under this approach, informed practice becomes an area of educational research while encouraging multisectoral involvement and users' participation in reflecting on their own practice. This integrative approach is increasingly widespread in educational policies and the academic world. Currently, practice-informed education (PIE) is nourished by knowledge obtained through field studies, rigorous statistical data analysis, and contrasted empirical results to identify change variables and propose systemic transformations, which in turn will revert to classroom process improvements (Lorenzo & Burriel, 2022). PIE seeks to improve

the quality and effectiveness of teaching and learning by applying the best available knowledge to make informed decisions in educational practice, whether in lesson planning, pedagogical approaches, system evaluations, or the implementation of transformative educational policies.

On a micro-scale, in the classroom, the EBP-PIE model requires sensitizing teachers to identify the processes, conditions, and results of each student and to establish the appropriate link that stimulates each student's motivation and abilities through the personalized strategies and adaptations necessary in each case. On a meso-scale, at the organizational level, the focus is on using observable data and learning evidence to make decisions based on the school's outcomes, and to select priority resources and promote the success of all students in the center. At the system level, on a macro-scale, the search for evidence involves the use of scientific methods and controlled research processes to evaluate the effectiveness of various educational interventions and identify the most significant variables for teaching and learning improvement.

According to experts (Romeu, 2023), in order to foster trust in EAI systems the existence of reliable information protection devices (which are both the source of information and the historical record) and user data protection mechanisms is key. The transparency of algorithms in justifying and explaining automated decision-making processes is equally necessary. EAI environments must be capable of explaining the functioning and reasons behind their proposals and decisions, and ensure accountability for the consequences, avoiding biases and discrimination of any kind. The inclusion of users in development, data protection, and continuous monitoring are also fundamental. These strategies are essential for the acceptance and success of these systems:

- a) **Transparency:** Clearly expose the limits and risks of EAI programs and their algorithms in decision-making to build credibility and trust. Users should have access to information about data collection and processing, decision-making criteria, and their own participation in the entire process.
- b) **Explainability:** EAI systems should be designed to provide explanations for their decisions and recommendations, helping users understand the system's reasoning and build trust in its capabilities (Doshi-Velez & Kim., 2017). The so-called

“explainability by design” refers to the creation of programs that include “factory-set” ethical filters in the initial design. It also requires control over the clarity and difficulty of the explanations, which by law must be simple and accessible to the intended users.

c) Accountability: Establishing accountability mechanisms is important. This includes ensuring that AI systems are fair, impartial, and free of discrimination. Regular internal and external audits and assessments, always contrasted, can help identify and address potential biases or ethical concerns (Felzmann *et al.*, 2019).

d) User participation: Including users in the design and development process of AI-based educational systems can foster trust. By incorporating user feedback and preferences, the system can better align with users’ needs and expectations.

e) Privacy and security: Ensuring the privacy and security of users’ data is essential to building trust. Implementing robust data protection measures, such as encryption and anonymization, can help alleviate concerns about data misuse or unauthorized access.

f) Continuous monitoring and improvement: Regular monitoring of AI systems can help identify problems or errors that may arise in continuous feedback. It is important to have mechanisms for continuous improvement and refinement of the system based on user feedback and evolving educational needs.

To consider the necessary precautions without detracting from the possibilities of EAI, the author of this article would add the need to apply and develop e-governance.

E-governance refers to the principles of digital leadership and social commitment in the virtual world, and requires its own strategies that include the control of program obsolescence, content updating, and the replacement of management algorithms as necessary.

If we ask ChatGPT to evaluate generative AI with natural language models on these characteristics (from 1 to 100) to see if they offer sufficient criteria to foster credibility and facilitate trust in EAI, the scores are somewhat uneven:

“PROMPT [Neus Lorenzo]: As LLMs, ChatGPT and other natural language AI models must exhibit certain characteristics before they can be prudently used in education. Can you please rate AI on the following characteristics from 1 to 100? (1 being none, and 100 being absolutely all). Can you add a justification of up to 12 words for each response, please? [The previous list is attached]

RESPONSE [ChatGPT4.5]: Here is the evaluation and justification for each characteristic applied to LLMs like ChatGPT and other natural language AI models:

- *Transparency: 70. Good but can improve in technical details.*
- *Explainability: 60. Explanations available, but sometimes complex.*
- *Responsibility: 50. Advances in fairness, but still with challenges.*
- *User participation: 55. Integration of feedback in development.*
- *Privacy and security: 70. Solid measures, with room for improvement.*
- *Continuous monitoring and improvement: 65. Constant improvement needs rapid adaptation.*
- *eGovernance: 60. Aware of obsolescence requires more robust strategies.*

These ratings reflect the current state and capacity of AI models in each of these aspects, considering both their strengths and areas that need further development.

(OpenAI-ChatGPT4, December 2023)

It should be noted again that these responses do not represent an evaluation of reality but are mediated transfers that the algorithms make from their lexical frequency files. However, the interpretation that users can make of this message provides very valuable information, for example, about the human perception of generative AI and widespread beliefs about EAI. The fact that responsibility (50) and user participation (55) are the characteristics with the most room for improvement does not seem to correspond with the perception users have of the risks of transparency (70), privacy and security (70), or continuous improvement (60). In any case, it would be necessary to investigate whether, with these strategies, EAI systems can genuinely generate trust among users, which demonstrably leads to greater adoption and positive educational outcomes.

On the other hand, the cult of scientific evidence has raised alarms among some educators, who speak out against a potential excessively mechanistic algorithmism and even warn of a growing algoritharism that generates distrust and increasingly well-founded suspicions (Sabariego *et al.*, 2020). The social risk this implies deserves a more detailed study in the near future.

5.2. *Credibility in algorithm-directed social changes*

In both social media and international news regarding global conflicts, there is a pervasive sense of discouragement, pessimism, and widespread distrust. Do we trust institutions? According to the latest OECD study (OECD, 2023a), “only 32.9% expect governments to adopt the opinions expressed in a public consultation”. This seems to indicate a general loss of confidence in governance: only half of the respondents in 22 OECD countries surveyed (on a national average) trust their government to use their personal data solely for legitimate purposes (51%).

The Edelman Trust Barometer (Edelman, 2023) acknowledges a worsening societal mood over recent years on a global scale, especially regarding future economic confidence. In 2017, 53% of respondents believed they and their families would be better off economically and socially after five years, and by 2022, 50% of respondents said they maintained confidence in a better future. In 2023, only 40% believed their family would enjoy a better quality of life in five years, marking a 10-point decrease, a 20% plummet in future hope within just one year.

Overall, trust in public institutions is experiencing some erosion, with clear ideological and political polarization (OECD, 2022b). In OECD countries, people tend to view public institutions as trustworthy organizations and are fairly satisfied with existing public services: 41% of the population expressed high satisfaction or moderately high confidence in their national governments. Paradoxically, another 41% of the global population stated their government has very low or low credibility. Despite skepticism about politics or governments, about two-thirds of respondents are satisfied with their health system (68%), educational system (67%), and administrative services (63%) (OECD, 2023b).

The rapid acceleration of digital development in recent decades has led to widespread ignorance about the presence of AI algorithms in the most common technological processes of governance, political management, and all areas of our lives.

Experts from United Nations Educational, Scientific and Cultural Organization (UNESCO, 2023) and university research centers echo widespread concerns about the physical and ethical dangers of the most startling advancements. Ethical concerns and challenges presented by AI, including privacy, data security, and equity, must be a legislative priority. Higher and university education, hitherto bastions of research and scientific culture, are now in question. Education, especially at higher and university levels, seems to fail in convincing its users, experiencing a rapid erosion of trust in efficiency and expectation fulfillment. In the 2023 Gallup study in the United States (Brenan, 2023), when asked about how much confidence they have in higher education, respondents who answered “Very little confidence” went from 6% in 2015 to 15% in 2018 and 22% in 2023, while those responding “A lot of confidence” decreased from 28% in 2015, to 23% in 2018, and to 17% in 2023.

The percentage of adults in the United States expressing a lot or quite a bit of confidence in higher education has notably decreased between 2015 and 2023 (19% among men and 22% among women). Non-university youths expressing a lot or quite a bit of confidence in higher education in 2015 (54%) and in 2018 (45%) have now dropped to less than a third (29%) in 2023.

In education, technological advancements based on big data management and deep learning processes remain distant from classrooms, except in the case of a few teachers or experts linked to techno-scientific disciplines who advocate for their development. Due to their speed and extreme complexity, most AI algorithms are beyond the reach of human cognitive processes and mental activities. It is precisely this complexity that intimidates and conditions authorities and all those who must make decisions about their scalability, transfer, and generalization (Gibert, 2023). In many cases, they either are unaware of the tool or only partially understand its utility, leading to resistance that hardly fosters progress.

There is a growing interest in aligning political decisions about the school system with the vast amount of macrodata collected worldwide, interpreted digitally by specialized

organizations through periodic studies and surveys (PISA, TIMMS, PIRLS, etc.). The influence of this algorithmism can be enormous. For instance, the widespread decline in reading proficiency among 15-year-olds in many countries (after three years of intermittent remote schooling and increased screen time) has incited heated calls for banning mobile phones, implementing new handwriting plans, and reverting to traditional methods proven ineffective and exclusionary. This threat of reverting to a less promising past stems from a progressive loss of confidence in education, argued with data without applying a reliable interpretation of the information, and therefore without a real and verified understanding of the situation (Mortensen & Gardner, 2021).

Educational outcomes in recent years are complex and suggest social changes that still need to be contrasted: Is the mother's level of education still relevant? A glance at the latest PISA results can spark a new debate. In some cases, it seems easier to blame mobile phones than to conduct a thorough study of trend changes and variables that impact social transformation.

The average citizen equally doubts the processes of biological selection of efficient crops, the sterilization and transgenic alteration of food products, the risks of 5G technology, and the dependence created among teenagers by 3D interactive video games. Education experts question the potential neural alterations derived from learning with immersive models (e.g., Metaverse) and the risks with AI agents in extended language environments (e.g., ChatGPT, Bard, etc.). Families ask teachers to ban mobile phones in school because parents cannot do it at home. Major companies managing technology on a global scale attempt to demonstrate that there is insufficient evidence about the dangers of algorithms and the risks of incorporating them into the school system, although personnel or student selection algorithms could be opaque, irresponsible, unilateral, or authoritarian by nature, and remain hidden and impenetrable to the average user.

OECD study groups, UNESCO, and university networks address (often with more anxiety than scientific method) the challenges of algorithms used in political, social, economic, health, or educational decision-making. These and other international institutions are interested in exploring and assessing the adoption of AI and its ethical constraints, with risk identification and control and possible solutions, to mitigate negative impacts and maximize

educational benefits. Their studies demonstrate how the use of EAI digital technologies in education can contribute to reducing the gender gap, favoring the inclusion of the most vulnerable students, incorporating young women into the labor market, and extending basic education in rural areas (UNESCO, 2023), provided these experiences are accompanied by teacher involvement and community social references.

At the same time, the role of algorithms in managing public information is frequently questioned as they create territorial biases that deepen global conflicts. Studies show how algorithms, without supervision, can increase the recursive feedback of personal interest bubbles, the manipulation of beliefs and fake news in digital social network communities, and the promotion of political or religious phobias and phobias on any open public platform.

It is urgent to separate successes from threats. More projects where international collaboration is paramount are needed to place scientific methods at the center of research and demonstrate with practical evidence the strengths and possibilities of EAI when accompanied by teachers committed to working with verified information, undergoing quality training, and promoting responsible educational transformation. EAI resources are an opportunity if applied with sound judgment. Teachers should engage with their best practices of reference.

6. Conclusions and suggestions

From the author's personal experience, the algorithms of generative AI in natural language models have proven to be of unreliable content accuracy in the field of EAI. While useful for managing and generating multiple documentary models, algorithms cannot yet be considered reliable enough to incorporate ChatGPT or any other generative AI model without adult educator supervision into educational environments for minors. They are prone to errors and biases when lacking proper data and can be highly vulnerable to falsified information on social networks (fake news).

Therefore, the application of EAI in the classroom requires the construction of a conducive ecosystem where trust can grow. The journey begins in the teaching and learning process and advances in multisectoral collaboration, with clear proposals:

- a) A change in the role of teachers, who must acquire greater critical and scientific thinking, as well as creativity, to work in harmony with the rest of the educational

community, developing the new digital skills (communicative, emotional, and civic) required for the application of EAI in the school environment.

b) The creation of networks of centers with organizational flexibility to ensure mutual support in the application of AI practices informed by scientific evidence, and to facilitate coordination in peer verification networks and collaborative work.

c) The institutional generalization of teacher training in techno-pedagogy and techno-scientific didactics (smart pedagogy) to build an action-research framework based on reflection on practice, synchronizing the spheres of university research and evidence-based teaching practice for continuous improvement.

With the increase in automated algorithms capable of establishing correlations, classifying observable phenomena, and detecting significant variables in an increasingly complex reality, it seems logical to guide institutional decisions and educational practices on the basis of research and positive data from the educational field: evidence-based practice (EBP) and practice-informed evidence should be incorporated into the repertoire of teachers involved in the use of EAI.

The proliferation of AI in society is a fact, and the application of EAI in primary and lower and upper secondary schools is not only inevitable but also desirable, under appropriate ethical conditions. If we do not want to fall into a dangerous neglect of duties, teachers must explore and apply the EAI artifacts that best suit their objective, context, and educational reality. Teachers should know and rationally and efficiently use EAI tools that can facilitate their teaching, tutoring, and socio-educational tasks in the classroom in order to offer the most appropriate personalization and support in each situation. Teacher training can incorporate the TPACK model and the SAMR approach for helping teachers to become aware of the possibilities that EAI can provide for increasing efficiency and transforming education.

Similarly, management teams and administrative technicians of the system must promote ongoing training in and updating of the processes necessary in the development of rights and duties relating to digital identity, cybersecurity, and legal privacy required by the institution and each of its members. In this respect, governments are adopting clear and

direct measures, such as the Guide to Privacy by Design (Agencia Española de Protección de Datos [AEPD], 2019), which must be disseminated and valued in depth.

The three paradigms or models of AI introduction in schools presented by Ouyang and Jiao are a good example of how EAI can improve with teacher training:

- First step: AI-directed, learner-as-recipient.
- Second step: AI-supported, learner-as-collaborator.
- Third step: AI-empowered, learner-as-leader.

Education professionals cannot be left out of this process and training will be essential. At stake is the transformation of public opinion and the very essence of democracy. Academia must engage in research on the uses and consequences of EAI, with its traditional scientific rigor, or it will lose the credibility and trust of the population. Social, cultural, and political representatives must facilitate action-research programs to responsibly involve families, students, and educational centers, with a future vision that addresses the transformation of personal and social trust and therefore the evolution of education, the future of knowledge, and the cultural sustainability of the human species.

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A case study in artificial intelligence-assisted qualitative analysis: The use of ChatGPT prompts with UNESCO texts

Un estudi de cas en l'anàlisi qualitativa assistida per intel·ligència artificial: l'ús de «prompts» de ChatGPT en textos de la UNESCO

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Abstract

This article presents the practical application of a range of ChatGPT 3.5 prompts in the qualitative analysis of United Nations Educational, Scientific and Cultural Organization (UNESCO) and United Nations (UN) reports and blogs on ethics, education and artificial intelligence, giving details of the text structure and the results yielded. The prompts were designed to extract relevant information, identify patterns and trends, and facilitate the understanding and processing of the data. Through this exploratory study, we endeavor to show their usefulness as a tool for analyzing academic and research texts. The combination of approaches, bringing together both the advantages of AI and human research experience, reveals the importance of comprehensive education for researchers on scientific integrity and ethics in research in general and in qualitative research in particular, in order both to reap the benefits of AI with confidence in its scientific validity and to avoid its pitfalls through rigor and sound judgement.

Keywords

Qualitative analysis, artificial intelligence, ChatGPT, prompts, UNESCO, education.

Resum

L'experiència que presentem exemplifica l'aplicació pràctica de diversos prompts en ChatGPT 3.5 dissenyats per dur a terme els procediments associats a l'anàlisi qualitativa d'informes i blogs de l'Organització de les Nacions Unides per a l'Educació, la Ciència i la Cultura (UNESCO) i les Nacions Unides sobre l'ètica, l'educació i la intel·ligència artificial, detalla l'estructura dels textos i els resultats obtinguts durant la tasca d'anàlisi. Aquests prompts han estat formulats per extreure informació rellevant, identificar patrons i tendències, i facilitar la comprensió i el processament de les dades. A través d'aquesta exploració, pretenem mostrar-ne la utilitat com a eina per a l'anàlisi de documents textuais en l'àmbit acadèmic i de recerca. La combinació d'enfocaments, utilitzant els avantatges que ens proporciona la IA juntament amb l'experiència investigadora humana, posa de manifest la importància d'incentivar des de la formació investigadora coneixements progressivament més profunds en integritat científica i ètica de la recerca en general, i qualitativa en particular, per a poder aprofitar-ne amb seguretat i validesa científica els beneficis i sortejar-ne amb criteri i rigor els perills.

Paraules clau

Anàlisi qualitativa, intel·ligència artificial, ChatGPT, prompts, UNESCO, educació.

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1. Introduction

The use of natural language processing (NLP) technologies in social science and education research has been gaining ground in recent years (Tabone & De Winter, 2023; Zhang, 2023). The ChatGPT language model, developed by OpenAI and based on GPT 3.5 and subsequent models, has particularly emerged as an attractive tool for qualitative data analysis in educational sciences since it can be used as an assistant, as is occurring in other fields (Hamilton *et al.*, 2023). This possibility calls for more in-depth analysis of its functionalities in tasks that lead to the interpretation and construction of human meanings.

Data and information analysis techniques and procedures in education research are closely linked to the methods used to examine and understand the data collected. These techniques and procedures make it possible to organize and interpret information and draw meaningful conclusions, with the aim of answering the specific research questions posed (Mason, 2018). In qualitative research there is no exclusive set of methods or practices, although it generally makes use of narrative data produced by observations, interviews, texts, images, videos, letters, emails, social media, stories, artifacts, etc. “The art of practice and interpretation, evaluation and presentation” in qualitative research, as Denzin and Lincoln (2018) call it, can hardly be generalized and it is always recommended to refer to manuals giving analytical guidelines for the particular study perspective adopted. It is generally agreed, however, that qualitative research involves large amounts of information that usually take varied and unstructured forms, and that therefore the analytical approaches we choose should facilitate inquiry, enabling us to examine the data systematically in order to delineate its dimensions and to discover the relationships between them and with the whole. In short, all analysis seek to gain a greater knowledge of the situation studied and, as far as possible, to advance through description and understanding towards the development of explanatory conceptual and theoretical models (Sandín, 2003).

Broadly speaking, the analytical strategies used to make sense of data (Miles *et al.*, 2020; Taylor *et al.*, 2016) are: (a) notes, memos, reflective writing and “assembly”; (b)

categorization, such as coding and thematic analysis; and (c) connection strategies, such as narrative, discourse or network analyses.

In this context, ChatGPT appears as a potential tool for facilitating qualitative analysis tasks, as the scientific community has indicated in its contributions to the dialogue between AI and qualitative research (Zhang, 2023). The ability of AI to generate real-time responses can help researchers identify emerging patterns, themes and trends in qualitative data (Hamilton *et al.*, 2023). This can be done by generating automatic summaries, identifying key themes and exploring connections and relationships between different aspects of the data. The ChatGPT model is trained to generate text based on a given prompt or set of instructions. A prompt is a natural language instruction given to a generative artificial intelligence (AI) tool to guide its production of outputs (i.e., responses; Gao, 2023). It has the function of an informational input in which the researcher specifies the context and the task that the tool is expected to complete. On receiving the prompt, the AI model produces an output (or result) based on what the researcher has stipulated. A well-formulated prompt will result in the production of more relevant and coherent answers and enable the model to adapt to the user's specific needs.

By incorporating ChatGPT into qualitative data analysis, researchers can streamline and enrich the process, enabling a more agile and in-depth exploration of the education phenomena studied from various perspectives. Its use can also contribute to addressing the challenges of managing and organizing large volumes of information, identifying hidden patterns and producing significant insights from the data. Through the use of prompts, ChatGPT generates automated reports that can assist in the content and thematic analysis of texts (Braun & Clarke, 2006; Krippendorff, 2018). Lopezosa and Codina (2023), for example, illustrate the use of ChatGPT for analyzing interviews, identifying the following possibilities (p. 9):

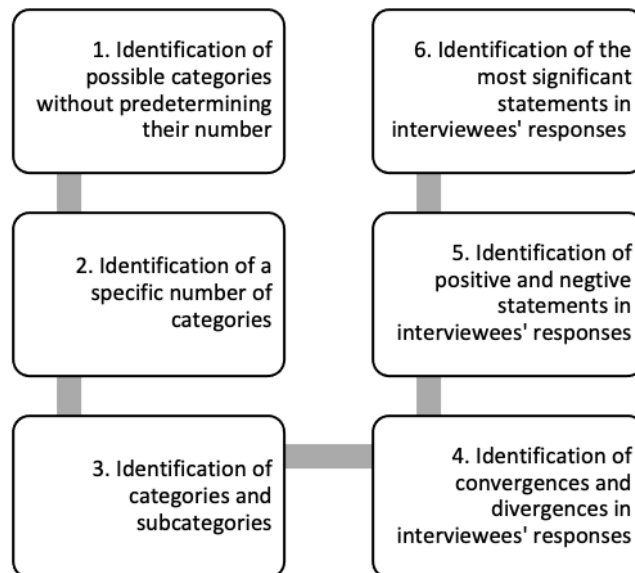


Figure 1. Uses of ChatGPT for analyzing interviews. Source: Own elaboration.

Prompts can also be used for analyzing other texts obtained with qualitative approaches: documents and discussion groups, for example. In general, the usefulness of ChatGPT in qualitative analysis is in facilitating the processes of identifying key ideas, summarizing information, identifying positive, negative or neutral tones in a text, giving ideas for the initial codes in the coding process or comparing codes with those created by researchers. Lastly – and this list is not exhaustive – it enables us to organize our data into tables by showing the main themes identified in the text, with the related codes, their definitions and relevant quotations (although we should always be aware that some of its answers may contain errors).

It should be noted, however, that the algorithms cannot identify key ideas per se but work by searching for the most frequent words or terms representing categories constructed via statistical lexical classification, with outcomes that are not necessarily meaningful as they are simply quantitative results guided by the prompts. Hence, these processes require great care on the part of the researcher. While AI tools like ChatGPT may seem smart, capable and reliable, they have many limitations. Often their responses do not have any intentional semantic significations or interpretations similar to the human processes of cognition and identification of meanings but may be inaccurate, biased or meaningless (Hamilton *et al.*, 2023). Their purely mathematical

approach to reasoning is not equivalent to human intelligence, since they use a self-regression model which has no introspective capacity or access to the external resources that a person has and which cannot monitor its own coherence or correct itself (European Council, 2023).

Therefore, the main objective of this paper is to demonstrate how artificial intelligence (AI), and in particular ChatGPT 3.5, can be used as a generative tool for qualitative data analysis, specifically through the use of prompts. Thus, we seek to illustrate how AI can aid in this process by providing a guide that facilitates researchers' initial tasks of data description and interpretation. At the same time, we also aim to raise awareness of certain unresolved ethical issues and challenges in the use of these tools, which require great caution on the part of the research community.

