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THE TRANSITIONAL SPACE. GENERATIVE ARTIFICIAL INTELLIGENCE AS AN OPPORTUNITY FOR GROWTH

Lo spazio transizionale. L'Intelligenza Artificiale Generativa come opportunità di crescita

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ABSTRACT This theoretical paper offers an interpretation of Generative Artificial Intelligence (GAI) as an opportunity for growth for individuals and in particular for the professional development of teachers. It argues that GAI systems foster a metacognitive standpoint in human partners, implying that the latter necessarily draw on their own knowledge in the prompt formulation and output analysis phases. This evocative nature is joined by a transitional one: GAI systems are objects, phenomena that stand for the "external" knowledge, that of the corpus of training data, only indirectly, i.e., through standing for an "internal" knowledge, that of the human partner. Consequently, interaction with these systems represents a transitional space, a neutral playing field where internal and external realities coexist. It is a collaborative experience during which new ideas emerge, while others may evolve or take on a specific form. In order to create an active partnership with AI aimed at growth, it is emphasized that teachers are called to be metacognitive professionals who possess complex knowledge that provides for a dynamic relationship between technology, pedagogy and the content of the subject taught.

KEYWORDS Generative Artificial Intelligence (GAI); Metacognition; Transitional Space; Teachers' Professional Development; Technological Pedagogical Content Knowledge (TPACK).

SOMMARIO Il contributo propone una lettura dell'Intelligenza Artificiale Generativa (GAI) come occasione di crescita per l'individuo e, in particolare, di sviluppo professionale per i docenti. Sostiene che tale tecnologia stimoli un atteggiamento metacognitivo da parte del partner umano, in quanto implica una riflessione sulla conoscenza nelle fasi di formulazione del prompt e di analisi del risultato generato. A questa natura evocativa, si

aggiunge quella transizionale: i sistemi di GAI sono oggetti, fenomeni, che significano una conoscenza esterna, ossia i dati di addestramento, indirettamente, cioè attraverso il significato di una conoscenza interna, quella del soggetto. Di conseguenza, l'interazione con tali sistemi rappresenta uno *spazio transizionale*, un'area neutra di gioco in cui realtà interna e realtà esterna coesistono. Si tratta di un'esperienza di collaborazione e interdipendenza durante la quale emergono nuove idee, mentre altre evolvono o assumono una forma specifica. Per poter attivare una partnership attiva con l'IA, tesa dunque alla crescita, si sottolinea infine come i docenti debbano essere professionisti metacognitivi in grado di mettere in gioco una conoscenza integrale, che contempli una relazione dinamica tra tecnologia, metodologia educativa e contenuto disciplinare.

PAROLE CHIAVE Intelligenza Artificiale Generativa; Metacognizione; Spazio Transizionale; Sviluppo Professionale dei Docenti; Technological Pedagogical Content Knowledge (TPACK).

1. INTRODUCTION

The educational world is currently experiencing a transformative shift fueled by technological advancements and by the evolution of teaching and learning methods. Over the past five years, this shift has been accelerated by the proliferation of Artificial Intelligence (AI) systems, which has prompted numerous policies that highlight the need for a conscious interaction with them in society.

Within the context of the United Nations 2030 Agenda for Sustainable Development, the *Beijing Consensus on Artificial Intelligence and Education* (UNESCO, 2019) recognizes the emergence of a requisite set of AI literacy skills for effective human-machine collaboration. It underscores AI's potential to innovate teaching and learning practices and address educational challenges. Concurrently, in the European context, the 2022 update of the *Digital Competence Framework for Citizens* considers it a priority to engage with AI confidently and safely. This means adopting a critical stance in order to identify the challenges, risks, and opportunities associated with AI, also within educational environments (Vuorikari, Kluzer, & Punie, 2022). Furthermore, the sixth action of the European Digital Education Action Plan (2021-2027), the *Ethical Guidelines on the Use of Artificial Intelligence and Data in Teaching and Learning for Educators* (European Commission, 2022), provides specific support to educators and school leaders for the ethical understanding and application of AI and data technologies, also clarifying common misconceptions about AI.

Throughout 2023, the widespread adoption of Generative Artificial Intelligence (GAI or GenAI) models, particularly OpenAI's GPT and Google's LaMDA, has led to the development of new publications aimed at exploring their use across all tiers of the educational spectrum. The UNESCO program document entitled *ChatGPT and Artificial Intelligence in Higher*