2. Context

The context of the study presented here focuses on the exploration and application of a range of prompts which, while specifically formulated to assist qualitative data analysis on a specific topic, could also be used for any other subject (for example, education, sustainable development, culture, etc.). To test ChatGPT 3.5, it was decided to start with a number of UNESCO reports and blogs, since they usually contain a large amount of textual information that can be challenging to analyze manually.

These prompts were designed with the aim of assisting the qualitative analysis of data during different phases of the process, including the identification of emerging themes, the categorization of relevant information and the detection of connections or relationships between different sections or concepts within the reports and blogs, thereby facilitating the processing and understanding of the documents in question. It should be remembered that the language model of ChatGPT works to achieve these tasks by learning statistical models from large amounts of textual data, which allows it to recognize semantic relationships, infer intent and tailor responses to the specific context of a conversation.

Thus, the study presented here involved implementing the prompts and analyzing the results from a number of official UNESCO and United Nations documents on ethics,

education and artificial intelligence (UNESCO, 2019; 2022; 2023), in addition to other blogs and press releases on the same topics both from the UN (United Nations, 2023a; 2023b; 2023c; 2023d) and from UNESCO (2023, June 8; 2023, October 16).

Through this study, the versatility of ChatGPT 3.5 as a generative tool for beginning the qualitative analysis of textual documents in the academic and education research field is demonstrated. Accordingly, the purpose of this article is not to explain the technical details of how ChatGPT works but to explore the tool as a “black box” capable of processing natural language queries with a dataset that can generate various responses.

Before doing so, however, the first steps of using ChatGPT in qualitative analysis should be explained. Firstly, whatever version is chosen, we need to create an account on the platform. Second, it is necessary to define the type of tasks to carry out with the application – since it is on this basis that the tests will be run – through the use of prompts or instructions to obtain various types of outcomes. At this point, it is important to have a fairly clear idea of how to proceed and which references to use before starting to ask the tool questions. The more precise the instruction, the more likely it is that the result will be accurate. To this end, we recommend training ChatGPT with various short test excerpts and data types to explore its versatility. One way to do this is through roleplay, since prompts in this form allow ChatGPT to produce answers from the standpoint of specific scenarios and contexts. Among possible prompts, you may instruct it, for example, as follows: “Imagine that you are a qualitative researcher”, “Imagine that you are the author of an educational research report”, “Imagine that you are an expert on this subject and that you need to perform a data analysis” or “Imagine that you are an expert on analytical topics”. Assigning such roles to ChatGPT can improve the quality of the output, although in fact quality has more to do with the iteration of questions that explore the data from multiple perspectives, as is common in qualitative research, than with the real ability of the tool to provide truthful and reliable results.

3. Exploring the potential of ChatGPT for analyzing qualitative data: implementation and reflections

Without a basic understanding of qualitative data analysis, even with the assistance of CAQDAS (Sabariego, Vilà, & Sandín, 2014), one's ability to properly take advantage of generative AI tools is severely limited and can lead to many errors. When using these applications, therefore, a familiarity with the basics of qualitative data analysis is absolutely essential (Sandín, 2016). This (as noted above) generally involves procedures that include: (a) reducing and synthesizing information in order to answer specific research questions; (b) representing this information in various formats such as tables, graphs and diagrams; and (c) interpreting data on different levels of theorization (always bearing in mind that AI cannot substitute for any of these procedures: Miles & Huberman, 1994; Miles *et al.*, 2020). During this process, the essential activities performed by the researcher include identifying relevant information, coding, grouping codes into categories or themes, and identifying patterns in the data.

Below we explain in more detail the analytical approaches that we suggest can be assisted by AI. All of them form part of a process that can facilitate subsequent human interpretive analysis on different levels (Figure 2), bearing in mind that the proposed prompts only simulate an interpretation of the content of the articles provided and/or the understanding of a text or text summary. AI produces segments of words organized by algorithms of transformation, prediction and generation of the order of words, without perceiving or thinking about their meanings; its "understanding" is limited to natural language processing and text generation based on learned patterns and does not entail understanding in the broader human sense, which involves consciousness, experience and abstract reasoning.

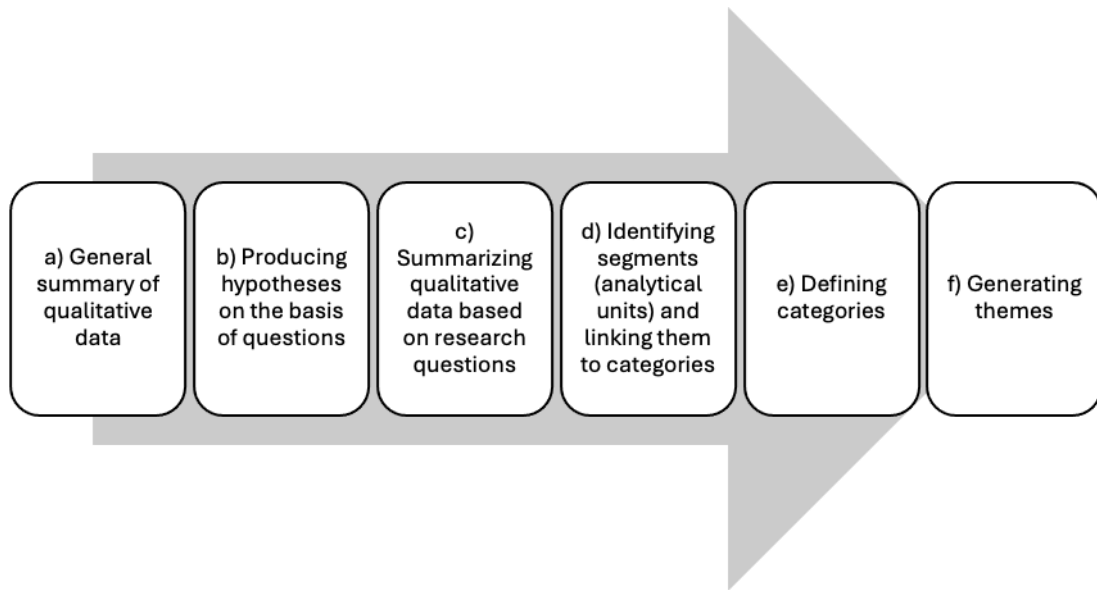


Figure 2. AI-assisted analytical procedures. Source: Own elaboration.

In order to explore the application's operation and outputs, a specific prompt was designed for each of the analytical procedures, indicating that it should be applied to the sample of the UNESCO and United Nations materials mentioned above. In general, the characteristics and structure of the prompts were as follows:

Table 1: Structure of prompts

Role that ChatGPT was to adopt (optional, but this provides more precise outcomes)	For example, if a medical, juridical or educational response is required.
Task (clear and specific)	Summarize, create codes, define, select, create, etc.
Context or broader view of the task (if necessary)	For example: consider the following research question { }
Output	Characteristics and format that we wish to give to the information solicited. For example: organization in three-column table, codes of two to five words, 150-200 word summary, etc.

Source: Own elaboration.

3.1 General summary of qualitative data

Sometimes what is needed to start the analysis of a data corpus is to have an overview of the material, a global snapshot of the information. In this example, we requested a summary of the UNESCO Beijing Consensus Report (2019) on how artificial intelligence (AI) is transforming education and how we can make the most of the opportunities it offers. The information obtained from this type of prompt can be used as a memorandum associated with the documents analyzed. A summary of a document can also become a new document in the analytical corpus of a study. Figure 3 shows the prompt used (both the length and the instruction itself can always be adapted to the researcher's specific needs).

ChatGPT Prompt:
Summarize the transcript below in 200 words.

Figure 3. Example of prompt for generating a summary. *Source:* Own elaboration.

The output obtained is shown below:

 **ChatGPT**

The International Conference on Artificial Intelligence (AI) and Education, held in Beijing in May 2019, gathered government officials, international representatives, and stakeholders to discuss AI integration in education. Participants reaffirmed commitments to Sustainable Development Goal 4 (SDG 4) and its targets, emphasizing the need for innovative education approaches. They recognized AI's complex impact on society and education, stressing the importance of ethical AI development centered on human values. Recommendations included aligning AI policies with education objectives, investing in AI implementation, and leveraging AI for education management, teacher empowerment, and learning enhancement. The document also highlighted the necessity of addressing gender disparities in AI, ensuring equitable access, and promoting inclusive education. It emphasized ethical AI use, data privacy, and the importance of monitoring AI's impact on education. The recommendations urged international cooperation, capacity-building, and resource mobilization to bridge AI disparities and promote AI's role in achieving SDG 4. Additionally, UNESCO was invited to establish an AI for Education platform, develop guidelines for AI integration in education policies, and reinforce its leadership in AI education initiatives globally.

Figure 4. Summary generated by ChatGPT

In the case of multiple interviews, for example, ChatGPT would yield an individualized summary of each, thereby giving us a preliminary understanding of the participants before going into further depth in the analysis of the same data.

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3.2 Generating hypotheses using questions

Another interesting possibility for exploratory data analysis is the formulation of hypotheses. Using a prompt like that in Figure 5 below, ChatGPT can not only provide various hypotheses (Figure 6) but also classify the segments or analytical units of a document (Figure 7).

ChatGPT Prompt:
Propose hypotheses that can help guide the research and analysis of this interview by providing possible explanations or interpretations of the themes and messages present in it. Formulate three hypotheses about the following question: "What could the overall impact of the introduction of artificial intelligence be, in terms of socioeconomic inequality, ethics, government regulation and human rights?"

Figure 5. Example of a prompt for generating hypotheses. Source: Own elaboration.

Although we are aware that the sentences stating the AI-generated hypotheses may not be exhaustive, or not always plausible, they can be of interest for reflecting on the data.

1. Hypothesis 1: The introduction of artificial intelligence technology may exacerbate socioeconomic inequality by widening the gap between those with access to advanced technology and those without, leading to unequal opportunities for economic advancement and social mobility.
2. Hypothesis 2: Ethical considerations surrounding the use of artificial intelligence technology may become increasingly complex and contentious, as the potential for biases, discrimination, and privacy violations raises concerns about fairness, accountability, and transparency in decision-making processes.
3. Hypothesis 3: Government regulation of artificial intelligence technology may struggle to keep pace with rapid technological advancements, resulting in inadequate safeguards to protect human rights, such as privacy, freedom of expression, and non-discrimination, thereby leaving individuals vulnerable to exploitation and abuse.

Figure 6. Hypotheses generated. Source: Own elaboration.

Also, by rephrasing the prompt, the analytical units can be generated in table format (Figure 7). The resulting chart, as shown below, organizes the text in terms of the hypotheses generated, with the relevant supporting citations.

Hypotheses	Supporting Excerpts from the Interview
Hypothesis 1: Socioeconomic Inequality	"With the information we have so far, it would seem that they are increasing or at least not being used to reduce the gaps because we have half of the world's population that is either not connected to the internet, or connected to low-quality internet, or lacks the skills to use technology more effectively."
Hypothesis 2: Ethical Concerns	"Given that artificial intelligence has the potential to amplify biases and discrimination inherent in data sets and algorithms..."
Hypothesis 3: Government Regulation	"The fact that they currently have this spirit of self-regulation, and that many of them are lobbying against the adoption of any regulation, does not mean that the State is powerless and that governments do not have the tools to improve things."

Figure 7. Excerpts from documents classified according to the hypotheses generated.

Source: Own elaboration.

3.3 Summarizing qualitative data based on a research question


This third strategy also involves using ChatGPT as a tool for a preliminary examination of qualitative data before doing a thorough line-by-line analysis when coding. In this case, it allows us to explore the content of the data through a summary provided by the application addressing a specific research question. The following example shows how the prompt includes a question about "skills needed in the age of AI", which guides the analytical focus for the three summaries that ChatGPT will generate from the UNESCO reports (2020, 2021 and 2022). In the prompt we specify the format and length of the output required (Figure 8).

ChatGPT Prompt:
Summarize the three transcripts based on the research question, "What competencies are required in the AI era, and what strategies are needed to prepare everyone to live and work effectively with AI?" Generate a table containing the summary of the three forums. Each summary should not exceed 150 words.

Figure 8. Example of a prompt for generating summaries based on a research question.

Source: Own elaboration.

The output is shown in Figure 9 below:

 ChatGPT

Forum	Summary
UNESCO 2020	The forum emphasized the importance of understanding AI's implications for education and society. It highlighted the need to teach young people about the theory of the artificial mind, emphasizing computational thinking and human control over AI. AI integration in education was discussed, addressing challenges like bias and surveillance. It underscored the necessity of inclusive AI education to ensure informed decision-making and prepare students for the future.
UNESCO 2021	This forum focused on promoting gender equality and empowering women and girls with AI competencies. It highlighted the widening gender gap in digital skills and emphasized the importance of equitable access to technology and AI skills for women and girls. Strategies discussed included mentorship programs, targeted training initiatives, and collaborations with the private sector to create opportunities for women and girls in AI-related fields.
UNESCO 2022	The forum discussed AI competencies for teachers, emphasizing the need for teachers to understand AI both as a subject and as a tool for teaching. Competencies ranged from basic AI understanding to designing AI-enhanced classroom environments. Strategies for upskilling teachers included incorporating AI education into teacher training programs and providing in-service training through various models and collaborations.

Figure 9. Results of the prompt in table format. Source: Own elaboration.

As may be seen, the table gives the requested information based on the research question, a result which will always need to be checked since the algorithm gives answers but does not guarantee veracity. This enables us to capture the core themes regarding AI discussed in the UNESCO forums. The summaries prioritize one salient idea for each document, namely: accounting for AI competences in education to prepare students for the future (UNESCO, 2019); focusing on strategies for developing gender-related AI competencies (UNESCO, 2021); and addressing AI competencies among teachers and in teacher education programs (UNESCO, 2022).

3.4 Identification of segments (analytical units) and association with categories

The analysis of qualitative data involves the selection and organization of the information to be analyzed. This means selecting relevant, quality information. For this reason, Taylor and Bogdan (1987) recommend careful, close, continuous reading and re-reading of the data in order to gradually reflect on them, classify them, measure them, and establish themes, concepts, categories and relationships.

3.4.1 Identification of segments with inductive code generation

ChatGPT was also of use in identifying relevant fragments in the text, based on our research question, through the prompt below (Figure 10). An exploration of possible associated codes was also included in the prompt so that it could provide ideas for setting up the system of categories and for starting the categorization and coding process.

ChatGPT Prompt:

Review the text. (1) Extract all portions addressing the following research question “What are the challenges posed by the introduction of artificial intelligence (AI) in the education system?” (2) Generate codes that best represent the excerpts identified. Each code should be from two to five words. Provide a code for each extract. List each excerpt along with its suggested code.

Figure 10. Example of a prompt for identifying segments and creating initial categories.

Source: Own elaboration.

The results are shown in Figure 11 below:



-  ChatGPT
1. **Excerpt 1:**
 - **Code:** Privacy Concerns
 - **Excerpt:** "In the educational context, concerns about data privacy and security are paramount. With AI systems collecting vast amounts of student data, there are significant risks of privacy breaches and unauthorized access to sensitive information."
 2. **Excerpt 2:**
 - **Code:** Bias and Discrimination
 - **Excerpt:** "Another challenge is the potential for AI algorithms to perpetuate bias and discrimination. If these algorithms are trained on datasets that reflect societal biases, they may inadvertently reinforce existing inequalities in education."
 3. **Excerpt 3:**
 - **Code:** Accessibility Issues
 - **Excerpt:** "Accessibility is a major concern when integrating AI into education. Not all students have equal access to technology, and there is a risk that relying too heavily on AI-driven tools could exacerbate existing disparities in access to quality education."
 4. **Excerpt 4:**
 - **Code:** Ethical Dilemmas
 - **Excerpt:** "Ethical dilemmas also arise with the use of AI in education. For example, there are questions about the appropriate use of student data, the transparency of AI algorithms, and the implications of relying on AI for tasks traditionally performed by human educators."
 5. **Excerpt 5:**
 - **Code:** Teacher Training
 - **Excerpt:** "A significant challenge is ensuring that teachers are adequately trained to integrate AI tools into their teaching practices. Many educators may lack the necessary skills and knowledge to effectively leverage AI for educational purposes."

Figure 11. Identification of excerpts based on a research question, with proposed codes.

Source: Own elaboration.

As seen earlier, the information can be obtained in tabular format by adding an additional request to the system or by including it in the initial prompt (Figure 12).

 ChatGPT

Code	Excerpt
Privacy Concerns	"In the educational context, concerns about data privacy and security are paramount. With AI systems collecting vast amounts of student data, there are significant risks of privacy breaches and unauthorized access to sensitive information."
Bias and Discrimination	"Another challenge is the potential for AI algorithms to perpetuate bias and discrimination. If these algorithms are trained on datasets that reflect societal biases, they may inadvertently reinforce existing inequalities in education."
Accessibility Issues	"Accessibility is a major concern when integrating AI into education. Not all students have equal access to technology, and there is a risk that relying too heavily on AI-driven tools could exacerbate existing disparities in access to quality education."
Ethical Dilemmas	"Ethical dilemmas also arise with the use of AI in education. For example, there are questions about the appropriate use of student data, the transparency of AI algorithms, and the implications of relying on AI for tasks traditionally performed by human educators."
Teacher Training	"A significant challenge is ensuring that teachers are adequately trained to integrate AI tools into their teaching practices. Many educators may lack the necessary skills and knowledge to effectively leverage AI for educational purposes."

Figure 12. Table generated through an additional instruction to organize excerpts and codes into two column. Source: Own elaboration.

3.4.2 Identification of segments on the basis of already established codes

Adopting a theory-oriented or deductive analytical approach, it is also possible, for example, to request the identification of excerpts that respond to a code and a prior definition established by the researcher (Figure 13 below).

ChatGPT Prompt:
Extract quotes from the data offering insights into “personalized learning” within the framework of AI integration in the education system. “Personalized learning” in the context of AI integration involves tailoring educational experiences to individual students’ needs, abilities and interests, and leveraging technology to optimize engagement and learning outcomes.

Figure 13. Example of a prompt for generating category definitions. Source: Own elaboration.

3.5 Category definition

Another task that ChatGPT can carry out is to define categories for research. For example, focusing on excerpts previously identified by the researcher, we requested the software to write a definition of a code based on the empirical data and to provide an example. In this type of task, the relevant excerpts need to be entered in ChatGPT, and a prompt of this type can be used (Figure 14):

Figure 14. Example of a prompt for generating category definitions

The result is shown in Figure 15 below:



ChatGPT

Definition:

"Ethical dilemmas" refer to moral conflicts or issues arising from the introduction of artificial intelligence (AI) in the educational system, where ethical principles, values, or concerns are at stake.

Example:

One example from the excerpts is the discussion about the potential biases and discrimination perpetuated by AI algorithms in educational settings. For instance, the concern raised about algorithms reinforcing stereotypes or limiting access to opportunities based on biased data.

Segments that might not fit:

Some segments discussing the benefits of AI in education, such as enhancing personalized learning experiences or improving educational outcomes, might not directly address ethical dilemmas. While these segments are relevant to the broader discussion about AI in education, they do not specifically focus on the moral conflicts or ethical concerns associated with its introduction.

Figure 15. Results of a prompt for generating category definitions

3.6 Generating themes

Following a systematic process of analysis, we can ask ChatGPT to review the categories and generate themes based on them. In the context of qualitative data analysis, a theme can refer to any recurring concept, idea or pattern relevant to the research objective that is identified in the data. These themes may represent key ideas or concerns, shared experiences or any other significant feature found in the data that can be systematically analyzed and categorized to better understand the phenomenon under study.

Themes can be explored in an initial synthesis of the documents (interviews, diaries, focus groups, etc.; see section a) and can also be constructed from a code listing provided by ChatGPT (section c).

In the following example, we generated themes from a list of codes. First, four documents were analyzed (UNESCO, 2019; 2021; 2022; 2023), requesting the generation of codes and identification of excerpts that answered the research question: "How does the integration of artificial intelligence (AI) affect the education system in terms of equity, accessibility and quality of education?" ChatGPT produced a

total of 20 codes with their corresponding excerpts. Figure 16 below shows part of the list created:

Excerpts	Codes
The integration of artificial intelligence in education can improve equity by offering personalized resources for students with different needs.	Equity Improvement
AI can increase educational accessibility by providing adaptive learning tools that cater to each student's preferences and abilities.	Adaptive Learning
Educational quality can be enhanced through the use of AI to analyze student performance data and provide instant, personalized feedback.	Quality Enhancement
Introducing AI in the classroom could level the playing field for students of diverse abilities and socioeconomic backgrounds.	Leveling Effect

Figure 16. Example of excerpts and categories provided by ChatGPT

Based on this information, we wanted the program to propose themes representing different aspects of how the integration of artificial intelligence affects equity, accessibility and quality in education (Figure 17).

ChatGPT Prompt:
 Categorize codes leading to development of themes addressing the following research question: "What are the risks and benefits of the introduction of artificial intelligence (AI) into the education system?" Each theme should be from two to five words.

Figure 17. Example of a prompt for generating themes. Source: Own elaboration.

It should be remembered, once again, that the researcher will always have to examine, verify and analyze the results to make sure that the categories emerging in each of the themes are relevant.

The result is shown below:

Theme	Codes
Equity Enhancement	Equity Improvement, Leveling Effect, Democratization, Learning Gap Reduction, Needs Identification
Accessibility Advancement	Adaptive Learning, Online Accessibility, Special Needs Support, Rural Access, Mobile Accessibility
Quality Improvement	Quality Enhancement, Objective Assessment, Interactive Learning, Student Retention
Personalization Promotion	Personalized Learning, Individualized Learning, Adaptive Platforms
Language Barrier Mitigation	Language Barrier

Figure 18. Table resulting from a prompt for generating themes. Source: Own elaboration.

With a few additional instructions, ChatGPT can provide a more complete table, including third and fourth columns with illustrative excerpts and the source document (Figure 19).

Theme	Codes	Excerpts	Document
1. Equity Enhancement	Equity Improvement	"AI promotes equity by providing personalized learning experiences tailored to each student's needs."	Document 1
	Leveling Effect	"The introduction of AI helps level the playing field by offering resources and support to underprivileged students."	Document 2
	Democratization	"AI in education leads to the democratization of knowledge, making high-quality learning accessible to all."	Document 3
	Learning Gap Reduction	"One of the benefits of AI integration is the reduction of learning gaps among students, ensuring equal opportunities for all."	Document 4
	Needs Identification	"AI systems excel in identifying individual student needs, allowing educators to provide targeted support."	Document 5

Figure 19. Table resulting from a prompt for generating themes and linking them to analytical units. Source: Own elaboration.

4. Findings

Our findings on the usefulness and limitations of ChatGPT in qualitative analysis, resulting from the exploration of the application's versatility, are discussed below.

The first observation was that the use of this tool in qualitative analysis is particularly helpful in the initial stages of analysis, when approaches are brought into play that help us summarize the data and start the processes of categorization, thematization and coding of the analytical units. AI tools like ChatGPT are useful because they can quickly turn large segments of text into numbered or bullet points, which can make it easier to understand and process the information in the dataset. Thus, although it is clear that it is important to use tools like ChatGPT with great caution, we found it interesting that the debate on these strategies, rather than focusing on whether their analyses may become superior to human ones, centers on the investment of time needed to start using them and on comparing results in diverse ways. Precisely at the current moment, when the postmodern and post-experimental movements have caused qualitative research to bring increasing attention to bear on new forms of creation such as literary texts, rhetoric, art, narratives, and visual and multimodal approaches to data analysis (Denzin & Lincoln, 2018), the iterative querying of a dataset using AI tools becomes interesting not only to aid interpretation but also for researchers to advance their understanding and representation of the phenomena studied.

However, it is also clear that directly copying the ChatGPT prompts used in this study would not always be the most effective strategy. In fact, the generation of outputs and their quality involves a back-and-forth engagement with the data that requires multiple iterations and the design of multiple prompts (adjusting them as necessary) as the data is explored. This highlights the importance of using ChatGPT as it is; i.e., a chatbot: a tool that enables us to iteratively converse with the data and to explore it in order to refine and improve the results it provides as we progress to deeper levels of qualitative analysis.

At this point, we should also mention the differences between the free and paid versions of ChatGPT, as well as between versions 3.5 and 4.0. The small-scale study described here also stresses the importance of testing these different versions and

specific features of ChatGPT when interpreting and analyzing results, since these will always be different and more or less refined depending on the version used. Similarly, as AI-assisted research gains more importance in tandem with the exponential growth of online information, it also poses challenges in terms of assessing the quality and reliability of the data gathered, which in turn means that the researcher needs extensive training and should maintain a constantly critical awareness of automatically generated outputs. In fact, the tool itself points out in its interface that “ChatGPT can make mistakes. Consider checking important information” (OpenAI, 2023). Hence, it is recommended to avoid depending on it and the results it generates.

Furthermore, we would also emphasize the need to thoroughly explore and study one’s own qualitative data rather than relying solely on the analysis generated by ChatGPT. It is absolutely necessary for researchers to read, re-read, explore and study their data, making use of the literature, memos, diagrams, art, design, and all the approaches at their command for manually seeking relationships, labelling, categorizing, etc., and at the same time comparing these with automatically generated outputs. Therefore, in qualitative analysis under no circumstances would we recommend carrying out analytical procedures solely with AI and copying and pasting the results into a report. As always, qualitative analysis requires us to go far beyond what emerges on the surface of the data.

Lastly, we wish to close this section by highlighting the importance of experimentation and creativity when using and testing ChatGPT in qualitative analysis. The more different functionalities one asks of the tool by exploring its various functions (emojis, graphs, tables, etc.), the richer and more interesting the exploration of the data will be, the more the tool will adapt to the specific needs of the study, and the more closely it will conform to the ontological and epistemological perspective of the researcher. The most relevant results depend on the approach and the queries of the person behind the data; a person who needs to adopt an active attitude of exploration and ongoing learning rather than relying on the automated results of prompts.

5. Conclusions and discussion

In the light of the above, we should not fail to mention that in this study we have collected only a few non-exhaustive examples of prompts for using ChatGPT in analyzing qualitative data, and that these can and should be adapted on the basis of the capacity and flexibility of the system, which currently can be used to generate new scenarios in a wide variety of tasks and projects.

Whatever approach is adopted, what we propose here is essentially that the use of AI involves strategies and methods, some of which may be automated and perhaps faster, and that these strategies and methods should continue to be seen as sensitive activities, always demanding engagement with the data, and not as a set of ready-made AI procedures that lay out the route for us to take. Thus, in all cases, we should be aware that the results offered by AI are not the outcome of a cognitive or argumentative process of comprehension of the documents in our study corpus, but that they vary depending on statistics of word usage, organized by algorithms using predictive mathematics without understanding the meanings of the words. Consequently, when using AI we should exercise great caution, always insuring monitoring by the researcher.

Furthermore, it would be meaningless to use AI for its own sake, or because it is fashionable or simply because it exists. Indeed, these are the real risks we may run if we let ourselves be over-impressed by the ever-expanding range of AI potentials. These can be interpreted as an easy route to qualitative research, without thinking seriously about what they can offer us either as researchers or for the particular study at hand. As researchers (in training or otherwise), we should be aware of the increasingly wide range of possible methods, learn from them and continue to ask ourselves why we wish to use a particular tool, what kind of data or insights it can provide in relation to our research objectives; what degree of veracity is ensured by the results yielded, how we can check the information we obtain, etc. Likewise, it is essential to bear in mind that, despite the advantages that these tools offer, we should be aware that AI models are not infallible or fully reliable and may inherit biases from the data, algorithms or interpretations with which they are constantly trained.

The rapid evolution of AI and its creative potential in various fields (Sánchez-Santamaría & Olmedo, 2023), including both text creation and art forms like painting

Sandín Esteban, M. P., & Sánchez Martí, A. (2024). A case study in artificial intelligence-assisted qualitative analysis: The use of ChatGPT prompts with UNESCO texts. *Revista Catalana de Pedagogia*, 26, 38-63. <https://doi.org/10.2436/20.3007.01.209>

and music, is not only producing a fundamental change in our way of seeing activities that until now were the preserve of human beings but also raises legal and regulatory issues related to copyright, intellectual property and authorial rights. In particular, the application of AI to text analysis may entail the processing and reinterpretation of copyrighted material, which therefore involves both ethical and legal issues. The automated nature of content generation by artificial intelligence systems can further complicate the delineation of responsibilities and due attribution of authorship. Hence, it is crucial to develop clear protocols for the use of protected data and for safeguarding intellectual property rights in the field of academic research. This will ensure not only regulatory compliance but also integrity and transparency in the production and dissemination of scientific knowledge. In the current context of exponential technological advances, it is essential that we should remain abreast of the field in terms of legal and regulatory developments in copyright and intellectual property and the editorial policies of the journals in which research is published.

In relation to the above, it should be remembered that in December 2023 the European Parliament passed the Artificial Intelligence Act (AI Act), which will go into force in May 2025, with the aim of regulating the uses and risks arising from the use of AI. Among the obligations it sets out, this law requires risk assessment and reduction, transparency and precision when reporting AI-assisted procedures, and constant human supervision.

In conclusion, this study has provided detailed insight into the use of AI (which generates responses that reflect the conditional probabilities of word sequences based on learned statistical patterns) in qualitative research, through its practical application to the analysis of the official discourse of organizations such as UNESCO, a body that has particularly recommended bringing attention to bear on the lack of regulation of the use of data and the ensuing ethical issues that need to be addressed by society (UNESCO, 2023). As we have seen, these analytical AI tools enable progress in line with the most recent and, in many ways, diverse developments in qualitative research. At the same time, we face multiple unresolved ethical issues and challenges relating to the veracity, privacy and security of data, which should be addressed by establishing practices and policies that protect rights and the privacy of information while at the

same time harnessing the potential of AI technologies for qualitative data analysis. For this reason, it is necessary to thoroughly review the conditions and implications behind the use of these tools in order to ascertain to what extent it is possible and advisable.

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The ARTificial revolution. Introducing generative artificial intelligence tools into artistic education

La revolució ARTificial. Introducció d'eines generatives d'intel·ligència artificial en l'educació artística

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Abstract

This article presents an experience of integrating generative artificial intelligence (AI) technologies in artistic education in the Primary School Teaching degree course. The aim of combining AI algorithms with traditional image editing techniques is not only to teach instrumental skills but also to foster a critical understanding of the limitations and risks associated with these technologies, promoting responsible and ethical use. The ability of AI to rapidly generate original content from text, images, video, and code, presents a complex landscape of opportunities and challenges. AI is redefining human cognitive processes and creativity, making it crucial to emphasise the importance of maintaining human intelligence as an irreplaceable complement to technology. The implementation of generative AI in art education not only enriches visual and aesthetic learning but also prepares students to contribute critically and creatively to the intersection of art and technology, equipping them with essential skills for innovation in their artistic practices.

Keywords

Artificial intelligence, content generator, creativity, art education, critical thinking, technology.

Resum

Aquest article exposa una experiència d'integració de les tecnologies d'intel·ligència artificial (IA) generativa en educació artística al grau de mestre d'educació primària. En combinar algorismes d'IA amb tècniques tradicionals d'edició d'imatges, es busca no sols aprendre habilitats instrumentals, sinó també fomentar una comprensió crítica de les limitacions i riscos associats a aquestes tecnologies, i promoure'n un ús responsable i ètic. La capacitat de la IA per a generar contingut original ràpidament, des de textos i imatges fins a vídeos i codis, presenta un panorama complex d'oportunitats i desafiaments. La IA està redefinint els processos cognitius humans i la creativitat, i és fonamental incidir en la importància de mantenir la intel·ligència humana com a complement irremplaçable de la tecnologia. La implementació d'IA generativa en l'educació artística no sols enriqueix l'aprenentatge visual i estètic, sinó que també prepara l'alumnat per a contribuir críticament i creativament en la intersecció de l'art i la tecnologia, equipant-lo amb habilitats essencials per a la innovació en les seves pràctiques artístiques.

Paraules clau

Intel·ligència artificial, generador de continguts, creativitat, educació artística, pensament crític, tecnologia.

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1. Introduction

The discourse on machines as creators, furthered by Benjamin (2018) concerning the loss of art's "aura" in the age of mechanical reproduction, has been significantly advanced with the advent of generative artificial intelligence (AI) in the realm of artistic creation. This technological progression calls into question traditional notions of art and authorship, leading to a reassessment of the creativity, authenticity, and aesthetic value inherent in AI-generated art. Generative AI effectively obfuscates the distinction between human and machine creativity, necessitating a reevaluation of art definitions and the role of authorship and originality in the AI era. While AI facilitates broader access to art, its involvement in artistic production mandates a critical appraisal of art's value and significance within societal contexts. As technological advancements continue to redefine creative expression, discussions regarding innovation and human creativity in an increasingly digitised world gain critical importance. Historical shifts in artistic methodologies, such as CNC tools or photography, highlight the evolving dynamics of artistic creation and its gradual emancipation from technical prowess. Vartiainen and Tedre (2024) alongside Habbal, Ali and Abuzaraida (2024) accentuate the profound influence of AI on creative methodologies and underscore the imperative of the judicious use of technology.

Software, deeply embedded in contemporary everyday life, influences economic, cultural, creative and political aspects in both overt and imperceptibly subtle ways. The complexity of new technologies has opened new frontiers in human-machine interactions, developing a social dependence on mobile devices and social networks that nurture big data and, through deep learning, make AI the backbone of a media system primarily for marketing purposes (Dwivedi *et al.*, 2023). For decades, without full awareness, we have been subjected to analysis by AI tools that aim to predict our preferences based on our digital consumption habits. Deep neural networks that learn directly from our aesthetic choices have marked a turning point in AI's ability not only to describe and predict human behaviour, but also to create artefacts and simulate those behaviours, ushering in a new paradigm on a scale comparable to previous technological revolutions.

When AI is mentioned, it is often thought of as a single, homogeneous entity capable of autonomously performing complex tasks. However, this widespread view does not reflect the diversity and richness that characterise these tools. AI encompasses a wide range of models and systems designed with specific functions and objectives in mind. Each model is based on different principles and is designed to solve various problems, including prediction, content generation, classification, and natural language processing.

Table 1: AI models

Model	Description	Applications
Predictive	Uses historical data to make predictions about future events.	Weather forecasting, financial analysis, product recommendations.
Generative	Generates new data similar to training data.	Creation of images, video, text, music.
Classification	Identifies which category a new observation belongs to.	Image recognition, spam filtering, medical diagnosis.
Recommendation	Predicts user preferences and recommends products or services.	Streaming platforms, e-commerce, content services.
Anomaly detection	Identifies unusual patterns that do not conform to expected behaviour.	Fraud detection, health monitoring, predictive maintenance.
Decision	Assists in making complex decisions, based on a set of rules or strategies.	Expert systems, optimisation algorithms.
Regression	Estimates relationships between variables to predict a continuous quantity.	Estimation of relationships between variables.

Source: the author.

The significant progress of AI is mainly attributed to the generative applications that are now accessible to the general public through generative adversarial networks (GANs). Nguyen (2021) predicts that GANs will account for 10% of all generated data by 2025. The GAN architecture relies on two neural components: the discriminator network (D) and the generator network (G). The primary purpose of the G network is to generate new samples that imitate the domain of the original data, while the D network's objective is to distinguish between real samples (i.e., directly drawn from the original dataset) and fake samples (artificially generated by G). This training process is concurrent and competitive, promoting continuous enhancement in both models (Mulé *et al.*, 2023). The process involves refining G to produce data that closely resembles real data, with the aim of deceiving D. Meanwhile, D evolves to identify the subtle differences between authentic and synthetic samples. This feedback loop ensures that the generation and discrimination of samples iteratively improve, resulting in the production of highly realistic synthetic data.

Among generative applications, the most advanced language model that has spurred the current AI frenzy is the generative pre-trained transformer (GPT). GPT was first introduced in 2018, and subsequent versions have been released, including GPT-2 (2019), GPT-3 (2020), GPT-3.5 (2022), GPT-4 (2023), and GPT-5 (2024), all developed by OpenAI. The processing technique behind these models is known as the transformer. In 2017, Google introduced a model that revolutionised natural language processing. The architecture relies on attention mechanisms to enhance contextual understanding of data. Compared to previous models that relied on linear sequences for data analysis, the transformer enables each element of the sequence to access any other element directly. This facilitates a more nuanced and comprehensive interpretation of the context and relationships between words or elements in a sequence (Bhandari *et al.*, 2023). Attention layers are used to weigh the relative importance of different parts of the input data. Its non-recurring design allows for faster and more efficient training by dynamically adapting to optimise information processing based on the specific context.

While AI has opened new creative opportunities for many artists, it also poses a threat to those who rely on their ability to deliver bespoke and high-quality work (Campbell, 2022). Illustrators may be particularly vulnerable to this threat (Barandy, 2022). Computer-generated imagery (CGI) technology, developed by the film industry, has been adopted to create deepfakes, which allow the creation of manipulated videos that look authentic thanks to algorithms that allow the embedding of third-party faces and voices into a video with hyper-realistic results (Montasari, 2024). It is important to note that advances in deepfake technology have changed the game in the creative industry by allowing people to be recreated in an extremely realistic way. Simply by providing the system with a set of images and a face, it learns to superimpose the face onto the images. The sophistication of fake content is such that the fictitious is almost indistinguishable from the real. It expands the creative possibilities of audiovisual media, but also facilitates the manipulation of reality (Nguyen *et al.*, 2022). Its ability to deceive any viewer is so great that it can be used for malicious purposes, including creating hoaxes, fabricating news, committing fraud, and attacking the honour or reputation of a person, institution, or government (Buschow & Suhr, 2022). Deepfakes create the illusion that their subjects are doing or saying things they have never done or said, or participating in situations that have never occurred. To make matters worse, the technology used to create synthetic fakes is becoming increasingly accessible, so that today anyone can create artificial content without any special knowledge of CGI or digital retouching.

Deep lies do not represent a philosophical leap from simple lies (hoaxes). The psychological underpinnings of both are the same: people tend to believe and spread any lie that fits their prejudices; labelling something as a hoax does not prevent people from continuing to believe and spread it; the relentless repetition of a falsehood turns it into truth for uncritical audiences. A well-faked video, however, works even better than a written lie. After all, seeing is believing. Our confidence in our ability to distinguish real from fake videos lacks empirical support because we overestimate our ability to discriminate (Köbis *et al.*, 2021).

As a result of the opportunities and threats posed by AI, an art education experience has been developed with the main aim of integrating generative AI as a new creative
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tool for students. This is not a tool that avoids the need to think, however, but one that, taking an imaginative stance, uses technology from the perspective of the creator.

Learning to draw; educating the eye; understanding the basic aspects of composition, lighting, and colour treatment; and developing a library of visual references remain essential to the development of the ability to project ideas. Within the context of technical, material, and procedural knowledge, generative AI would be integrated as a means of expanding creative expression. Although we are still in an early stage, the significant impact that this technology is expected to have soon may modify aesthetic standards and visual communication, making it another relevant aspect to foster students' ability to identify and to interpret, on the basis of certain criteria and in a critical and sceptical manner, the artefacts created by generative AI. In addition to the artistic (interpretive and creative) approach, the third fundamental objective is to deal with the new medium with an educational focus, making it possible to foster a critical and responsible attitude in students who will become teachers in the future. This new medium should be integrated as a didactic tool that can be incorporated into their programming and used to create educational materials.

Future teachers need to be aware of generative AI to be able to integrate it as a creative and didactic tool. We deal below with an experience developed for the Art Education subject of the Primary School Teaching degree course. This experience aims to enhance the exploration and understanding of the fundamentals and applications of generative AI in the visual arts, thereby fostering creative experimentation and promoting critical thinking and media literacy in relation to the creation and consumption of AI-generated products. It seeks to cultivate skills among students to merge generative AI tools with traditional digital editing techniques so that they become aware of the creative possibilities that current technology offers, including image selection, advanced editing, and the integration of visual elements using open digital tools. This methodology is designed to elicit reflection on the significance of authorship and originality in creative endeavours involving AI, illustrating how it serves as a tool that requires human creative direction for the selection, manipulation, and final editing of images, thus emphasising the importance of maintaining creative

control over the process. Furthermore, this task serves as instrumental training for broader undertakings, promoting the development of artistic projects that effectively integrate generative AI. It encourages ongoing experimentation with new tools and techniques in generative AI, stimulating students to continually explore and learn about the emerging capabilities of technology in the field of visual arts.

This educational proposal aims to integrate technology to enrich creative and educational processes, promoting a deep understanding of its foundations and applications and the development of digital competencies necessary for effective use in artistic creation in various forms (visual, audiovisual, textual, and auditory). Additionally, it seeks to encourage artistic experimentation through the combination of generative AI with other traditional methods. This educational approach aims to promote critical thinking and media literacy among students. It fosters reflection on the social, ethical, and cultural impact of generative AI in the arts and develops skills for the informed critique of works generated by AI. The importance of an ethical perspective on artistic creation that recognises authorship, originality, and copyright is emphasised, while attention is given to the potential biases inherent in the technology and whether it is currently feasible to introduce it as a creative tool in basic education.

2. Needs analysis

One aspect that favours students' interest in subjects related to artistic education is their inclination towards visual communication, which makes them more receptive to digital resources and tools involving visual and audiovisual media. In general, apart from Chat GPT, they have not experimented with generative AI tools, as this is a rather unknown field.

3. Context

Today's Generation Z students are heavily influenced by entertainment and communication technologies, which shape their communication, interaction, and information-seeking behaviours. As digital natives, they excel in the intuitive use of technology, remote collaboration, and multitasking, yet struggle with concentration and sustained attention. However, exposure to a digital environment does not necessarily ensure advanced technical skills or digital literacy. Many individuals lack

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proficiency in selecting information, audiovisual literacy, and technical skills for creating digital content. They often rely on pre-made filters instead of developing original content. Due to their accustomed immediacy, they face challenges in critical analysis and reasoned judgment. Additionally, there is a noticeable disregard for the ethical use of technology, highlighting the need for education that fosters responsibility and reflective consideration of one's digital actions. This experience was developed as an update to the digital module of the subject Visual and Plastic Education in Primary Education, which was compulsory in the Primary School Teaching degree course in the 2023-2024 academic year, with 68 students.

4. Proposal of the intervention or experience

One of the objectives of the didactics of artistic education is to familiarise teachers with the artistic creation processes. On the one hand, they can learn how artists work, how they research and strive to question the viewer and contrast the multiple interpretations offered by their works. On the other hand, it can help students to develop a more open attitude towards art and to participate more actively in contemporary culture. Based on the work of the photographer Joan Fontcuberta, students are asked to reflect on the veracity of images and to design and create a fake located on the Mundet campus, which before hosting the faculties of Education and Psychology was successively the temporary residence of the President of the Catalan Government during the Spanish Civil War, a Francoist concentration camp, a refuge for the homeless and an orphanage (Navarro & Torres, 2023). The fake, used by artists as a Trojan horse to challenge consciousness and rethink how we distinguish truth, blends narrative and aesthetics to test the viewer's credibility, mixing facts with inventions. In this process, evidence is created that seems truthful without revealing its fraudulent nature, forcing students to see the everyday differently and to question the credibility traditionally granted to photography, now viewed as susceptible to manipulation in the digital age.

This project is not new: it has been ongoing for three years. It provides an excellent opportunity to develop instrumental and creative skills in digital image editing using Gimp. The image is used as a discursive medium to construct narratives that go beyond aesthetics and the production of closed works. Instead, it generates proposals that

encourage debate and reflection. However, in the 2023-2024 academic year, generative AI technologies were incorporated as a creative tool.

The project was carried out in two phases. The first phase involved testing and understanding various generative AI tools and their integration into image creation. It was important to convey to students that these tools are not a panacea for instant solutions but rather that different operations must be worked on to obtain a good result. This approach helped us to achieve our goals with less time and technical effort. To conduct the task, the focus was on revisiting the “I was there” activity. The objective of this activity was to modify a photograph of a historical moment by including oneself (as seen in Fontcuberta’s projects). However, in this experience participants were given the freedom to choose an image that represents their visual culture.

This project aims to delve into the principles and applications of generative AI in the visual arts, fostering creative experimentation and enhancing critical thinking and media literacy regarding AI-generated art. It seeks to endow students with the ability to merge generative AI with traditional editing skills, thereby broadening their understanding of the artistic opportunities that current technology presents. By focusing on image selection, editing, and the integration of visual components with open digital tools, the course encourages students to reflect on the role of authorship and originality in AI-involved art creation, emphasising the necessity of human oversight in the creative process. Furthermore, it prepares students for larger-scale projects by encouraging ongoing engagement with new generative AI tools and techniques, aiming to cultivate a proactive approach to discovering and leveraging the evolving tech landscape in visual arts.

The working process was as follows:

Once the image had been selected, the students had to find or create an image of themselves from a similar point of view as that of the image in order to insert themselves into it using the digital Face Swap tool from Pica AI (Figure 1).



Figure 1: Insertion of the face onto the original frame from *La La Land* by Damien Chazelle. Note: The image has been adapted from the Internet Movie Database (IMDB). *Source*: the author.

A first version of the characters was then created using the Adobe Express tool for removing image backgrounds, which had to be tweaked several times in Gimp to ensure an optimal result. If the background had many elements with similar tonalities and lighting to the characters, the AI sometimes did not recognise them correctly. Using Adobe Firefly's "text to image" generation tool, they had to imagine a new background in which to reposition the characters in a way that was surprising while maintaining visual logic. They also had to consider the formal elements of the image so that the overlay would fit properly. After writing the prompt and specifying a number of stylistic features, the programme generates four images for the user to choose from or instructs him or her to create new alternatives based on the image that comes

closest to what was intended. This makes it possible to introduce new specific modifications into the chosen image (Figure 2).



Figure 2: Cutting out the characters and creating the background, first of the landscape and then of the rope. *Source:* the author.

The next step was to merge the characters, adjusting their scale to the background using Gimp and converting the image to greyscale mode to make it easier to adjust the values of both images for a better overlay, focusing only on the luminance values of brightness and contrast. Using the My Heritage “In colour” tool, the AI recoloured the image to obtain a more homogeneous result, with similar temperature and saturation. Likewise, as in all phases, the result generated by the AI was retouched with Gimp to adapt it to the desired result; in Figure 3 you can see how the yellow colour has disappeared with the “In colour” tool. Finally, Wall-e 2 from Open AI was used to extend the field and canvas of the image with text. The final image was achieved by experimenting with generative AI tools combined with traditional digital editing.

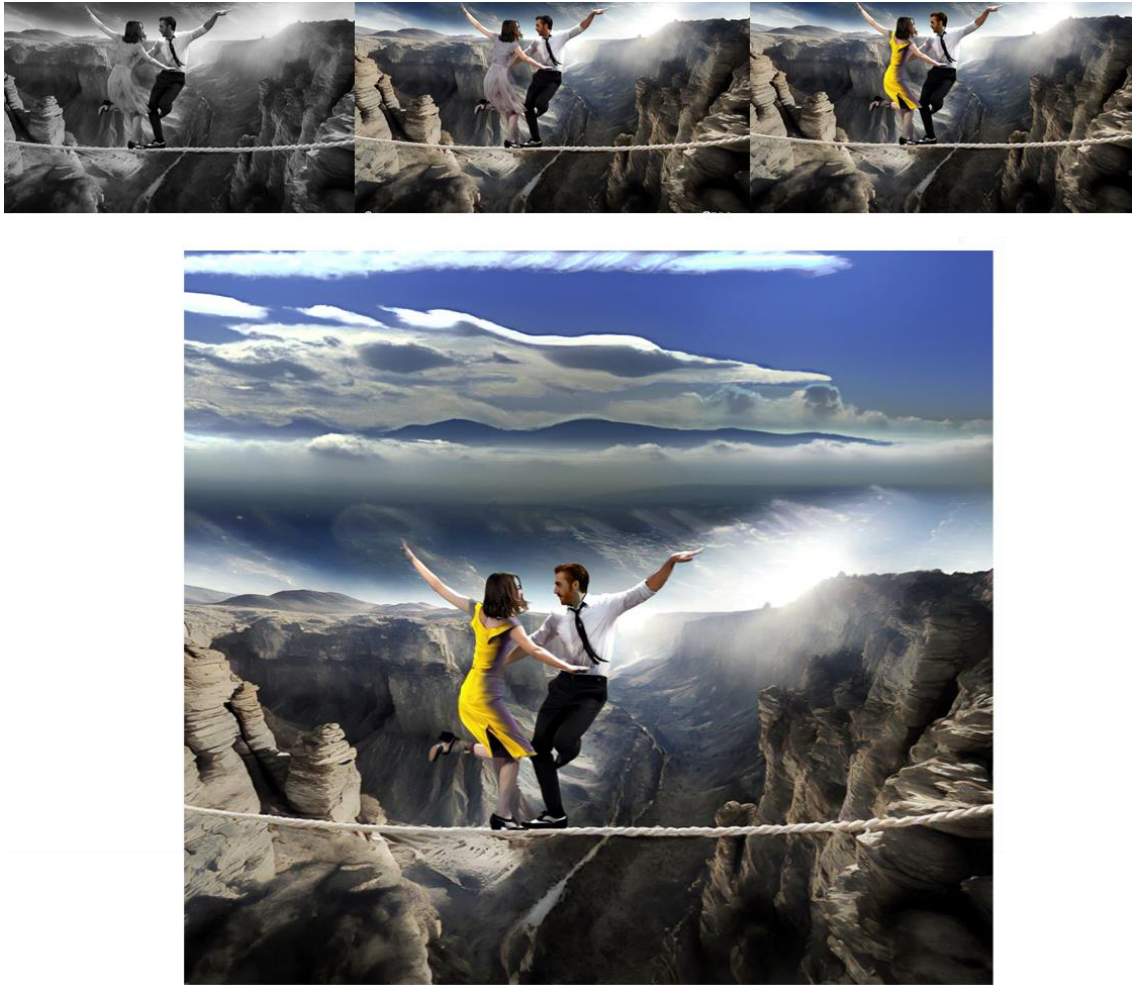


Figure 3: Embedding of the characters into the background, recoloration, and enlargement of the image canvas. *Source*: the author.

This task served as instrumental training to practice with different generative AI tools, which the students subsequently had to use to create the images in the *Fake Mundet* project (Torres-Carceller, 2022).

5. Results

As a result of the experience, the students developed a broad understanding of the creative application of AI in the arts, which enhanced their critical thinking and media literacy. This enabled them to evaluate the content generated by generative AI and understand ethical dilemmas such as copyright and plagiarism. They also recognised these technologies as a means, not an end. It was understood that technology facilitates the materialisation of ideas, but does not replace the need for basic knowledge and artistic skills.

However, during the implementation of the project, it was noted that some of the students tended not to question the results provided by the AI and found it difficult to assume their role as creators rather than mere recipients of generations. This observation underlined the importance of focusing on empowering future teachers as creative individuals who use technology as a means to facilitate the embodiment of their ideas, rather than as passive and uncritical recipients. The need to strengthen students' perceptions of their ability to interact with AI in a critical and creative way became a crucial aspect of the educational process, emphasising the responsibility of educators to cultivate a deep understanding of the active role they must assume in the face of advanced technology.

The training of future educators focused on the teaching and critical evaluation of these tools, ensuring that technology was used as a means of enriching the creative and educational experience, thus preparing a society that uses technology in an ethical and responsible way. The introduction of generative AI provided first-hand knowledge of the potential of the new technology and also of its most obvious dangers (media manipulation). This first contact – for most of the students – with these technologies allowed them to reflect on the great impact they could have on education in a very short time, implying an uncertain transformation that will force them to rethink current models and perhaps place less emphasis on technical aspects, focusing on activities that encourage reflection, analysis, and thinking to prepare future people capable of communicating effectively, accurately, and clearly what they want the machine to do.

6. Conclusions and discussion

Advances in artificial intelligence present a complex landscape of opportunities, limitations, and threats. Given the scale of advances in content creation, it is imperative to examine these new developments and their potential impact on society. The Internet has profoundly altered human cognitive processes by changing the way we access, create, and communicate data. In the long term, artificial intelligence is likely to bring about a similar transformation, with uncertain consequences. We must

therefore work to ensure that AI becomes a powerful tool that complements our thinking but never replaces it.

Another key aspect is the need to redefine the concept of authorship and to adapt it to the new paradigm, even introducing hybrid terms where some credit could be given to the technology itself, considering that in many cases the images generated by AI are the result of a collaborative process between humans and machines (created by humans). It is the human who provides the data and guidelines for the AI to generate the image, and then selects and edits the AI-generated images to create the final product. In this scenario, authorship could be attributed to the humans who provided the data and oversaw the process, although AI also played a significant role in the creative process. The introduction of generative AI can provide art students with a deeper understanding of design principles, visual narrative, and aesthetics by allowing them to intuitively manipulate visual elements and receive immediate feedback on the creative process. At the same time, the process of working with AI challenges students to articulate their creative intentions precisely, encouraging the development of critical and analytical skills. To ensure a democratic society, it is crucial to integrate artificial intelligence tools into basic education in a critical and reflective way. These tools should be embraced as resources that facilitate the materialisation of ideas rather than as a substitute for ideas themselves. They should be used to enhance imagination, not replace it.

Integrating generative AI tools into arts education is essential to foster creativity, not only to inspire students to explore new artistic territories and techniques but also to enhance their learning experience. By interacting with AI, students receive immediate feedback, enabling a deeper understanding of their artistic choices and facilitating rapid mastery of complex concepts and skills. Moreover, as technology and the arts become increasingly intertwined, students who can use AI for creative purposes will be better prepared for future careers, combining artistic sensibilities with technological skills. Generative AI tools democratise art education by making art creation more accessible to students who lack traditional resources, ensuring that creativity is within reach for everyone, regardless of background. In addition, the use of AI in the creative process encourages students to critically evaluate the role of technology in art,

teaching them to balance human creativity with technological tools and to consider the ethical and philosophical questions that arise from the integration of AI into society.

The introduction of generative AI tools to university students has provided them with an opportunity to experience the technology firsthand. This experience often leads to surprise at the potential of AI and the speed with which results can be achieved. However, this rapidity poses a significant danger. Due to the high volume of work and, at times, a nonconformist attitude, students may accept the results provided by AI uncritically, without understanding that it is merely a tool that facilitates rather than completes the work of generation or editing. Therefore, the initial idea and objectives of what they aim to achieve must originate from the students themselves. The use of AI has sparked a debate on the potential dangers of its development, including whether it should be limited and how it could be integrated into basic education. This integration prompts a reevaluation of the teaching-learning process, considering the increasing power of these tools. It is acknowledged that maintaining creative control requires knowledge of artistic subjects to use AI based on creative criteria. This ensures that the machine responds to our will rather than relying on random outcomes and becoming servants to the machine's serendipity. This debate highlights the need for a balanced approach to integrating AI in education. It is important to cultivate a thorough comprehension of the capabilities and limitations of AI among students. This will enable them to use AI as a tool to enhance their creativity rather than as a replacement for it. Educators can play a crucial role in guiding students through the intricate terrain of technological advancements, empowering them to use AI responsibly and creatively in their future careers.

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Avantatges d'aplicar la robòtica i la intel·ligència artificial amb la càmera Smart AI Lens i la placa Micro:bit a primària

Advantages of applying robotics and artificial intelligence using the Smart AI-Lens camera and Micro Bit board in primary school

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Resum

En la situació actual de l'educació, la reflexió sobre la pràctica és una necessitat per garantir evidències d'èxit. A l'Escola Espai-3 utilitzem la robòtica i la intel·ligència artificial (IA) per tal d'estudiar-ne els avantatges a les aules de primària.

En moltes ocasions, la robòtica necessita la intel·ligència artificial per dur a terme determinades accions. La càmera Smart AI Lens d'Elecfreaks, juntament amb la placa Micro:bit, ofereix l'oportunitat a l'alumnat de primària d'endinsar-se en el món fascinant de la programació de robots.

Després d'haver creat mitjançant Scratch un assistent personal basat en la IA, aquesta experiència té com a objectiu principal introduir els estudiants en la relació entre la robòtica i la intel·ligència artificial mitjançant la creació i programació de robots utilitzant la càmera Smart AI Lens i la placa Micro:bit.

Els resultats obtinguts permeten valorar la motivació, la millora conductual i la disposició a l'aprenentatge de l'alumnat participant, que mostra una millora creixent en les competències treballades i un clima de centre harmoniós i sostenible.

Paraules clau

Intel·ligència artificial (AI), robòtica, internet de les coses, pensament computacional, objectius de desenvolupament sostenible (ODS).

Abstract

In the current state of education, reflection on practice is a necessity to ensure evidence of success. At Escola Espai 3, we employ robotics and AI to study their advantages in primary education classrooms.

Robotics often requires artificial intelligence to carry out certain actions. The Elecbreaks Smart AI-Lens camera, along with the Micro Bit board, provides primary school students with the opportunity to immerse themselves in the fascinating world of robot programming. Having created an AI-based personal assistant using Scratch, this experience aims to introduce students to the interplay between robotics and artificial intelligence through the creation and programming of robots using the Smart AI-Lens camera and the Micro Bit board. Our results allow us to assess the motivation, behavioral improvement and learning disposition of the participating students. What's more, these results show an increasing improvement of the competences and skills worked on, and a harmonious and sustainable school climate.

Keywords

AI, smart city, robotics, Internet of things, computational thinking, Sustainable Development Goals, SDGs.

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1. Introducció

En la nostra societat, la irrupció de la intel·ligència artificial (IA) és un repte que cal encarar per treure'n tots els avantatges i minimitzar-ne els riscos amb una visió ètica i equitativa. Com diu Stefania Giannini, subdirectora general d'educació a l'Organització de les Nacions Unides per a l'Educació, la Ciència i la Cultura (UNESCO), és el nostre deure prioritzar la seguretat, la inclusió, la diversitat, la transparència i la qualitat (World Economic Forum, 2023).

Per l'Escola Espai-3, la decisió d'utilitzar IA és no només un deure d'equitat a l'escola pública, sinó també una necessitat ètica vers els més vulnerables i una responsabilitat professional per afavorir el futur laboral de l'alumnat. Tal com ens diu l'estudi de "Informe Mundial sobre les Ciències: Polítiques de Ciència amb Equitat de Gènere" (UNESCO, 2015), cal garantir que el sistema escolar aborda la innovació tecnològica de forma inclusiva i transversal, per tal de fomentar l'equitat tecnològica en un món en contínua transformació. En aquest informe, la UNESCO destaca la importància d'assegurar que totes les persones, independentment del seu gènere o ubicació geogràfica, tinguin accés equitatiu a la tecnologia i a les oportunitats que aquesta ofereix.

Per donar resposta a aquest horitzó educatiu d'equitat i justícia social, en aquest article es presenta una experiència singular d'innovació que s'aplica als processos d'ensenyament i aprenentatge guiats propis de l'educació reglada i formal en un centre escolar de primària de titularitat pública a Catalunya (Espanya). El projecte de centre que justifica pedagògicament aquesta experiència desenvolupa uns propòsits educatius i ètics clars, i vinculats a la millora acadèmica de l'alumnat i a l'èxit dels resultats, ampliat amb un propòsit humanista que vol afavorir el creixement personal i social de cada un dels alumnes. Es tracta d'un centre educatiu situat al cinturó urbà de Barcelona que ha decidit contrarestar l'entorn socioeconòmic desfavorit del territori amb metodologies participatives, la prioritjació de les llengües en el currículum i la inclusió tecnològica per a tothom com a força de canvi i motor social.

2. Anàlisi de necessitats

Aquesta experiència s'ha dissenyat per donar a l'alumnat de primària l'oportunitat d'explorar aquests conceptes tecnològics a través de la pràctica i la programació pràctica

de robots després d'haver experimentat només amb programari. A més a més, ofereix l'oportunitat d'aplicar aquests coneixements a situacions de la vida diària i de vincular-los a d'altres projectes relacionats com el de la creació d'una ciutat intel·ligent o el de les impressores 3D, creant prototips per incorporar a la càmera.

L'alumnat de primària de l'Escola Espai-3 és un col·lectiu d'alta diversitat, amb alumnat vulnerable per raons socioeconòmiques i nouvinguts que no sempre dominen la llengua de treball a l'aula. Malgrat els reptes, el centre està altament implicat a experimentar la innovació tecnològica, pedagògica i socioemocional emergent amb el suport d'entitats i organismes que financen activitats com les realitzades els cursos anteriors: Smart City, STEAM, etc. (Fuente, 2023).

Avançar en l'àmbit tecnològic és clau per al futur de l'alumnat. La robòtica i la intel·ligència artificial són camps emergents que ofereixen oportunitats educatives úniques no només en l'experiència d'usuari sinó també en la comprensió de com crear-les fomentant el pensament computacional.

Des del punt de vista curricular, aquesta experiència té com a objectiu principal desenvolupar les competències comunicatives i tecnocientífiques de l'alumnat, i promou capacitats i habilitats d'anticipació, execució i reflexió, amb projectes pràctics, per introduir els estudiants en la relació entre la robòtica i la intel·ligència artificial mitjançant la creació i programació de robots utilitzant la càmera Smart AI Lens i la placa Micro:bit. L'experiència s'ha constituït en una proposta de referència del centre, que es treballa anualment amb l'alumnat de sisè de primària, a cada promoció: la creació d'una ciutat intel·ligent o *smart city* que els estudiants han de planificar, dissenyar i realitzar en equips, afegint-hi les millores de sostenibilitat, eficiència i innovació que vagin decidint i justificant cada any.

El curs anterior l'escola havia portat a terme altres projectes relacionats amb la programació i la robòtica, com ara la programació de la placa i els materials gratuïts d'aplicació educativa Micro:bit (vegeu <https://microbit.org/ca>) amb experimentació de l'entorn MakeCode a la classe. Amb aquests recursos s'aconsegueix involucrar així l'alumnat en el pensament computacional i la recerca de solucions a problemes senzills, amb la incorporació de noves fites en el domini de la tecnologia. L'alumnat de 5è de primària, que aquest any fa 6è i participa en el projecte en curs, ja estava preparat per a

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fer un canvi significatiu, atès que havia realitzat també una activitat d'iniciació a la IA de creació d'un assistent d'alimentació saludable amb intel·ligència artificial, que va ser seleccionat com a bona pràctica d'àmbit estatal i publicat per l'Institut Nacional de Tecnologías Educativas y de Formación del Profesorado (INTEF, 2021). Les propostes de millores derivades d'aquest projecte de 5è es van incorporar al pla anual del centre i s'han utilitzat d'orientació per redactar els objectius del nou projecte «Explorant la robòtica i la intel·ligència artificial amb la càmera Smart AI Lens i la placa Micro:bit».

a. Novetats i expectatives inicials

Fins el 2023, l'experiència de 6è de primària s'havia realitzat amb elements de STEAM i d'internet de les coses, i s'havia donat a conèixer en revistes educatives especialitzades degut a la seva reconeguda qualitat (Fuente, 2023). Aquest darrer curs, el projecte ha donat un salt qualitatiu i s'ha convertit en un itinerari pioner per la incorporació de la intel·ligència artificial al centre, la formació digital docent d'última generació i la introducció de les primeres expectatives d'investigació educativa tecnològica en col·laboració amb entitats de recerca reconegudes. Les novetats poden identificar-se clarament en cada un dels àmbits essencials:

- a) *S'incorpora* a l'aula la tecnologia d'intel·ligència artificial amb experiències controlades, per interposició del docent com a recercador i analista de la pròpia pràctica (amb pràctica reflexiva).
- b) *S'amplia* l'experimentació del professorat en els àmbits d'autoformació docent i formació entre iguals.
- c) *S'usa* la la generativa per part del professorat, com ara l'ús de ChatGPT o altres models de llenguatge extens (LLM, de l'anglès *large language model*), i la IA generativa (IAG) per facilitar imatges representatives d'acord amb els suggeriments de l'alumnat.
- d) *S'estableixen* prioritats per definir indicadors de procés i/o assoliment que reflecteixin les novetats curriculars en l'àmbit de la IA per les diferents situacions d'aprenentatge (SdA) que es donen al llarg de la realització dels projectes, per part de cada equip d'alumnes, en la construcció de la ciutat intel·ligent.

3. Context educatiu de l'experiència

L'Escola Espai-3, situada a prop de Barcelona, està implementant la IA dins del seu projecte «Ciutats intel·ligents» amb l'objectiu de millorar l'aprenentatge dels seus alumnes de primària. Amb el suport de la Societat Catalana de Pedagogia (SCP), filial de l'Institut d'Estudis Catalans (IEC) han incorporat la IA per fomentar el pensament computacional entre els estudiants. Aquesta iniciativa segueix una sèrie de passos:

1. Experiències prèvies: basant-se en projectes previs centrats en robòtica i sostenibilitat, el centre ha decidit avançar cap a la integració de la IA. Amb l'ajuda de la SCP, han creat un assistent personal basat en IA mitjançant Scratch.

2. Proposta d'intervenció: la nova etapa implica la creació i programació de robots utilitzant la càmera Smart AI Lens i la placa Micro:bit. Aquesta iniciativa té com a objectiu introduir els estudiants en la relació entre la robòtica i la IA. Es destaca l'ús del pensament computacional per millorar el desenvolupament dels alumnes, especialment aquells en entorns socioeconòmics desfavorits.

3. Objectius i activitats: la proposta està estructurada en diferents fases:

- Introducció a la robòtica i a la IA.
- Familiarització amb el maquinari.
- Programació bàsica.
- Entrenament de targeta de direccions.
- Reconeixement de boles de colors.
- Reconeixement facial bàsic.
- Desenvolupament de la creativitat.
- Presentació de projectes.

4. Metodologia: s'utilitzen metodologies com el treball per ambients, l'aprenentatge basat en projectes i la recerca en acció. Aquest enfocament permet als estudiants ser actius en el seu aprenentatge, explorant i reflexionant sobre les seves experiències.

5. Difusió i validació: el projecte culmina amb la presentació dels projectes en una jornada dedicada a la programació i la robòtica, on els estudiants tenen l'oportunitat de compartir els seus treballs i rebre reconeixement per la seva dedicació.

A través d'aquesta iniciativa, l'Escola Espai 3 busca no només millorar l'aprenentatge dels seus alumnes, sinó també fomentar el pensament crític, la creativitat i les habilitats

del segle XXI.

4. Reflexió sobre la pràctica

La proposta d'intervenció amb l'alumnat va acompanyada de la reflexió sobre la pròpia pràctica del professorat, guiada per les orientacions rebudes en el Curs APLICA esmentat en l'apartat de context d'aquest article.

En paraules de Marc Prensky (González, 2022), la intel·ligència artificial pot ser una eina poderosa per abordar les bretxes d'aprenentatge, personalitzar l'educació i millorar l'eficàcia dels docents. Tot i la precaució necessària, que no es pot obviar, és imprescindible que els sistemes educatius adoptin aquesta tecnologia per afrontar els reptes del segle XXI. L'escola ha de proporcionar evidències de perfeccionament mesurables en l'avaluació de l'alumnat i en el desenvolupament professional del professorat. Aquesta avaluació formativa i formadora estableix un cercle de millora que afecta l'alumnat i els professionals de l'educació, per la qual cosa podem dir que també permet enriquir i fer avançar tot el sistema educatiu. En l'estudi que es presenta en aquest article, la millora afecta en especial la introducció de la tecnologia educativa a les aules.

Fa quasi una dècada, la recerca sobre el domini de les tecnologies al final de l'educació obligatòria eren força decebedores. L'informe *NMC Horizon Report: 2014 K-12 Edition* (Johnson *et al.*, 2014), fruit de la col·laboració entre el New Media Consortium (NMC) i el Consortium for School Networking (CoSN), alertava que els nivells de competència digital dels nens i nenes europeus eren insuficients per l'aprenentatge amb suport digital. En tots aquests anys les coses no han canviat gaire: els darrers informes del Programme for International Student Assessment (PISA) de l'Organització de Cooperació i Desenvolupament Econòmic (OCDE, 2021) alerten de la vulnerabilitat que comporta no disposar d'estratègies de digitalització de l'aprenentatge al llarg de la vida en el món actual. Aquesta habilitat és especialment rellevant per a l'alfabetització crítica i participativa, és a dir, quan els estudiants han d'aprendre a participar activament en equips de treball i crear espais de consens on aportar respostes pròpies per aprofundir en la col·laboració amb els altres per a la resolució de problemes. En el nostre centre, les dificultats socioeducatives accentuen aquest risc i ens fan replantejar les prioritats

escolars.

Catalunya va ser pionera en l'aplicació de programes d'incorporació digital a les escoles amb la creació del Programa d'Informàtica Educativa (PIE), creat el 1985 com un programa de cinc anys que finalment en va durar més de vint (Generalitat de Catalunya, 1986a i 1986b), però el repte ha estat sempre aconseguir posar l'atenció en els processos d'aprenentatge de l'alumnat més que no pas en la darrera versió del programari o de l'aparell digital aparegut en el mercat. En l'actualitat, les principals avaluacions educatives internacionals han relegat la tecnologia a l'espai de «context» i han adoptat els «usos de la tecnologia» i els «principis d'inclusió per a la transformació digital» dins dels indicadors avaluable. A tall d'exemple, el full de presentació de les proves Trends in International Mathematics and Sciences Study (TIMSS) del 2023, *Key Features of TIMSS 2023*, publicat recentment, fa especial èmfasi en les habilitats de l'alumnat per aprendre, raonar i comunicar amb eines connectades a escala global, i en les correlacions amb les seves actituds vers el propi aprenentatge (TIMSS, 2022).

En la mateixa línia, l'Escola Espai-3 es proposa, en el projecte educatiu de centre (PEC), que els objectius de l'ensenyament i aprenentatge no estiguin formulats únicament en funció dels continguts centrats en les matèries d'instrucció (currículum tradicional), sinó en el perfil de sortida dels alumnes (resultat educatiu) i en el suport que cada un necessita per aconseguir-lo (personalització). L'objectiu desitjable per tot l'alumnat s'ha d'assolir des de metodologies participatives, solidàries i tecnocientífiques que validin plantejaments humanistes. L'escola és molt explícita i la seva comunitat vol alumnat «que siguin persones autònomes i resolutives; responsables d'ells i dels seus actes vers la societat i el medi en què viuen; crítics i autocrítics; bons comunicadors; tolerants i solidaris; empàtics; col·laboratius; reflexius i pacients; curiosos per aprendre; resilents i assertius, i creatius» (Escola Espai-3, 2022).

En un món digitalitzat en contínua evolució, el domini de competències digitals per a l'aprenentatge al llarg de la vida esdevé un dret de tots els nois i noies. L'OCDE, conscient de la creixent desigualtat digital que s'agreuja a mesura que les aplicacions d'intel·ligència artificial es fan més universals i invisibles, ha compartit investigacions i propostes (OCDE, 2019b) per afavorir el creixement econòmic amb una major equitat, i amb principis ètics que són essencials per garantir un món més just i sostenible. Les dades demostren la

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correlació entre les polítiques inclusives i el benestar de les comunitats, però posen en evidència la necessitat d'una major transparència en la presa de decisions que afecten els ciutadans, una major participació dels usuaris en els espais comuns i una educació ciutadana més implicada i responsable en temes que els afecten de forma directa (com ara la seguretat en els usos digitals, el dret a la confidencialitat de les dades i la protecció de les dades personals).

És evident que a hores d'ara l'ús de les eines de comunicació i de gestió de la informació en entorns virtuals forma part de les estratègies d'inclusió i equitat en un món global. El pensament computacional i les pràctiques escolars amb tecnologia automatitzada (com ara la robòtica, la connectivitat d'aparells amb sensors o la motorització d'objectes i vehicles de transport) han demostrat ser un coneixement especialment útil per iniciar estudis professionalitzadors inclusius en els àmbits de les ciències i la tecnologia.

En les experiències de l'any anterior, l'Escola Espai-3 ha identificat diverses necessitats de millora: major eficiència organitzativa, revisió de protocols per a la gestió de la interacció entre els alumnes a l'aula, major integració dels programes de desenvolupament de competències digitals que dona i estímul a la gestió d'emocions. En aquest aspecte, l'escola ha detectat la necessitat de treballar el control de la frustració, en especial quan les coses no surten com s'han planificat inicialment en l'equip de treball. Aprendre dels errors, remuntar després d'un fracàs i desplegar estratègies de resiliència esdevenen objectius necessaris en aquest projecte, que neix amb la intenció de transformar l'educació de l'alumnat participant amb criteris de qualitat relacional dins i fora del centre escolar (Fuente, 2022).

El centre forma part de la Xarxa d'Escoles Associades a la UNESCO i participa en programes internacionals (p. e., Erasmus+ o eTwinning) que tenen molt present el reconeixement de la creativitat, la innovació, l'emprenedoria i la participació en la societat.

La incorporació dels objectius de desenvolupament sostenible (ODS) ha permès, d'altra banda, posar en pràctica principis de solidaritat i consciència social, que són la base per a l'increment del capital social de les comunitats i per a un millor desenvolupament de plans estratègics que assenten el concepte de «creació d'una *smart city*» a la societat actual. A més, el fet que l'alumnat reflexioni sobre el procés del desenvolupament del

projecte i la identificació de possibles millores i ajustos en els programes i en la configuració dels robots crea un procés de reflexió i millora contínua que potencia la metacognició. En el cas de la nostra escola, el treball realitzat durant tota l'etapa de primària per a la creació d'hàbits és un perfecte ecosistema planificat per a la incorporació de rutines cognitives (què veig?, què en penso?, què faig per participar-hi?). La metacognició esdevé part de l'aprenentatge verbal de planificació, que ens permet ser conscients dels nostres propis processos mentals, desigs i estratègies d'aprenentatge. És una habilitat essencial per a l'aprenentatge efectiu i la resolució de problemes.

5. Resultats

Els resultats de l'experiència es poden identificar des de la valoració qualitativa, descrita pels participants, i les evidències de procés i producció identificades al llarg del projecte en el treball de l'alumnat. Aquesta experiència pràctica no pot incorporar encara una valoració qualitativa, atès que l'avaluació final del curs no s'ha dut a terme encara ni s'ha pogut valorar el nombre d'alumnes que presenten major dificultat. No obstant això, la continuïtat sostenible de resultats positius en les competències bàsiques anuals de l'alumnat del centre (molt per sobre de les aconseguides per l'alumnat de centres de característiques socioeconòmiques similars) donen indicis d'èxit que s'hauran d'analitzar quan les dades estiguin disponibles.

a. Valoració del projecte

L'experiència es desenvolupa al llarg del segon trimestre del curs 2023-2024, en gran grup i amb dos docents a l'aula sota la responsabilitat de proporcionar a l'alumnat una oportunitat per a la seva participació activa i la implicació en processos d'innovació. El punt de partida de l'anàlisi de resultats és clar:

- **Alumnat:** els cinquanta-dos alumnes de 6è de primària, amb cinc alumnes que requereixen atenció singular.
- **Centre educatiu:** Escola Espai-3 de Sant Joan Despí.
- **Objectiu:** desenvolupar les competències digitals, introduir la IA en l'entorn educatiu i incorporar habilitats emprenedores, creatives i sostenibles en processos d'experimentació i entorns emocionalment segurs, amables i

afavoridors del benestar i la resiliència de l'alumnat.

- **Tasca:** crear un assistent personal basat en la IA, mitjançant Scratch.
- **Temporalitat:** 1.30 h setmanal, durant tres mesos.
- **Espais:** aula ordinària.
- **Modalitat de treball:** projecte, amb activitats en equip, reflexió individual i col·lectiva.
- **Metodologia:** aprenentatge actiu (*learning by doing*), mètode científic i experimental, tècniques de reflexió-acció.
- **Recursos:** càmera Smart AI Lens i la placa Micro:bit.
- **Vinculació tecnocientífica amb el currículum:** introducció a la robòtica i a la IA.
- **Avaluació disponible:** el centre recull anualment indicadors de resultats acadèmics, de competències bàsiques i de promoció. També disposa d'un índex d'acceptació (petició de matrícula) anual per part de les famílies i un índex de fidelització del professorat.

a) *Els resultats organitzatius.* En un context internacional d'incorporació de la IA a la vida de les persones, l'equip docent de l'Escola Espai 3 ha optat per formar-se en les diferents eines, centrant-se en les educatives, i poder oferir així al nostre alumnat la visió del potencial que tindrà en les seves vides sempre vinculant-lo al sentit ètic que cal donar a totes les noves tecnologies com a eines de progrés i facilitadors de vida.

b) *El projecte de l'Escola Espai-3* és un dels pioners a l'Estat espanyol a afegir principis de valor vinculats al desenvolupament emocional de l'alumnat, a la millora relacional dels equips implicats, amb la incorporació dels ODS. La idea de portar a terme aquest projecte sorgeix de la necessitat del seu alumnat de superar les frustracions i aprendre dels fracassos. L'alumnat de sisè de primària de l'Escola Espai-3 de Sant Joan Despí ha estat capaç d'implicar-se amb sorprenent capacitat en activitats de reflexió i pensament computacional d'alta complexitat.

c) *Actualització documental i millora en la gestió competencial.* La coordinació docent i la formació compartida han permès identificar i consensuar les competències específiques i transversals que s'han treballat durant el projecte, la qual cosa ha facilitat l'actualització documental. La vinculació de la competència digital en el currículum

interacciona de forma transversal amb els sabers i vectors educatius que transcendeixen els continguts i permet treballar les competències de manera integrada:

- *Competència: coneixement i interacció amb l'entorn natural, social i cultural.*
- *Competència: tractament de la informació i competència digital.*
- *Competència: d'autonomia i iniciativa personal.*
- *Competència: social i ciutadana.*
- *Competència: d'aprendre a aprendre.*

b. Ús de la tecnologia en processos de qualitat educativa

L'experiència presentada implica l'ús de les tecnologies de manera diferenciadora des del sistema educatiu, que incorpora l'ODS 17, de col·laboració i partenariat, cosa que construeix evidències de millora docent i de sistema organitzacional.

a) Sostenibilitat en la creació de tarannà i xarxa educativa. Les activitats s'han dut a terme amb la col·laboració dels poders públics (com l'Ajuntament de Sant Joan Despí), les associacions de suport professional docent (com la formació compartida per la SCP), la xarxa socioeconòmica del territori (CaixaBank, 2020) i la implicació de les famílies del centre. També s'hi troba representada la indústria i les empreses amb fundacions socioeducatives, que difonen eines i actuacions de robòtica educativa (vegeu, per exemple, <https://www.fundacionendesa.org/es/educacion/endesa-educa>), i els centres de recerca i innovació digital (Citilab de Cornellà, Centre of Innovation in Telecommunications and Integration of Service).

b) Millora docent i desenvolupament professional. El projecte té el repte de contribuir a l'educació de qualitat mitjançant la introducció dels estudiants a la robòtica i a la intel·ligència artificial. Per això, el professorat ha après a planificar microactivitats que ajuden a traslladar l'aprenentatge basat en l'observació i l'experimentació pròpia dels entorns educatius, tal com s'ha il·lustrat anteriorment, associant els objectius i les activitats identificables i mesurables. El producte resultant és la part intangible de l'ensenyament i l'aprenentatge a l'aula i l'aplicació de la interacció entre l'alumnat, visible en situacions reals situades dins i fora de l'aula.

c) *Aprentatge pedagògic en el centre.* Aquest vol ser un projecte on el valor del coneixement adquirit resideix en la seva utilització per crear, barrejar, resoldre, saber identificar i aplicar les millors alternatives o solucions a un problema educatiu. S'utilitza la tecnologia en processos de qualitat amb un esperit col·laborador i inclusiu, cercant l'equitat per a tothom. Ens interessa especialment que l'alumnat aprengui de quina manera saber utilitzar la tecnologia pot millorar la qualitat de vida de les persones.

d) *Internacionalització i alineació dels ODS als continguts curriculars.* La UNESCO (2015) ha integrat en educació els plantejaments de qualitat socioeducativa recollits a l'Agenda 2030 de les Nacions Unides i defensa que la transformació dels sistemes educatius s'ha d'assolir des d'una intervenció en el centre coherent amb els ODS. La vinculació curricular del projecte amb els ODS és la següent:

1. Introducció a la robòtica i a la IA (ODS 4: educació de qualitat).
2. Familiarització amb el maquinari (ODS 9: indústria, innovació i infraestructures).
3. Programació bàsica (ODS 4: educació de qualitat).
4. Entrenament de targeta de direccions (ODS 4: educació de qualitat).
5. Reconeixement de boles de colors (ODS 12: consum i producció responsables).
6. Reconeixement facial bàsic (ODS 5: igualtat de gènere).
7. Desenvolupament de la creativitat (ODS 9: indústria, innovació i infraestructures).
8. Presentació de projectes (ODS 17: aliança pels objectius).
9. Treball en equip (ODS 4: educació de qualitat).
10. Reflexió i millora contínua (ODS 4: educació de qualitat).

És essencial, doncs, que les activitats d'aula es planifiquin acuradament per desenvolupar models d'aprenentatge actius i participatius, impulsant iniciatives directament relacionades amb l'educació interactiva de les nenes i els nens, per tal d'apropar-los, des de l'escola, a uns aspectes tan complexos com la robòtica, la tecnologia o diverses disciplines científiques.

5. Avaluació i discussió

Com que és un projecte que encara estem portant a terme i l'execució planificada al llarg del curs no ha finalitzat, no tenim dades dels resultats acadèmics (qualificacions de l'alumnat participant), però disposem de les avaluacions parcials i els estudis de seguiment dels processos educatius (motivació, implicació, recollida de dades, cocreació de propostes i dissenys inicials). Sense ser exhaustius, poden assenyalar els primers indicis i evidències de millora en factors concrets i mesurables:

- Manteniment de l'assistència regular, alta motivació i constància en la realització de les tasques.
- Disminució general dels microconflictes interpersonals durant la sessió de treball en el projecte, i autoregulació de conductes entre l'alumnat més caracterial.
- Major constància, resiliència, resistència a la frustració i intensitat comunicativa per a la realització d'exercicis que requereixen concentració, processos executius i col·laboració amb els companys d'equip durant el procés de treball.
- Augment de la fluïdesa relacional entre l'alumnat en risc de marginació i els docents de suport, per a la sol·licitud d'ajuda, la recerca d'informació i l'assessorament de proximitat en les rutines cognitives i les situacions d'aprenentatge programades a l'aula per a cada sessió.

En resum, podem afirmar que a través d'aquest projecte, l'alumnat ha tingut l'oportunitat de conèixer de prop la robòtica i experimentar per primera vegada algunes de les possibilitats de generació de text i imatge amb la IA:

- Han après a programar robots mitjançant la càmera Smart AI Lens i la placa Micro:bit, experimentant amb reconeixement de colors, targetes de direccions i fins i tot reconeixement facial bàsic. Aquesta experiència ha obert la porta a futures exploracions tecnològiques i ha fomentat la creativitat.
- Han participat en converses d'iniciació a la IA, de la mà del professorat, i han començat a participar en propostes pedagògiques elaborades amb ajuda de les IA.

Som conscients que en finalitzar el procés de treball de la «Ciutat intel·ligent» haurem d'intensificar aquesta anàlisi parcial de resultats i creuar les dades qualitatives amb els resultats quantitius de referències per indicadors de valor d'èxit escolar:

- a) Les taxes de superació de curs i promoció escolar.
- b) Les dades de competències bàsiques de 6è de primària per aquesta mateixa cohort d'alumnat.
- c) Les qualificacions d'avaluació final per l'alumnat participant a 6è de primària

Aquest projecte ha rebut el reconeixement de Projecte Innovador en el "Encuentro de la Red de centros españoles de la UNESCO" del juliol del 2023 marc dels on s'ha presentat com escola i activitat de referència.

Igualment, cal esmentar que el projecte ha assolit l'acceptació de les autoritats educatives de referència a l'entorn local (territori i municipi) i que l'equip directiu del centre ha acordat presentar-lo al concurs escolar mSchools Students Awards durant el segon trimestre del curs, 2023-2024. Aquest concurs lliura els seus premis en el marc del Mobile World Congress de Barcelona, que espera concentrar més de vuitanta mil persones entre el 26 i el 29 de febrer de 2024.

6. Conclusions i reflexió final

Aquest ha estat el primer any que l'alumnat de sisè ha dut a terme aquest projecte al centre i en el moment d'escriure aquest article el projecte roman actiu i en contínua evolució, per la qual cosa la informació sobre els indicadors d'assoliment del projecte no estan encara disponibles. El treball realitzat ja ofereix conclusions molt significatives sobre el procés desenvolupat per a la millora de les competències de les nenes i els nens que hi han participat (les dades parcials s'han recollit a partir de les avaluacions del trimestre i el nombre d'incidències de conducta a l'aula, i les dades finals inclouran també la comparació anual de les competències bàsiques de 6è en acabar el curs). Igualment, està previst mesurar la participació de l'alumnat en la societat en què viuen (qüestionari final sobre implicació en l'entorn). D'aquesta manera, en la mesura en què s'ha treballat al voltant de reptes relacionats amb la cerca de solucions a problemes reals que ells mateixos han detectat a la seva ciutat, es pot conèixer el grau d'implicació en l'entorn social i cultural, que contribueix a la comprensió de la realitat social i al compromís inicial per contribuir a millorar-la.

Amb aquest projecte l'Escola col·labora en la divulgació científicotecnològica de forma pràctica. D'una banda, el protagonisme de l'alumnat a la fira del Citilab de Cornellà (com

a creadors de solucions tecnològiques per a la millora de la vida), en definitiva, contribueix a apropar-los als estudis científicotecnològics i a fer que els tinguin en compte com a possibles vies per al desenvolupament professional. De l'altra, altres professionals docents de disciplines diverses s'han mostrat interessats a rebre assessorament per part de l'Escola Espai-3 per portar a terme aquesta iniciativa amb el seu alumnat. El reconeixement que això suposa pel claustre de professors i professores de l'escola i per l'equip directiu mateix contribueix molt a la motivació professional, el benestar laboral i el desig de millora contínua del sistema educatiu.

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The utilization of generative artificial intelligence in the professional development of teachers

La utilització de la intel·ligència artificial generativa en el desenvolupament professional del professorat

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Abstract

This study focused on the integration of generative artificial intelligence, represented by ChatGPT, as an educational tool in teacher training courses in Brazil and Spain. The aim was to explore how this tool could promote cognitive and critical skills among future educators. A case study with participant observation was conducted to investigate two experiences of pedagogical activities applied in the classroom using ChatGPT, focusing specifically on teacher training. The activities involved debates and ethical reflections on the presence of AI (artificial intelligence) in education, fostering engagement and active participation among students. The results highlighted the effectiveness of ChatGPT in creating adaptable educational stimuli that promote the development of critical and reflective thinking. However, they also pointed out ethical challenges such as privacy issues and algorithmic bias. The conclusions emphasized the potential of ChatGPT as a tool for developing personalized activities aligned with constructivist approaches. The research indicates that the ethical and responsible incorporation of AI in

education can drive more interactive and personalized learning, albeit requiring meticulous ethical considerations.

Keywords

Generative artificial intelligence, ChatGPT, teacher training, critical thinking, argumentative skills, ethics.

Resum

Aquest estudi es va centrar en la integració de la intel·ligència artificial (IA) generativa, representada per ChatGPT, com a eina educativa en cursos de formació de mestres al Brasil i a Espanya. L'objectiu era explorar com aquesta eina podia promoure habilitats cognitives i crítiques entre els futurs educadors. Es va realitzar un estudi de cas amb observació participant per investigar dues experiències d'activitats pedagògiques aplicades a l'aula mitjançant ChatGPT, centrant-se específicament en la formació del professorat. Les activitats van implicar debats i reflexions ètiques sobre la presència de la IA en l'educació, fomentant el compromís i la participació activa entre els estudiants. Els resultats van posar de manifest l'eficàcia de ChatGPT en la creació d'estímul educatius adaptables que promoguin el desenvolupament del pensament crític i reflexiu. No obstant això, també van assenyalar reptes ètics com qüestions de privacitat i biaix algorítmic. Les conclusions van posar l'accent en el potencial de ChatGPT com a eina per desenvolupar activitats personalitzades alineades amb enfocaments constructivistes. La investigació indica que la incorporació ètica i responsable de la IA a l'educació pot impulsar un aprenentatge més interactiu i personalitzat, tot i que requereix consideracions ètiques meticuloses.

Paraules clau

Intel·ligència artificial generativa, ChatGPT, formació del professorat, pensament crític, habilitats argumentatives, ètica.

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1. Introduction

This article analyzes the experience of generative artificial intelligence (AI) applied as an educational tool in activities of two introductory courses in higher education in two distinct learning environments, a university in Rio de Janeiro (Brazil) and another one in Catalonia (Spain). The central objective was to employ OpenAI's ChatGPT 3.5 to stimulate the cognitive and critical skills of students, especially those preparing to become teachers. The experiment aimed to integrate emerging technologies into the educational context, exploring their potential to enrich the professional development of teachers.

The choice of ChatGPT (generative pre-trained transformer) was motivated by its generative and conversational characteristics and its potential to observe the improvement of critical and argumentative skills of students, i.e. their ability to understand ideas, comprehend problems and apply work plan solutions (Organization for Economic Cooperation and Development [OECD], 2015). As a large language model (LLMs), besides reducing repetitive practices and stimulating dialogic construction (Sichman, 2021), ChatGPT is capable of understanding and generating language similar to that of humans (Ramos, 2023). Its command-based action mechanism also acts as a learning facilitator. As commands are entered, the tool reuses the training data from that conversation to solve new problems, which stimulates the student in the process of knowledge acquisition. This transforms the tool from one of intuitive use to one that triggers different stages of complexity of thought.

Contributions from authors outline the trends and challenges associated with the use of generative AI in education. The study took as its premise those who advocate the improvement in critical and argumentative capacities. For active participation in the social world, essential skills of effective communication, mobilization, negotiation, moderation and collaboration demand the development of these capacities beforehand.

However, from Bloom's perspective (Anderson & Krathwohl, 2001), the hierarchical process of skill acquisition from lower order (remembering, understanding, applying) to higher order (analyzing, evaluating, creating) is not sufficient to grasp the dynamic and the adaptable flow of thought during learning, producing varied responses from

students in educational interactions. The perspective of Marzano and Kendall (2007) suggests a more holistic and multidimensional approach to the development of capacities and highlights three dimensions: cognitive, metacognitive, and self. In the self dimension, there is the level of self-awareness, that is, the moment when students decide to begin their learning process, being intrinsic to the attitude of implementing a proposed activity. Then, in metacognition, the student organizes the cognitive process, that is, defines goals, plans how to learn, and applies the learning strategies established by the teacher. These strategies seek to mobilize the cognitive dimension, organized into levels of remembering (naming and executing information), understanding (identifying and categorizing), analyzing (using, relating, and generalizing what has been learnt to create new knowledge), and using knowledge (applying it in a specific situation, making decisions, investigating, solving problems). One of the points of attention in this approach is the valorization of continuous feedback and formative assessment.

Through this perspective, one starts to consider how generative AI can serve as a facilitator in the learning cycle, covering knowledge acquisition, deepening, and creation. Wang and Zhang (2022) observe that tasks generated by AI stimulate students' analysis and creativity, encouraging them to question, criticize and construct arguments more effectively. Interaction with ChatGPT can promote these skills, preparing students to be critical thinkers and lifelong learners.

Curiosity, an essential attribute in learning, is driven by the desire to know (Rubinstein, 2019). ChatGPT can awaken this curiosity, offering experiences that stimulate the desire to explore the unknown (Ramos, 2023). The use of ChatGPT for personalized learning (Rosenberg *et al.*, 2021) not only adapts to students' needs but also promotes the metacognitive dimension, encouraging active questioning and knowledge seeking.

Generative AI can create dynamic and adaptable teaching materials (Berner *et al.*, 2020), enhancing student engagement. Santos and Silva (2023) highlight how ChatGPT can support language teaching, facilitating real-time interactions. Almeida and Rocha (2024) explore how AI enhances socio-emotional skills like empathy and collaboration in activities that simulate real scenarios, aiding students' cognitive development.

Considering the ethical aspects of using AI in education, Rodrigues and Rodrigues (2023) emphasize the importance of regulations to ensure the responsible use of technology. Santaella (2023) highlights the need to develop ethical and moral principles in AI use. According to Kohlberg's theory (1981), ChatGPT can guide the ethical development of students by offering experiences that stimulate ethical reasoning at different stages of moral development.

In this respect, it becomes imperative that the adoption of technologies such as ChatGPT should be evaluated as a means of educational stimulation, from the standpoint of cognitive and critical skills development, essential for 21st-century teachers given the need to offer solutions within the scope of the UN Sustainable Development Goal (SDG) 4, Quality education (2015).

Therefore, this empirical report aims to verify the interaction between generative AI ChatGPT and the development of students' competences during their professional teacher training course and seeks: *a)* To enhance curiosity and the desire to know through the use of ChatGPT, reducing the common inhibitor among students of asking questions – an essential attribute for learning; *b)* To enable the instrumentalization of the learning cycle – acquiring, deepening and creating knowledge, e.g. to deal with problems, from the simplest to the most complex, mobilizing higher and lower mental skills; and *c)* To consider the tool as a means of moral and critical development.

2. Needs analysis

Technological advances reshape educational practices, demanding continuous revision of teaching methodologies. Teacher training needs to integrate generative artificial intelligence (AI) into the educational curriculum. This analysis highlights the need to investigate the impact of generative AI on the development of critical skills in future teachers. There is a gap in the application of advanced technologies in pedagogical methods within the context of higher education for teacher training. Generative AI offers personalized learning and innovative insights but its effectiveness in teacher training has not yet been widely explored. The proposed experiment integrates generative AI into specific activities of teacher training courses. The lack of exposure to and training in emerging technologies may result in teachers being ill-prepared for contemporary educational challenges. A case study investigated the use of ChatGPT

3.5 at two universities to examine the development of the students' skills. Participants were selected based on the relevance and diversity of their previous experiences. Age and gender variation did not affect the results. Participants were informed about the nature of the research and the confidentiality of personal data was ensured.

3. Context

The use of ChatGPT 3.5 as a learning tool was applied in 2023 in two different disciplines, both introductory to the professional teacher training course: Foundations of Education: History, Politics, and Culture at a university in Rio de Janeiro, Brazil (Case 1) and Research and Innovation in Educational Practice at a university in Catalonia, Spain (Case 2). While Case 1 used the tool to generate questions during teachers' learning stages, Case 2 used it for an ethical reflection on AI in education. This scenario enabled a shared study of the experiences conducted.

Case 1 (Rio de Janeiro)

Students of Pedagogy and degree courses in History, Literature, and Biology who were enrolled in this discipline carried out the "Stage 1: engagement – identifying big ideas" activity, which was part of the challenge-based learning (CBL) methodology, adapted from the Apple Classrooms of Tomorrow-Today project (2008) and articulated with the pedagogy of problematization (Freire, 1996). Classes were organized on the basis of the three CBL stages: 1) Engagement: observing challenges within their context, identifying key ideas, and asking relevant questions; 2) Investigation: systematizing data, knowing where to investigate; and 3) Action: solving the challenge, acquiring in-depth knowledge of the area, and creating applicable solutions, followed by the evaluation of results. The selection of Stage 1 for ChatGPT's use was aimed at enhancing the development from a big idea to formulating an essential question and proposing a challenge related to SDG 4, fostering solutions through the curriculum. The activity encouraged engaging with big ideas, crafting questions, and organizing challenges. Students were informed about the curriculum, SDG 4 (in the opening class), the CBL methodology, and the limits and role of ChatGPT (in class 1 of the activity).

The benefits aimed to stimulate critical thinking and argumentative skills regarding educational challenges. Stage 1 of CBL revealed a need for refined questioning and idea organization skills, and enhanced group collaboration in education.

Case 2 (Catalonia)

Future primary school teachers at a university in Catalonia participated in the introductory activity in the discipline Research and Innovation in Educational Practice. The main objective was to engage students with the theme of ethics in educational technology, focusing specifically on the use of artificial intelligence (AI) in the context of primary education.

The 56 students were grouped to investigate various aspects of AI use in elementary education, such as virtual assistants in classrooms and adaptive learning platforms for children, among others. As part of the introductory activity, they used the free version of ChatGPT 3.5 to generate relevant questions related to the ethical aspects of AI use in primary education. Each group used ChatGPT to create questions and discuss different points on the assigned topic. They reviewed the responses generated by ChatGPT and selected the most relevant questions for discussion. During class, each group presented its questions generated by ChatGPT and conducted a debate on the ethical and social aspects of AI use in primary education.

Students deliberated on the potential positive and negative impacts of these technologies, considering ethical aspects, inclusion issues, and children's privacy, among other relevant points. After group discussions, a classroom debate was held, allowing each group to share the key points discussed during their sessions. As a concluding activity, students composed individual written reflections on the debate, highlighting the main insights gained, ethical issues raised, and possible approaches to ethical and responsible use of artificial intelligence in primary education.

The expected benefits were to stimulate critical analysis and reflection on the ethical implications of AI use in primary education; to foster debate, argumentation and critical thinking among future teachers; and to encourage different perspectives when addressing ethical issues related to the implementation of innovative educational technologies in primary education. This introductory activity gave future teachers an

initial insight into the importance of ethics when integrating technologies such as artificial intelligence into the primary educational environment, preparing them for more in-depth research and innovative approaches in educational practice throughout the course.

4. Experience

The use of the tool occurred in two distinct learning situations: Case 1 (Rio de Janeiro) and Case 2 (Catalonia), as reported below. To monitor experiences and verify the improvement in critical and argumentative thinking, three articulated dimensions were considered: 1) Self: active engagement and mobilization to learn during the proposed activities; 2) Metacognitive: how learning strategies were applied and choices were made during the process; and 3) Cognitive: the development of critical and argumentative thinking and problem-solving proposed in each experience. The possibility of improving critical reflection regarding the use of the tool was also evaluated, specifically in Case 2, considering the elaboration of a more complex understanding based on universal ethical principles (post-conventional stage).

Case 1

Implementation of “Step 1: engagement – identifying big ideas” of the CBL methodology, lasting 3 sessions of 4 hours each. Class of 47 students divided into 14 teams (free choice). Objective: To develop the essential question, and to move from big ideas to a concrete and actionable challenge.

Session 1: Identification of big ideas (4 hours)

Content: Identification of big ideas through essential questions and reading materials (SDG 4 goals in the Brazilian scenario, pre-reading lecture material *Pedagogy of Autonomy* by Paulo Freire, Chapter 1, and syllabus content).

Activities: Debate on reading materials. Ideas articulated into keywords: education and citizenship, education and power, education and ethics, education and technology. Formulation of a question without the tool. Use of ChatGPT to produce questions.

Methodology and duration: 1 hour of debate and question production in groups. Then each student had 1 hour to produce 2 or 3 questions with the tool. Final 2 hours for group work – each member shared their questions, then the team selected the best

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big idea: “What is your big idea?”. In the next stage, students refined this idea, aligned with the four keywords of the syllabus and/or SDG 4. Some example commands to ChatGPT were: “Create a table with keywords and ideas (all questions from team members)” (Team 8); “What is the relationship between the following text (their copied extracts from Freire’s book), SDG 4 and education challenges?” (Team 3); “Select a question about education problems that helps with SDG 4” (Team 7); “What is the most relevant challenge to address education among these (to choose from answers from group members)” (Team 11); “Which of the ideas about education and citizenship was closest to SDG 4.5?” (Team 6).

Evaluation: Production of questions without the tool and with the tool on an individual basis.

Session 2: Development of the essential question (4 hours)

Content: Development of the essential question. Improvement of previous ChatGPT commands. Reflection on SDG 4 goals.

Activities: Debate based on the developed questions. Articulation with specific SDG 4 goals. Group formulation of the question to refine the previous one. Improving commands in ChatGPT with interrogative pronouns and clauses (why, what if, how).

Methodology and duration: Each group had 1 hour for debates and to clarify doubts and 2 hours to summarize the creation of the ChatGPT command corresponding to the previous question and to incorporate a specific SDG 4 goal. These commands were saved in the account of the user who generated them. Then students developed a more specific question from the defined big idea/preliminary question and the linked SDG 4 goal, inspired by the example question: “Why is this big idea X important to solve the problem in school Y with characteristics Z?”. These experiments allowed participants to prioritize and categorize questions using ChatGPT, evaluating them as more or less relevant according to the context. Example: “If teenagers with ASD (autism spectrum disorders) had access to inclusive methodologies, could this ensure equity in access to and permanence in high school?” (Team 6). 1 hour for reading guidance for the next session.

Evaluation: Group’s essential question prioritized according to a specific SDG 4 goal.

Session 3: The challenge and reflections for the next phase (4 hours)

Content: Reading and analysis of academic texts to develop consistent questions. Creation of challenging questions based on summaries of academic articles. Debate.

Activities: Analysis of the texts indicated for the session to refine the answer to the essential question chosen by the group. Use of the tool to link the summary of an academic article with the question chosen by each team, forming the question that generates the challenge.

Methodology and duration: 2 hours for teacher-group clarification of the researched academic text used for refining the possible answer to the proposed challenge. 2 hours for debate and a brief oral presentation with conclusions. Each team asked questions to an opposite group determined at random. At the end of the Step 1 activities, each group presented their intentions or action plans based on their central question. The essential question formulated by the groups led to a specific preliminary answer or solution, initiating an investigation to be developed in Step 2.

Evaluation: Creation of the challenge aligned with the syllabus.

Case 2

Implementation of a plan that allows for a progressive in-depth introduction to ethical issues related to the use of AI in primary education, encouraging critical reflection and active participation of students throughout the four sessions.

The activity “Exploring ethics in the use of artificial intelligence in primary education” lasted for four one-hour sessions. The general objectives considered were: 1) To introduce elementary education students to the ethical debate about the use of artificial intelligence (AI) in education; and 2) To promote critical reflection on ethical and social issues related to the integration of AI in the classroom.

Considering a total of 56 students in a university course for primary school teacher training, the following format was planned for each activity:

Session 1: Initial session (1 hour)

Content: Introduction to the discipline. Basic concepts of ethics in educational technology. Formation of research groups.

Activities: Course Exploring Ethics in AI in Primary Education and presentation of activities. Brief explanation of ethics in educational technology. Formation of groups and assignment of different aspects of AI in primary education for research. Use of ChatGPT to generate initial questions about ethics in the use of AI in education.

Methodology and duration of intervention: Students were divided into groups of approximately 7 to 8 members. The first 20 minutes were devoted to a brief introduction to the discipline and basic concepts of ethics in educational technology. Then, 10 minutes were allocated for the formation of research groups and the presentation of different aspects of AI in primary education for research. The next 20 minutes were used for a practical activity, such as generating initial questions about ethics in the use of AI in education, using ChatGPT. The last 10 minutes were reserved for group discussions about the generated questions and to define the next steps in the research.

Evaluation: During this session, the active participation of students in forming research groups and generating initial questions about ethics in the use of AI in education was assessed. Additionally, students' conceptual understanding of the basic concepts of ethics in educational technology was verified.

Session 2: Ethical group debate (1 hour)

Content: Discussion about specific ethical issues related to AI in primary education.

Activities: Group presentation of questions generated by ChatGPT. Group discussions on specific ethical issues assigned to each team. Discussion of key points raised in each group. Review of the topics discussed in the previous session. The first 15 minutes were dedicated to the group presentation of questions generated by ChatGPT. Then, 30 minutes were provided for group discussions on specific ethical issues assigned to each team. The last 15 minutes were reserved for a classroom discussion on the key points raised in each group and for synthesizing the discussed ideas.

Evaluation: The active participation of students in group debates, their ability to present well-founded arguments and respect divergent opinions was evaluated. The quality of the arguments presented and collaboration in groups was also observed.

Session 3: Extended debate and discussion (1 hour)

Content: Summary of debates conducted by the groups. Reflection on different ethical perspectives.

Activities: Presentation of the main conclusions and discussions of the groups. Extended classroom discussion on the different ethical and social aspects addressed. Encouragement of participation from all students in the discussion.

Methodology and duration of intervention: The session began with a summary of the debates conducted by the groups in the previous session. The first 20 minutes were devoted to presenting the main conclusions and discussions of the groups. Then, an extended classroom discussion on the different ethical and social aspects addressed was performed, encouraging participation from all students. The last 20 minutes were reserved for students' individual reflection on the discussed ethical perspectives and for drafting a personal summary of the main ideas discussed.

Evaluation: During this session, the evaluation focused on students' ability to present the main conclusions of the previous debates, to contribute to the extended classroom discussion, and to reflect on the discussed ethical perspectives.

Session 4: Reflection and conclusion (1 hour)

Content: Final reflection on debates and discussions. Identification of ethical approaches to integrating AI in primary education.

Activities: Written individual reflection on debates, emphasizing insights and ethical considerations. Classroom discussion on possible ethical approaches to integrating AI in primary education. Conclusion of the activity with a summary of reflections and conclusions reached.

Methodology and duration of intervention: The session started with a final reflection on the debates and discussions of the previous sessions. The first 15 minutes were devoted to classroom discussion on possible ethical approaches to integrating AI in

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primary education. Then, 30 minutes were provided for students' written individual reflection, emphasizing insights and ethical considerations. The last 15 minutes were reserved for concluding the activity with a summary of reflections and conclusions reached, encouraging students to share their reflections and insights.

Evaluation: The quality of students' written individual reflections on previous debates and discussions, as well as their participation in classroom discussion on possible ethical approaches to integrating AI in primary education, were evaluated. The students' ability to synthesize reflections and conclusions into a final summary was also observed.

Throughout the process, active participation of students in debates and discussions, the quality of individual reflections and contributions to classroom discussion, and the observation of engagement, argumentation, and respect for different perspectives during activities were also evaluated.

5. Results

The integration experience of a ChatGPT tool revealed impacts on the dimensions of engagement, metacognition, and cognition of students, and on the promotion of critical reflection on the ethical use of technology.

In Case 1 (Rio de Janeiro), there was a notable improvement in the students' ability to formulate essential questions during debates after the introduction of ChatGPT. Previously, questions were usually generic, whereas afterwards they became more specific and aligned with the Sustainable Development Goal (SDG) 4. This reflects an advancement in critical thinking and argumentative skills of the students as well as a greater awareness of complex educational issues. One difficulty faced was deciding the group's main idea but those who used ChatGPT to prioritize and categorize questions achieved better results, producing more elaborate questions. The alignment of questions with the curriculum encouraged research and thematic analysis. The organization and categorization of questions with the support of ChatGPT allowed the exploration of connections between different concepts of the curriculum and the objectives of SDG 4. For example, Team 12, after investigating SDG 4, Target 4.6, formulated a central question aimed at addressing specific challenges of literacy and mathematical learning in low-literate adults. Collaboration in groups to debate and

refine essential questions promoted active engagement of students in their learning and demonstrated a commitment to solving real educational problems.

In Case 2 (Catalonia), the exploration of ethics in the use of artificial intelligence in basic education engaged students in critical reflections on ethical and social issues. The progression of classes, from the introduction of basic concepts to expanded ethical discussions, allowed students to develop a complex understanding of the subject. The activities encouraged active engagement, with students forming consistent opinions, respecting differences, and collaborating to find ethical solutions for the integration of AI in education. Assessments indicated an increase in students' ability to apply ethical concepts to real scenarios, a crucial skill for future educators. The final reflection highlighted the importance of ethical approaches in technological integration, evidencing an advanced stage of ethical understanding. This translated into: 1) Student engagement: high involvement was observed during activities, stimulated by ChatGPT to generate initial questions; 2) Participation in discussions and debates: students demonstrated active participation, presenting well-founded arguments and multiple perspectives on ethical issues related to the use of AI in elementary education; 3) Individual reflections: written reflections revealed significant insights into ethical concerns, with an understanding of implications and consideration of diverse viewpoints; 4) Variety of perspectives: diversity enriched discussions, demonstrating a broad understanding of ethical and social issues associated with the use of AI; 5) Identification of ethical approaches: students were able to discuss ethical approaches to responsible integration of AI, broadening the understanding of ethical implications involved. This suggests the integration of similar activities in teacher training, preparing them for the ethical use of educational technology.

6. Conclusions and discussion

Our research evaluated ChatGPT as an educational tool to develop cognitive and critical skills, aligned with UN SDG 4. The results showed benefits in the development of these skills but also highlighted challenges, such as the need for guidance in the use of technology and effective integration into the curriculum. Personalization of learning, promotion of curiosity and ethical reflection are fundamental, requiring a reassessment of pedagogical practices. The integration of AI in education reflects

Marzano and Kendall's (2007) holistic approach, emphasizing cognitive, metacognitive, and self-development. The use of AI allows students to ask reflective questions, explore complex themes and develop a sophisticated ethical understanding, promoting meaningful learning. The importance of aligning essential questions with specific goals highlights the need for continuous feedback and formative assessment.

Comparing experiences in Brazil and Spain can provide valuable insights into the effectiveness of the tool in various educational contexts. This may lead to a better understanding of how to adapt and optimize the use of ChatGPT to meet the specific needs of different groups of students and disciplines.

The improvement in the articulation of essential questions by students, observed in the case of Rio de Janeiro, highlights the potential of ChatGPT to enhance critical and argumentative skills, essential for active participation in the social world. This observation is aligned with Anderson and Krathwohl's (2001) perspectives on the importance of transcending lower-order skills to achieve higher-order ones, such as analyzing, evaluating and creating. The Catalan experience, in turn, highlights the role of AI in promoting a more advanced stage of ethical understanding, contributing to the development of ethical awareness among students, as proposed by Kohlberg.

Students' final reflections on the ethical implications of AI in education, especially in the case of Catalonia, echo the concerns of Rodrigues and Rodrigues (2023) about the impacts of AI in education and the need for regulation and collective discussions. This aspect underscores the importance of teaching the critical use of technology to promote responsible and transparent knowledge, in line with Andrew Feenberg's critical theory of technology. Finally, the use of ChatGPT as a pedagogical tool not only enhances student engagement through the creation of dynamic and adaptive contents, as suggested by Berner *et al.* (2020), but also promotes collaboration.

The ability of ChatGPT to facilitate the formulation of questions that stimulate critical thinking and effective argumentation, as seen in the two experiences, resonates with the observations of Wang and Zhang (2022) on how AI-generated tasks can encourage students to think more analytically and creatively. Moreover, the diversity of perspectives and the identification of ethical approaches in discussions about AI in education underpin Rosenberg *et al.*'s (2021) argument, which points to the potential

of personalized learning by using generative language models, meeting students' individual needs and promoting an inclusive and adaptive learning environment. But further studies are still needed, considering the applied collective evaluation scenario.

To advance and improve the integration of ChatGPT and similar technologies in education, it is crucial to conduct more studies to explore further educational and cultural contexts in order to better understand how AI can be more effective in different learning environments. It is also crucial to develop ethical safeguards, investing in clear policies and guidelines to ensure student privacy, minimize algorithmic bias and avoid excessive reliance on technology. Another aspect is to improve personalization and adaptation, working on refining ChatGPT's resources to provide even more adaptable and personalized educational support. Finally, it is relevant to involve teachers and educators in the design of training and resources to help them effectively integrate AI in the classroom to its full potential.

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Tecnopedagogia en un món de màquines intel·ligents

Technopedagogy in a world of intelligent machines

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Resum

Aquesta comunicació vol ser el relat d'una realitat objectiva que promou experiències tecnopedagògiques personalitzades, que abracen la intel·ligència artificial educativa (IAE) amb el propòsit d'afavorir el desenvolupament de les competències educatives al segle XXI a través de processos dialògics i reflexius.

En aquest article es parla d'un context singular i coeducatiu que focalitza la seva mirada holística a reconèixer la dimensió biopsicosocial de cada persona. En aquesta direcció, les experiències amb IAE són tractades també a través d'un diàleg socràtic que permet comprendre i aprendre en un món de màquines intel·ligents, sense renunciar a la dimensió pròpia de l'ésser humà.

En conjunt, l'objectiu que segueix és apropar aquest testimoni tecnopedagògic i descriure com l'ésser humà pot créixer, aprendre i desenvolupar al màxim els propis talents, si se li ofereix l'oportunitat de fer-ho, a través

dels reptes i del coneixement de les possibilitats reals que li ofereix la tecnologia amb IAE.

Tot plegat és una evidència pedagògica, amb resultats engrescadors, en aquesta tercera dècada del segle XXI, que accepta els reptes d'una societat tecnològica i que promou unes experiències que afavoreixin la possibilitat real de fer-se preguntes reflexives i desenvolupar el pensament crític, la creativitat, les capacitats, les habilitats i les competències de cadascú.

Paraules clau

Tecnopedagogia, dimensió biopsicosocial, flexibilitat cognitiva, reflexió, coneixement, creativitat, benestar.

Abstract

This paper seeks to present an objective reality promoting personalised technopedagogical experiences that embrace artificial intelligence in education (AIE) in order to favour the development of educational competences in the 21st century through dialogical and reflexive processes.

Specifically, it deals with a unique co-educational context that focuses its holistic vision on the recognition of the biopsychosocial dimension of each person. In this respect, it also addresses experiences with AI through a Socratic dialogue that allows understanding and learning in a world of intelligent machines, without renouncing the human dimension itself.

Overall, the aim here is to approach this technopedagogical testimony more closely and to describe how human beings can grow, learn and develop their talents to the fullest if given the opportunity to do so through their own challenges and a knowledge of the real possibilities offered by AI technology.

It is also pedagogical evidence of positive results in the third decade of the 21st century, a time when the challenges of a technological society are accepted and experiences are promoted that favour the real possibility of asking reflective questions and developing the critical thinking, creativity, abilities, skills and competences of each individual.

Keywords

Technopedagogy, biopsychosocial dimension, cognitive flexibility, reflection, knowledge, creativity, well-being.

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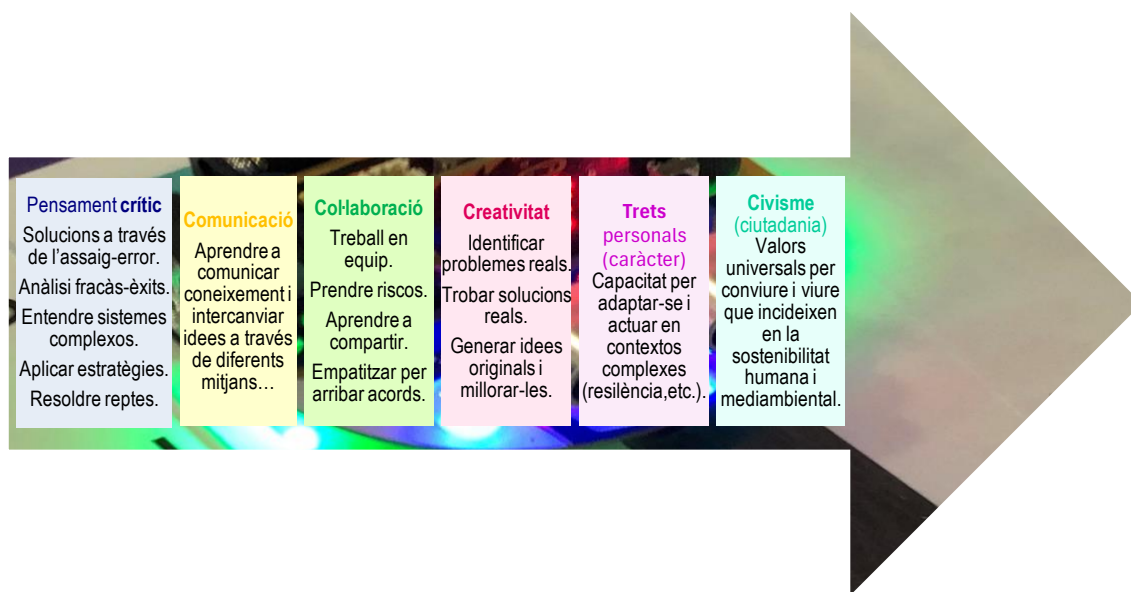
1. Introducció

Situem el marc teòric de la nostra experiència als inicis de la robòtica educativa, a la dècada del 1960, quan Seymour Papert, considerat un dels pioners de la intel·ligència artificial (IA), va crear el llenguatge de programació Logo el 1968 (Papert, 1984). Papert va coincidir amb Jean Piaget a la Universitat de Ginebra i, més tard, es va unir al Massachusetts Institute of Technology (MIT), on va fundar l'Institut d'Intel·ligència Artificial. Papert, basant-se en els treballs sobre constructivisme (Piaget, 1980), va desenvolupar una visió de l'aprenentatge anomenat *construccionisme*.

La teoria construccionista (Papert, 1984) és una teoria de l'aprenentatge que destaca la importància de l'acció, és a dir, de procedir de manera activa en el procés d'aprenentatge. En aquesta direcció, cal tenir en consideració Cynthia Solomon, pionera en tecnologia educativa que, juntament amb Papert, va cocrear el llenguatge de programació Logo. Convé destacar que Solomon, el 1971, va establir les bases del que actualment es coneix com el moviment *maker*.

D'altra banda, també es fa necessari considerar que en els fonaments de l'experiència que es vol compartir en aquest article queda inclosa la necessitat de focalitzar el compromís cap a les competències necessàries en l'educació del segle XXI (Prats, 2022). Al mateix temps que es persegueix l'objectiu pedagògic d'afavorir entorns d'aprenentatge on l'alumnat pugui apassionar-se i complaure's en el procés educatiu; un espai en el qual se li permeti ser i fer de manera proactiva per progressar en la construcció de coneixement.

Desenvolupar la connexió entre pensar i fer pot tenir un impacte profund sobre les ments dels alumnes (vegeu la figura 1), per això és important considerar que la teoria construccionista (Papert, 1984) és actualment vigent amb l'aparició de la IAE i la possibilitat que ofereix per desenvolupar les competències educatives essencials al segle XXI (Trilling i Fadel, 2009; Fullan i Langworthy, 2014).

FIGURA 1: *Competències educatives al segle XXI*

Font: Oliveras, 2022.

En conseqüència, l'article parla d'una realitat educativa amb una fonamentació pedagògica, psicològica i epistemològica que reconèixer la persona com agent principal de canvi des de la perspectiva biopsicosocial (Belloch i Olabarria, 1993). Fins i tot, dins d'aquest context tecnopedagògic de tradició i innovació psicopedagògica, es tenen en consideració diferents corrents i un recorregut teòric llarg amb un denominador comú: estimar la persona des de la seva singularitat i donar respostes a les seves necessitats psicoeducatives (Oliveras, 2022).

D'una forma breu, i per situar el lector de l'article, les línies que es comparteixen parlen d'una realitat que abraça la importància de la creativitat, la flexibilitat cognitiva, la curiositat, l'anàlisi personalitzada, l'intercanvi d'idees, el treball en equip, la cerca de les solucions, la col·laboració, la cocreació, la coavaluació i l'aprenentatge entre iguals; sempre amb el determini d'encoratjar l'alumnat a prendre riscos sense por al fracàs tot admetent el seu protagonisme en el procés d'ensenyament i aprenentatge (Bassedà i Oliveras, 2020).

En suma, aquesta experiència tecnopedagògica en un món de màquines intel·ligents és una realitat objectiva que promou situacions d'aprenentatge personalitzades, que

inclouen la IAE, amb el propòsit d'afavorir el desenvolupament de les competències educatives al segle XXI a través de processos dialògics i reflexius.

Al mateix temps, es parla d'un projecte tecnopedagògic que té un equip multidisciplinari que abraça la dimensió biopsicosocial de l'alumnat, amb el ferm compromís de promoure el desenvolupament del talent natural de l'ésser humà i fomentar l'impuls vital i el benestar de les persones. És un context humanístic i científic que es compromet, en cada experiència personalitzada, a empoderar l'alumnat cap a l'aprenentatge a través de la presa de consciència crítica (Freire, 1994). Una realitat tecnopedagògica que pren com a base indispensable els estils cognitius i els interessos d'aprenentatge dels alumnes mateixos (Montessori, 1939; Freinet, 1979; Piaget, 1980).

Així mateix, el projecte coeducatiu¹ té la finalitat de complementar, col·laborar i cooperar en diferents espais educatius, amb la mirada focalitzada a promoure l'aplicació d'un aprenentatge basat en problemes. Per això, mostra als alumnes el valor instrumental del pensament per resoldre situacions amb reptes reals a partir d'un tempteig experimental amb mitjans tècnics (Dewey, 1989; Delors, 1996).

Encara més, l'equip multidisciplinari accepta els estudis neurocientífics que confirmen la capacitat que té el cervell d'adaptar la conducta i els pensaments als canvis, per això en cada situació d'aprenentatge es fomenta la flexibilitat cognitiva o mental de l'alumnat (Dierssen, 2018). Simultàniament, ens referim a un dispositiu tecnopedagògic i psicoeducatiu que incideix en el desenvolupament de rutines cognitives i de competències d'aprendre a aprendre (Teixidó, 2011).

Per acabar aquest primer punt, cal destacar que ens situem en el marc d'un compromís psicopedagògic que també inclou l'oportunitat de desenvolupar el pensament computacional (Papert i Salomon, 1971) i la construcció de coneixement amb eines d'IA (*prompts*)² i diversos programes d'IA generativa³ que permeten abordar-la més enllà dels aspectes tècnics.

2. Anàlisi i avaluació de necessitats

Decidir què, com i quan integrar en l'entorn d'ensenyament i aprenentatge, especialment també pel que fa a eines pedagògiques, que inclouen la tecnologia actual, ha estat sempre una de les finalitats prioritàries i, específicament, un dels objectius operatius de l'experiència que s'exposa en aquest article.

Per aquest fet, la proposició psicoeducativa a la qual fem referència focalitza la seva mirada holística abraçant el model biopsicosocial (Belloch i Olabarria, 1993), amb la finalitat d'abordar i donar respostes a les necessitats identificades de cada alumne des de l'àmbit de la psicopedagogia i/o psicoeducació, i en un marc planetari al segle XXI que inclou un context de constant evolució tecnològica.

En aquesta direcció, convé destacar que l'equip humà de l'experiència sempre ha procurat dedicar esforç, recerca, reflexió i compromís per cada nova possibilitat tecnològica que potencialment pot afavorir la persona. Es prioritza incondicionalment l'equació psicopedagògica que situa la persona al centre del procés, perquè se senti motor del seu propi aprenentatge. Un compromís que integra fer descobrir a cadascú les competències i les capacitats que li són pròpies.

Abordar tecnopedagògicament aquesta realitat a la qual ens referim en aquesta comunicació, d'una banda, implica una sistematitzada recerca científica i, de l'altra, inclou una avaluació i valoració d'indicadors. Això suposa anàlisi i reflexió vers la millora del projecte coeducatiu¹ i l'ús adequat de les tecnologies en els processos d'ensenyament i aprenentatge (amb o sense pantalles, amb o sense IA!). Una anàlisi de necessitats que permet tenir en consideració la didàctica i el model tecnopedagògic en l'ús de les eines pedagògiques digitals seleccionades.

La proposta del model holístic que s'explica en aquest article, després de l'anàlisi de necessitats, assumeix la singularitat de cada alumne en la planificació didàctica del procés d'ensenyament i aprenentatge. Realment, és un compromís irrenunciable pel que fa a l'impuls de les potencialitats de l'alumnat i la consegüent qualitat dels aprenentatges significatius.

La nova era de la humanitat en què vivim, i que abraça la intel·ligència artificial, interpel·la que s'intensifiqui el compromís psicopedagògic d'experiències amb IAE.

Aquesta orientació fa que l'experiència que es comparteix es focalitzi en el diàleg socràtic per afavorir que la persona reflexioni i així aflori de dins seu el propi potencial, talent, en la construcció de coneixement i consegüent aprenentatge significatiu.

Permetre pensar i reflexionar sobre l'ús i la necessitat de la tecnologia, de forma ordenada, sistemàtica i respectuosa, contribueix a desenvolupar el pensament individual i la comprensió dels altres. El diàleg socràtic permet a l'alumnat, de qualsevol etapa educativa, comprendre i aprendre en un món amb màquines intel·ligents, sense renunciar a la dimensió de l'ésser humà mateix.

A més a més, la realitat del context de l'experiència i l'anàlisi de necessitats ha imposat la mediació pedagògica que facilita un marc dialògic i reflexiu adequat, des del coneixement i els valors universals; un diàleg íntim, i també col·lectiu, davant de les noves oportunitats tecnològiques, sobretot les que incorporen IAE. Cal assenyalar que la recerca de coneixement en el marc d'un diàleg col·lectiu afavoreix l'escolta activa i beneficia la senzillesa que caracteritza l'ésser quan admet la pròpia ignorància i entén el valor universal del coneixement compartit; a la vegada que creix sent i estant, tot aprenent a pensar i a fer, aixoplugat per un espai que promou els valors ètics universals.

És fa indispensable en un món tecnològic oferir l'oportunitat d'una reflexió constant fruit de la pròpia acció i el fer col·lectiu i participatiu. Acceptar la necessitat d'un marc dialògic i reflexiu permet abordar situacions d'aprenentatge amb IA generativa.³

L'anàlisi reflexionada habitual de la realitat coeducativa ha portat a unes situacions d'aprenentatge dissenyades per desenvolupar les competències i les habilitats pròpies de l'ésser humà en un món tecnològic com l'actual (Oliveras, 2022). Un context que es focalitza a promoure aptituds i actituds: la *curiositat* i l'*admiració* per afavorir l'esperit investigador de l'alumnat, que li permet replantejar una i una altra vegada els diferents sabers; la *il·lusió* i la *motivació*, que acceleren la inspiració de l'alumnat i que sens dubte apareixeran en els moments en què aquest aconsegueixi estar captivat i fascinat per la realitat; el *pensament raonat* i l'*esperit crític*, que potencien la creativitat i la flexibilitat cognitiva de l'alumnat vers l'inconformisme, la reflexió i el desenvolupament del propi pensament crític, i finalment, la *serenitat* i la *distensió*, que permeten somiar despert,

acceptant que la tensió psíquica pot frenar la creativitat i l'evolució harmònica de la persona.

En definitiva, la mirada del projecte tecnopedagògic d'aquesta experiència exigeix, per cada nova possibilitat d'ensenyar i aprendre, per cada nou artefacte cognitiu i tecnològic, per cada entorn d'aprenentatge, una nova reflexió psicopedagògica que permeti integrar didàctica i eines pedagògiques vers la personalització educativa. Tot plegat, aplicable a contextos educatius diversos, sempre que es consideri que cada opció pedagògica pot tenir resultats i implicacions molt diferents.

3. Context

L'engranatge tecnopedagògic que promou el context d'aquesta experiència inclou la interdisciplinarietat, la multidisciplinarietat i la transdisciplinarietat. L'objectiu és afavorir un entorn d'aprenentatge on l'alumnat aprengui experimentant a partir dels reptes que neixen de dins seu, amb les pròpies competències i des de la pròpia singularitat; on les diferents disciplines col·laboren, interaccionen i coparticipen (Bassedà i Oliveras, 2020). La velocitat d'aquest engranatge tecnopedagògic, al servei d'equips educatius pluridisciplinaris, fins i tot transfronterers, afavoreix l'impuls digital en l'educació del segle XXI.

Els principis fonamentals i els criteris psicopedagògics que permeten incorporar la proposta tecnopedagògica amb IAE a través d'experiències i situacions d'aprenentatge personalitzades aplicables a realitats educatives diverses, queden recollits en un decàleg tecnopedagògic amb els següents condicionants irrenunciabls: llibertat per aprendre; assumptió dels propis reptes; convivència vers l'aprenentatge, el desenvolupament i el benestar; gestió del propi temps; increment de competències i habilitats com la creativitat, la reflexió i el pensament crític; assumptió de lideratges i empoderament; personalització i itineraris educatius connectats; autoavaluació, coavaluació i avaluació (Oliveras, 2022).

El context de l'experiència parteix de marcs de referència⁴ i normatius⁵ actuals que permeten abraçar les necessitats reals, els talents naturals i les tendències personals

dels alumnes. Els valors psicopedagògics d'aquest context¹ exigeixen dissenyar plans personalitzats que inclouen eines pedagògiques, tecnologies i aplicacions.

En aquesta direcció, es promou la necessària comprensió dels processos mentals que poden existir al cervell humà (Damasio, 1994); de la mateixa manera que s'afavoreix l'impuls vital de l'alumnat, perquè reconegui els propis sentiments i els dels altres amb la conveniència de desenvolupar l'habilitat per gestionar-los (Goleman, 2018). Es destaca una realitat que reconeix la importància de la connexió humana i la solidaritat, i que s'oposa a la rigidesa de pensament i dogmatismes que limitin la llibertat, el pensament crític i reflexionat en un marc de valors universals de respecte i reconeixement de l'altre.

Un dels aspectes més rellevants d'aquest context coeducatiu (Bassedà i Oliveras, 2020) és la ferma vocacional de respectar la gènesi dels reptes que neixen de l'alumne mateix, el profund respecte cap a unes aspiracions de l'aprenent que li faciliten la possibilitat real de gestionar i construir el propi procés a través d'un portafolis i/o contracte de treball personal (Freinet, 1979) on, fins i tot, es poden incloure en cada pla de treball oportunitats educatives com la programació amb intel·ligència artificial o la robòtica educativa (Alimisis, Moro i Menegatti, 2017) vers el desenvolupament d'un currículum competencial i aprenentatges instrumentals. Un context tecnopedagògic que destaca per permetre a cada alumne desenvolupar habilitats i augmentar tant el nivell competencial com la capacitat d'aprenentatge i millorar el seu propi benestar. A més, es posa a l'abast de l'alumne un conjunt de procediments que permet incrementar la col·laboració i el potencial de cocreació i coelaboració de coneixement de l'alumnat. Instruments, eines, recursos i tècniques, com ara les activitats transversals amb IA i de programació, que faciliten el desenvolupament de competències clau com el pensament reflexionat, creatiu i computacional (Papert i Salomon, 1971; Resnick, 2023).

Al capdavant, parlem d'una realitat coeducativa,¹ on els alumnes desenvolupen els seus propis reptes convivint amb la inclusió de la diversitat en un espai híbrid, telemàtic o un espai físic diàfan amb un disseny neuroarquitectònic (Metzger, 2018); espais pensats per fomentar la creativitat, la concentració i la motivació dels alumnes, però també del personal docent i la codocència; uns espais que tenen en compte la relació que es crea

entre els estímuls i l'entorn percebut. Parlem d'un context que ofereix i afavoreix l'aprenentatge entre iguals i la convivència entre nivells educatius i evolutius diferents.

4. Proposta d'intervenció a través d'una experiència tecnopedagògica en un món de màquines intel·ligents

És important esmentar que l'experiència tecnopedagògica que es comparteix en aquest capítol neix de la personalització del procés d'ensenyament i aprenentatge (Bassedà i Oliveras, 2020), acompanyat i guiat pel docent que pren en consideració l'alumne i l'ànima a respondre des de la reflexió i el propi coneixement al *com* i al *per què*, i no només al *què*, atès que la realitat coeducativa¹ de la qual parlem acompanya el desenvolupament competencial i facilita la creativitat a partir de les necessitats de l'alumne mateix. En aquest sentit, resulta imprescindible saber fer les preguntes convenients que propiciïn l'aprenentatge (Sigman, 2016). Això fa que els alumnes puguin investigar el que els encuroseix i/o crear el que s'imaginem, i que el docent els pugui guiar en la construcció de coneixement i acompanyar en el procés, gestionant-ne possibilitats i limitacions.

La proposta es recolza en un enfocament basat en l'alumnat com a agent actiu, implicat, motivat i participatiu. Una experiència que aplica metodologies actives aplicades a l'educació del segle XXI, pensades per donar respostes als interessos i reptes que neixen de l'alumne mateix a la vegada que faciliten el desenvolupament i el potencial natural de cadascú. És fa indispensable, en un món de màquines intel·ligents, acceptar les metodologies actives d'aprenentatge que impliquen afavorir: l'escolta activa de les necessitats i interessos de l'alumnat; la participació activa i col·laborativa; la motivació cap a l'aprenentatge; la curiositat per saber; l'experimentació i la recerca de coneixement, i el descobriment i la construcció de sabers. Convé mencionar que l'experiència tecnopedagògica d'aquest article inclou aquestes metodologies, perquè la proposta es focalitza en: l'aprenentatge basat en la pràctica (Montessori, 1939); l'aprenentatge basat en la investigació i la recerca (Freinet, 1979); l'aprenentatge basat en l'experimentació i l'assaig-error com a font de coneixement i com a model educatiu basat en les passions i els interessos dels alumnes (Decroly, 2009); l'aprenentatge entre iguals (Montessori, 1939), i l'aprenentatge basat en projectes (Dewey, 1989).

Amb tot, el projecte coeducatiu de l'experiència (que inclou situacions d'aprenentatge amb IAE) persegueix els objectius psicopedagògics generals següents:

- Personalitzar l'aprenentatge per adaptar-se a les necessitats i interessos individuals dels alumnes.
- Fomentar la integració de les disciplines de ciència, tecnologia, enginyeria, arts (literatura, música, teatre, dansa...) i matemàtiques de manera interdisciplinària, multidisciplinària i transdisciplinària abraçant el currículum competencial i aprenentatges instrumentals per a la construcció de coneixement.
- Fomentar un aprenentatge més significatiu i motivador.
- Acompanyar i guiar el desenvolupament de competències per l'impuls vital i de talents de cadascú.
- Inspirar i motivar l'alumnat a practicar i desenvolupar habilitats decisives com la comunicació, la col·laboració, la creativitat i el pensament crític.
- Impulsar la creativitat i la innovació a través de l'ús d'eines pedagògiques que també poden incloure tecnologia digital.
- Encoratjar la persona vers la resolució de problemes complexos.
- Incrementar les habilitats de pensament crític i reflexionat dels alumnes.
- Afavorir la comunicació entre l'alumnat i els docents a través de processos dialògics i reflexius.
- Promoure l'aprenentatge actiu i col·laboratiu.
- Vetllar per la integració de la tecnologia digital a l'aula.
- Estimular la participació dels alumnes mitjançant eines digitals.
- Millorar les habilitats digitals dels protagonistes del procés d'ensenyament i aprenentatge.
- Avaluar, coavaluar i autoavaluar els processos d'ensenyament i aprenentatge.

Pel que fa als objectius específics de l'experiència dins el marc metodològic esmentat asseguren i respecten les intencions, els interessos, les hipòtesis, les tendències i talents naturals de l'alumnat. Per aconseguir-ho es parteix d'un marc teòric de referència que pot facilitar l'anàlisi i el desenvolupament del repte i del propi aprenentatge a través d'un procés educatiu que inclou el mètode científic (vegeu la figura 2).

Finalment, els objectius operatius de la proposta permeten quantificar i mesurar mitjançant indicadors el procés d'ensenyament i d'aprenentatge de cada alumne; d'una banda, el marc normatiu assenyala els objectius que estableix el currículum competencial i, de l'altra, la pròpia singularitat de la cada alumne també determina indicadors d'avaluació que es van recollint a través del procés que segueix per assolir els reptes que es proposa. Les rúbriques d'avaluació recullen l'aprenentatge significatiu que assolix l'alumne, el desenvolupament de les competències educatives del segle XXI que realitza i la construcció de coneixement que obté a través del mètode científic.

L'equip multidisciplinari, que es responsabilitza de cada situació d'aprenentatge personalitzat en un entorn educatiu que abraça la diversitat (vegeu la figura 2), assegura el guiatge i l'acompanyament amb el compromís de personalitzar el procés d'ensenyament i aprenentatge (Bassedà i Oliveras, 2020).

FIGURA 2

Pauta d'acció científica i procés educatiu (objectius específics i operatius)



Font: Oliveras, 2022.

Convé destacar que l'experiència tecnopedagògica ofereix la possibilitat d'abastar una realitat social, científica i tècnica, perquè la persona pugui desenvolupar la capacitat de pensar més enllà de les idees admeses identificant problemes reals, per trobar solucions reals i conduir el propi aprenentatge, una realitat que ofereix eines i estratègies per desenvolupar les habilitats necessàries al segle XXI en un món de màquines intel·ligents.

Aquesta iniciativa tecnopedagògica convida l'alumnat, a través de cada situació d'aprenentatge, a desenvolupar una actitud filosòfica vers la reflexió i la conscienciació que l'ésser humà disposa dels sentits i de la raó per assolir coneixement. Un actitud reflexiva que ha de permetre contrastar coneixement per avançar cap a la certesa consensuada i, consegüentment, cap a l'hàbit del raonament i la lògica.

4.1. Experiència STEAM amb IAE: aprenentatge automàtic.

A l'inici de cada experiència STEAM es generen camins dialògics i reflexius per desenvolupar situacions d'aprenentatge personalitzades que permeten a l'alumnat comprendre què ofereix la tecnologia i la IA, perquè quan la utilitzi ho faci de manera conscient. I, d'altra banda, l'alumne aprèn i entén la utilitat de la tecnologia, amb o sense IA, pel seu procés d'aprenentatge, desenvolupament vital i benestar (vegeu la figura 3).

FIGURA 3

Síntesi del procés d'ensenyament i aprenentatge d'una situació d'aprenentatge a través d'una experiència STEAM a l'aula de primària (2022-2023)



Font: Centre Tecnopedagògic Binomi i escoles públiques Arrels de Perpinyà. Elaboració pròpia.

Un exemple d'experiència STEAM amb IAE, que es duu a terme en el context descrit i que permet afavorir especialment el descobriment de les pròpies capacitats, talents i trets personals d'acord amb l'etapa evolutiva, és la proposta d'experiència STEAM que convida l'alumne a crear un model d'aprenentatge automàtic per analitzar el propi estat d'ànim i la pròpia capacitat per identificar, entendre i gestionar emocions; fomentar la capacitat d'empatia, i desenvolupar la intel·ligència interpersonal i intrapersonal. Concretament, aquesta activitat també és una proposta en què intervenen diferents àrees curriculars de manera interdisciplinària a la vegada que es promouen funcions cognitives bàsiques.

Aquests tipus de reptes amb IAE permeten que l'alumnat obtingui recursos i estratègies que potencien l'autoconeixement, l'autonomia emocional i, també, que conegui tècniques per desenvolupar competències socials i utilitzar eines que faciliten el seu benestar i la curiositat per aprendre (vegeu la figura 4).

FIGURA 4

Exemple d'una plantilla de treball personal

NOM I COGNOMS ALUMNE/A [nivell/s educatiu/s]							
Repte	Títol repte	Símbol repte	Què em proposo?	Com ho vull aconseguir?	Què necessito?	Alternativa a la proposta inicial	Observacions

Font: Oliveras, 2022.

Aquesta proposta amb IAE facilita que els alumnes s'introdueixin en el món de la IA a través de la creació d'un model d'aprenentatge automàtic (*machine learning*, en anglès), aportant informació al sistema, entrenant-lo, aplicant un algorisme i provant-ne el funcionament (vegeu la figura 5).

FIGURA 5

Creació d'un model d'aprenentatge automàtic amb IA

The screenshot shows the LML interface with three main sections:

- 1. Entrenar (Train):** The user has added a new class of text. The interface shows two classes:
 - negativo (3):** mejor quedamos otro día, no tengo ganas de verte, no quiero que vengas.
 - positivo (5):** estoy jugando, estoy alegre, no me importa que llueva.
- 2. Aprender (Learn):** The user has selected the language as Spanish and is ready to learn to recognize texts.
- 3. Probar (Test):** The user has entered the expression "voy a jugar" and tested it. The results show:
 - positivo (60.92%)
 - negativo (39.08%)

Font: Elaboració pròpia, 2022.

Un cop escollit el propi repte i identificats els objectius, l'alumne crea dues classes o etiquetes on es recullen un conjunt de frases que denoten emocions i sentiments. És aleshores que el docent també ha d'intervenir des del seu domini del llenguatge, ja que les frases han d'estar ben estructurades, a la vegada que cal assegurar-se que s'entengui la unitat comunicativa i que s'expressi amb coherència lingüística el sentiment o l'emoció que l'alumne desitja descriure i/o compartir. Quan es considera que hi ha prou frases, s'inicia l'entrenament del sistema tecnològic.

Cal tenir present que com més unitats comunicatives, més capaç serà el sistema d'analitzar, interpretar i donar-nos un resultat encertat i fiable. En aquest punt apliquem l'algoritme d'aprenentatge automàtic, el qual farà que el sistema aprengui a partir de la informació que hem introduït.

En darrer lloc, cal provar el funcionament. Es pot programar amb diversos llenguatges de programació; Python o Scratch en són alguns. La majoria de llenguatges orientats a alumnes de primària i secundària d'educació bàsica inclouen extensions i llibreries que permeten treballar amb models d'IAE.

Convé remarcar que oferir la possibilitat d'experiències STEAM com aquesta permet als alumnes veure que el que succeeix és el mateix que passa en grans sistemes, com per exemple ChatGPT, que són capaços de donar resposta de manera automàtica perquè prèviament s'hi ha introduït molta informació (big data).

L'exemple d'activitat exposat més amunt és una situació d'aprenentatge de les diverses que s'ofereixen en el context tecnopedagògic al qual es refereix aquest article i que promouen volgutament un espai dialògic i de reflexió per tractar els límits i desafiaments de la IA *versus* la intel·ligència humana. L'espai de diàleg i d'aprenentatge entre iguals és un camí educatiu a través del raonament col·lectiu que no es limita a un intercanvi d'informació, sinó que també inclou una construcció de coneixement, una obertura cap a altri per a l'intercanvi de diferents visions i versions del món; un intercanvi que amplia el propi pensament i l'experiència personal vers la pròpia transformació. És convenient destacar que afavorir el diàleg és promoure el benestar

emocional i relacional dels alumnes; sens dubte un aspecte clau en el procés d'aprenentatge i creixement vital. A més, el diàleg i l'escolta atenta faciliten el reconeixement i el respecte de l'altre, a la vegada que esdevenen una pràctica d'autoconeixement i autodomini essencial en una realitat tecnològica amb IA.

El procés de tota activitat o exercici com el descrit més amunt, i dins el marc metodològic també compartit, té uns objectius operatius des d'un marc avaluatiu que abraça la seva funció reguladora (Sanmartí, 2010) i que inclou: l'avaluació formadora que permet als alumnes desenvolupar l'oportunitat de coavaluar i autoavaluar-se, i l'avaluació formativa que permet a l'equip multidisciplinari, des d'una realitat que conté la codocència, prendre en consideració les valoracions de l'alumnat, en vista també d'una avaluació del desenvolupament del contingut curricular, de l'assimilació de l'alumnat i de la seva aptitud i actitud en el procés d'ensenyament i aprenentatge.

Per finalitzar aquest punt de l'article, cal assenyalar que un altre objectiu del procés d'avaluació que es porta a terme, que no és menor i tampoc es pot perdre de vista, és el d'avaluar i valorar científicament l'entorn d'aprenentatge tecnopedagògic per arribar a poder-lo considerar un entorn innovador d'aprenentatge. En aquesta direcció, al final del curs 2021-2022, es va confeccionar una enquesta amb els criteris dels entorns innovadors d'aprenentatge (ILE, de l'anglès *innovative learning environments*) (OCDE, 2017). De les diferents escales que hi ha per valorar els objectius exposats, es va escollir l'escala Likert, perquè és una eina que es pot utilitzar en una investigació psicoeducativa pel que fa a avaluar les opinions i les actituds de les persones implicades, una eina científica que facilita la finalitat que ens proposem pel que fa a la reflexió pedagògica vers la millora dels processos d'ensenyament i d'aprenentatge (Bisquerra, 2004). A través de l'escala Likert es van elaborar uns qüestionaris per poder-ne triangular els resultats, analitzar i avaluar l'experiència. Uns resultats que de manera sintetitzada s'exposaran a continuació i que ja es difonen en entorns de formació de formadors⁶ i en el grau de pedagogia de la Universitat de Barcelona (UB).⁷

5. Resultats

Els resultats de l'experiència indiquen que s'han fomentat les competències digitals dels protagonistes a través de les activitats STEAM, de processos dialògics i reflexius, l'ús d'eines pedagògiques i de recursos tecnològics. Consegüentment, l'experiència ha permès recollir dades i evidències educatives que garanteixen i fan constar com per mitjà d'aquest engranatge tecnopedagògic s'han potenciat metodologies actives, des de la pedagogia de la inclusió i de l'equitat, des del respecte al protagonisme, els ritmes i els temps de cada alumne. D'una manera definitiva, l'experiència ha permès l'impuls vital de l'alumnat i el desenvolupament del seu talent i potencial.

El projecte coeducatiu Binomi,¹ que colidra i participa habitualment d'aquesta experiència tecnopedagògica juntament amb equips pluridisciplinaris, com els de les escoles públiques Arrels de Perpinyà,⁸ sistemàticament ha anat recollint indicadors des de l'observació i la pràctica educativa (Elliot, 1993; Arnal, Rincón i Latorre, 1992). Els indicadors recollits a través de les activitats personalitzades dissenyades amb el propòsit d'afavorir el desenvolupament de les competències educatives al segle XXI, a través de processos dialògics i reflexius, han permès evidenciar com en diferents situacions d'aprenentatge, com per exemple l'aprenentatge transfronterer, es potencien en l'alumnat una actitud reflexiva i una capacitat crítica de fer-se preguntes. Durant l'activitat educativa s'observa habitualment en l'alumnat una major actitud empàtica (vegeu la figura 6).

FIGURA 6

Esquema dels beneficis dels processos dialògics i reflexius en un món de màquines intel·ligents recollits el curs 2022-2023

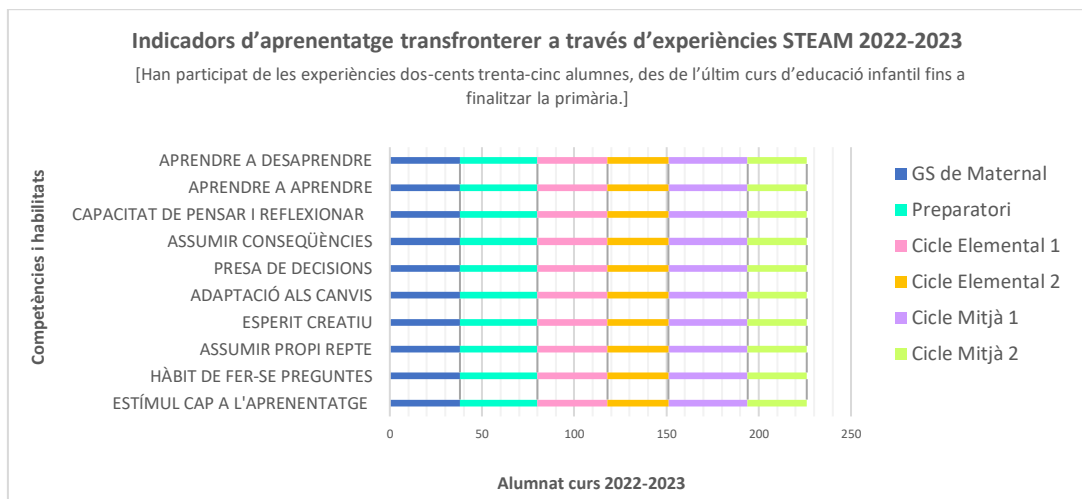


Font: Elaboració pròpia, 2024.

En aquests moments, estem situats a la fase d'inici de la recollida de les primeres dades (vegeu la figura 7); unes dades que ja ens permeten amb cautela començar a evidenciar elements importants pel que fa a la proposta tecnopedagògica personalitzada del projecte coeducatiu.¹ Uns indicadors psicopedagògics que ens ajuden a enriquir el debat sobre l'educació i la tecnopedagogia en un món de màquines intel·ligents, amb el propòsit de focalitzar-nos també en l'anàlisi d'unes evidències (vegeu la figura 8) que ens permetin continuar teixint camins tecnopedagògics i contribuint en el desenvolupament sostenible del nostre món (ODS, Agenda 2030).⁸

FIGURA 7

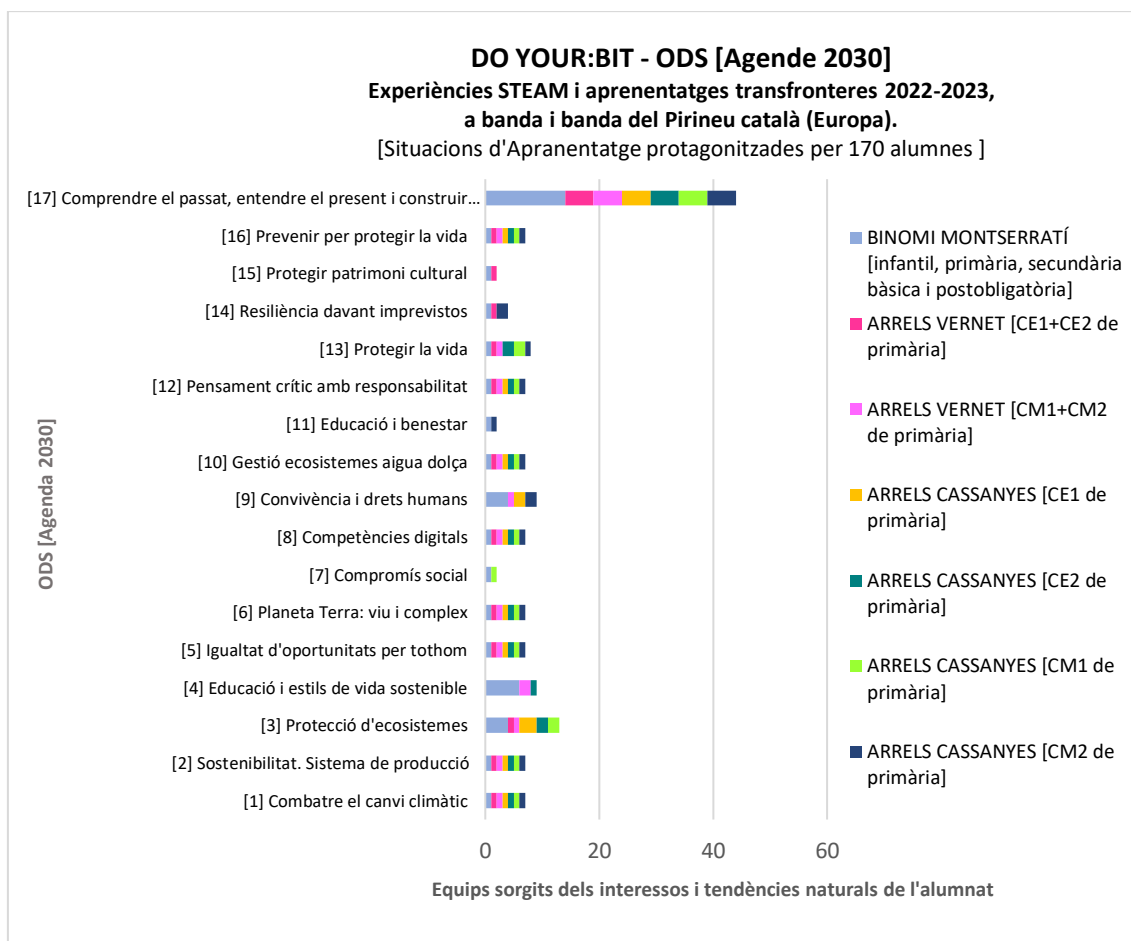
Gràfic que exemplifica els indicadors d'avaluació i d'aprenentatges transfronterers recollits el curs 2022-2023 a través de les experiències STEAM



Font: Centre Tecnopedagògic Binomi i escoles públiques Arrels de Perpinyà. Elaboració pròpia.

FIGURA 8

Experiències STEAM a través de la proposta «DO YOUR:BIT» amb plaques Micro:bit (aprenentatges transfronterers 2022-2023)



Font: Centre Tecnopedagògic Binomi i escoles públiques Arrels de Perpinyà. Elaboració pròpia.

Amb el consentiment informat dels participants, s'ha iniciat la valoració dels primers indicadors que es comparteixen en aquest article i que es recullen a través d'un formulari en línia i també en format paper; unes dades que s'intenten anar recollint de manera sistematitzada i, en la mesura que és possible, sense interrupcions.

En aquesta direcció, i amb prudència, es pot afirmar que s'han recollit uns indicadors que de moment confirmen la consideració d'entorns d'aprenentatge innovadors pel que fa a l'espai telemàtic, presencial i híbrid.

Es constata que l'experiència tecnopedagògica compartida ofereix la possibilitat real de desenvolupar un conjunt d'habilitats i competències que permeten resoldre situacions complexes i fomentar una actitud reflexiva. És una oportunitat real i aplicable a diferents contextos i complexitats educatives diverses, que capacita l'alumnat a raonar per si mateix davant els desafiaments que ens planteja una societat tecnològica que inclou la IA en la realitat educativa. Els indicadors educatius recollits durant l'experiència confirmen que es fa necessari respectar la curiositat de cadascú, la voluntat de trencar barreres mentals, la confiança en les capacitats pròpies de cada persona, i permetre que cadascú pugui experimentar amb les pròpies competències i des de la pròpia realitat.

En un altre ordre de coses, i com a darrer eix d'aquest engranatge tecnopedagògic, cal recordar de nou que les activitats digitals i experiències STEAM permeten desenvolupar el currículum competencial i afavorir el desenvolupament de l'alumnat com a ciutadans segurs, actius i responsables davant els nous reptes tecnològics, com és la IA en aquesta segona dècada del segle XXI.

6. Conclusions i discussió

L'experiència compartida és fruit d'un ferm compromís pedagògic que es caracteritza pel respecte cap a la persona que ja és tot alumne des del seu naixement, en el marc d'una aliança de profunda responsabilitat pel que fa a la sostenibilitat del planeta i els objectius de transformació social i educativa.

De manera específica, tal com hem anat esmentant, fins i tot es poden reconèixer els principis transversals que orienten la creació d'entorns d'aprenentatge al segle XXI (Delors, 1996) i igualment suggerits en el treball *The nature of learning: using research to inspire practice* (Dumont, Istance i Benavides, 2010).

Des d'aquesta realitat viscuda, fruit d'un profund esforç professional, que ha garantit la superació de variables imprevistes i impensables, es pot constatar com l'alumnat gaudeix de l'oportunitat real de desenvolupar les pròpies competències per trobar solucions reals i conduir el propi aprenentatge. En aquesta direcció, també hem pogut comprovar, de nou i amb satisfacció, que la clau de volta de l'èxit és respectar i estimar l'alumne des d'una perspectiva biopsicosocial que abraça les tres dimensions de la persona des de l'àmbit de la psicopedagogia, un model psicoeducatiu centrat en la persona i acompanyada per un equip multidisciplinari (Belloch i Olabarria, 1993).

Les evidències confirmen que si el marc educatiu facilita experiències personalitzades que incloguin factors decisius, com la curiositat de tots els alumnes, la seva capacitat d'admirar-se i apassionar-se amb il·lusió, la confiança amb les pròpies capacitats, etc., l'alumne aprèn significativament, desenvolupa un pensament reflexionat i computacional (Wing, 2006) que li permet experimentar amb les pròpies competències.

Consegüentment, l'entorn d'aprenentatge que hem compartit en aquest article ens dibuixa una experiència aplicable a diferents contextos educatius al segle XXI, basada en l'activitat dels alumnes, on es respecta la iniciativa de cadascú i la curiositat per comprendre i aprendre en un món de màquines intel·ligents.

Una realitat que abraça el compromís ètic d'una iniciativa neuropedagògica (Oliveras, 2022) i que neix de la necessitat d'un marc pedagògic democràtic i que permet a l'alumnat desenvolupar al màxim les seves capacitats cognitives sent els protagonistes del procés i del seu propi aprenentatge; cal estar convençuts que per més gran que sigui la complexitat o la perfecció de la IA, la intel·ligència humana no en pot deixar de ser el referent principal, en especial pel que fa al sistema perceptiu i al sistema motor, dels quals depenen les interaccions de l'humà amb l'entorn.

Finalment, només queda acceptar que aquesta nova era tecnològica de la humanitat, per més sofisticada que arribi a ser la tecnologia, exigeix un marc ètic que abracci la psicopedagogia com a clau de volta, perquè l'humà aprengui competencialment convivint amb intel·ligències artificials i aprofiti els avantatges de les tecnologies intel·ligents, sabent minimitzar els riscos, acceptar els límits i afrontar els progressius desafiaments, per assolir un ús conscient, responsable i respectuós de la tecnologia.

7. Agraïments i finançament

El context tecnopedagògic en un món de màquines intel·ligents descrit més amunt és una realitat objectiva gràcies al Centre Tecnopedagògic Binomi d'Esparreguera (Baix Llobregat), motiu pel qual l'autora d'aquest article vol agrair especialment el compromís a l'equip multidisciplinari del centre, el protagonisme a tot l'alumnat del Projecte Binomi, la confiança de les famílies i l'escalf dels amics i dels inestimables companys de viatge del projecte coeducatiu Binomi. Cal afegir una menció especial d'agraïment i reconeixement per a tot l'alumnat i els docents de les escoles públiques Arrels de Perpinyà (Catalunya del Nord).

8. Notes

1. Projecte coeducatiu que té el compromís de contribuir a la societat del coneixement, concebut per ser sostenible en el temps amb un impacte mínim en el medi ambient i identificat com a proposta innovadora d'acord amb els sectors de formació i educació, salut i benestar, innovació i tecnologia, coneixement i cultura. Vegeu www.binomi.cat.

2. Universitat Oberta de Catalunya (UOC) (2023). *Com preguntar a la IA? Prompts d'utilitat per al professorat per fer servir IA generativa*. https://openaccess.uoc.edu/bitstream/10609/147885/1/Manual%20IA_PROMTS_CAT.pdf

3. Universitat Oberta de Catalunya (UOC) (2023). *10 metodologies i activitats per avaluar i aprendre amb la IA generativa*. <https://uoc2thefuture.uoc.edu/recursos-conec/10-metodologies-i-activitats-per-avaluar-i-aprendre-amb-la-ia-generativa>

4. Organització de les Nacions Unides per a l'Educació, la Ciència i la Cultura (UNESCO) (2023, juny 19). *Guidance for generative AI in education and research*. <https://www.unesco.org/en/articles/guidance-generative-ai-education-and-research>

5. Departament d'Ensenyament (2024). *La intel·ligència artificial en l'educació: orientacions i recomanacions per al seu ús als centres*. <https://educacio.gencat.cat/web/.content/home/departament/publicacions/monografies/intelligencia-artificial-educacio/ia-educacio.pdf>

6. BINOMI promou i col·labora en l'impuls digital als centres educatius (vegeu https://sites.google.com/view/binomitecnopedagogia/press-room-binomi/cr%C3%A9ixerfentcr%C3%A9ixer_impulsdigital?authuser=0). També

desenvolupa programes que promouen i activen competències en un món de màquines intel·ligents (vegeu https://sites.google.com/view/binomitecnopedagogia/programes-binomi/programa_etitatic?authuser=0). El seu equip multidisciplinari fa formació de formadors, mentories de competències digitals de nivell B2, assessoraments, etc. Participa i col·labora en conferències, xerrades i jornades, com per exemple les Jornades DIM (didàctica, innovació i multimèdia) que organitza el doctor Pere Marquès (vegeu <https://dimglobal.ning.com/profiles/blog/list?user=dj09v3l0y3s>). També intervé en seminaris com el que impulsa el Col·legi Oficial de Doctors i Llicenciats en Filosofia i Lletres i en Ciències de Catalunya (CDL) a través del projecte «KBIP/COMconèixer», que focalitza la mirada en la construcció i la creació de coneixement de manera col·lectiva i col·laboraria (vegeu

https://sites.google.com/view/binomimontserrati/aulamontserrat%C3%AD/kbip_comcon%C3%A8ixer?authuser=0).

7. Activitats formatives obertes i vinculades a l'assignatura optativa de creativitat i innovació educativa del grau de pedagogia del Departament de Didàctica i Organització Educativa de la UB, amb l'objectiu d'apropar els futurs pedagogs a la realitat d'un pensament creatiu a través d'un diàleg socràtic, que permet ampliar el pensament des de la pròpia experiència i afavoreix la creativitat com a competència transformadora i de construcció pedagògica al segle XXI en un món de màquines intel·ligents (vegeu <https://sites.google.com/view/binomi-ub>).

8. Un total de quaranta-cinc grups de diferents nivells educatius de l'Escola Arrels-Vernet (vegeu <https://sites.google.com/view/binomi-arrels/inici>) i l'Escola Arrels-Cassanyes (vegeu <https://sites.google.com/view/binomi-arrels-cassanyes/inici>) de Perpinyà (Catalunya del Nord), i les aules lab_maker de Binomi.Montserratí (vegeu <https://sites.google.com/view/binomimontserratí>) d'Esparreguera (Baix Llobregat) van presentar els seus projectes «DO YOUR:BIT 2023» (vegeu <https://sites.google.com/view/doyourbit/p%C3%A0gina-dinici>).

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