Education examines the potential of tools such as ChatGPT at the highest levels of formal education (Sabzalieva & Valentini, 2023). This quick guide outlines ways to capitalize on these technologies not only to enhance teaching and learning outcomes but also to advance scholarly research, streamline administrative functions, and bolster community interaction. Moreover, it underscores the essential nature of tackling ethical issues such as academic integrity, the need for regulatory frameworks, privacy concerns, cognitive biases, and questions of gender and diversity, as well as accessibility and the impact of commercial interests. Among the outputs of the European Digital Education Hub (EDEH), a network of national advisory bodies on digital education, the third briefing report produced by the Squad on Artificial Intelligence in Education, *Use Scenarios & Practical Examples of AI in Education* (Cassidy et al., 2023), provides a detailed exploration of practical scenarios and examples of how AI, including GAI, can be used in teaching. Again, with reference to formal education, this report distinguishes between three categories of AI use: helping students to adopt a critical perspective on the use of AI in society (*teaching for AI*); imparting technical knowledge regarding AI's fundamentals (*teaching about AI*); and using AI systems to achieve teaching and learning goals, such as using them to enhance instructional design or to support learners while they study (*teaching with AI*). The UNESCO document entitled *Guidance for Generative AI in Education and Research* further deepens this topic, conducting a rigorous exploration into the essential steps and pivotal considerations necessary for a judicious governance of GAI within a framework that prioritizes human-centric values, striving to align the deployment of new technologies with educational goals and values (Miao & Holmes, 2023). This document examines the potential for integrating GAI technologies into the realms of curriculum design, teaching, learning and research activities, highlighting the aforementioned principles of ethical practice, safety, equity, and purposeful application. As of February 2024, the *AI Competency Frameworks for Teachers and School Students* are being developed, expected to be published in September 2024 during the Digital Learning Week organized by UNESCO. These drafts confirm the vision offered in the guidelines, outlining a framework for teachers comprising five aspects: *Human-centered Mindset*; *Ethics of AI*; *AI Foundations and Applications*; *AI Pedagogy*; *AI for Professional Development* (UNESCO, 2024).

The attention paid to the application of GAI in the contexts of education and research concerns not only international institutions and organizations, but also the academic milieu. Universities are releasing documents aimed at ensuring that students, researchers, and staff are

able to leverage the opportunities presented by GAI[1]. Although originally conceived in response to issues connected to academic integrity, they have been redirected to encourage the exploration of AI-based teaching, learning, and research methodologies, and support the development of new skills, setting a precedent for ethical, collaborative, and innovative educational approaches in the digital age. They also emphasize the critical need for a collaborative ethos within and between institutions, for example through the creation of interdisciplinary teams that blend computer science competence, pedagogical expertise, and subject-specific knowledge.

Abandoning gray literature and moving towards the area of scientific research, it is evident that during 2023 researchers undertook numerous experiments relating to the use of GAI in educational contexts, investigating ways it can be used to support or produce experiences of teaching and/or learning, identifying attitudes regarding the adoption of such emerging technologies and evaluating the benefits, risks, and challenges (Ansari, Ahmad & Bhutta, 2023; Bond et al., 2024; Fütterer et al., 2023; Grassini, 2023; İpek et al., 2023; Jeon & Lee, 2023; Su & Yang, 2023). The conversation on these issues has branched into those studies that were previously oriented towards the broader category of Conversational AI (CAI) and especially Intelligent Tutoring Systems (ITS) (Wollny et al., 2021).

The synthesis of perspectives presented across all the referenced documents, regarding both gray and white literature, appear to encourage a culture of innovation based on critical engagement with the personal and professional potential of GAI systems and on gaining tangible benefits from interaction with them while, at the same time, trying to avoid new facets of the digital divide.

This theoretical paper is underpinned by the above studies and aims to offer an interpretation of GAI as an opportunity for growth of individuals and in particular for the professional development of teachers. It begins by proposing an analysis of the phases that constitute the interaction between the human partner and GAI systems, focusing on the metacognitive attitude that the latter inevitably invite one to adopt (see Section 2). Subsequently, it highlights GAI systems' transitional nature, evident in their interpretation as objects, phenomena that stand for the "external" knowledge (the training data) only indirectly, that is, through standing for the subject's "internal" knowledge. The interaction with GAI systems is thus analyzed as a

[1] Noteworthy examples of universities that have pioneered such initiatives include the Italian universities of Siena and of Milan, the UK's Russell Group, the Federal Institute of Technology Zurich, the Aalto University of Helsinki, the University of Lugano, and the American universities of Berkeley, Harvard, and Stanford.

transitional space, a creative interplay between the human partner and the algorithm that belongs simultaneously to the self and the outside world (see Section 3). Finally, reconnecting to the educational context outlined above, it investigates the knowledge required of teachers to support their professional development using GAI and proposes some reflections on the role that this technology can play in the growth of students (see Section 4).

2. INTERACTING WITH GAI SYSTEMS

GAI is a subcategory within the broader domain of AI, specifically within the Machine Learning (ML) branch. As such, GAI systems need to be "trained", that is, they need to process a large amount of data from which they "learn" how to simulate a typical human function (e.g. writing or drawing). After the training, they are able, upon request of a user, to generate new content — such as text, images, videos, 3D models, or music — that is coherent with, or similar to, the data provided during the training phase. Technically, GAI operates by employing multiple technologies, among which are Generative Adversarial Networks (GANs), Recurrent Neural Networks (RNNs), and transformer architectures like Generative Pre-Trained Transformers (GPT). The generated content, even when stemming from the same request, is always different because these technologies incorporate elements of randomness and variability. By leveraging stochastic processes, they can explore a vast gamma of potential outputs, selecting those that are most likely to be coherent and novel based on the learned data distribution.

2.1. Hallucinations and bias

As underscored in the literature referenced in Section 1, in the terms of use and technical reports of some of the most well-known services, GAI systems may in some situations generate inaccurate, misleading, untruthful, or non-sense content, often referred to as *hallucinations* (OpenAI, 2023). Furthermore, this content may reflect various societal biases, that is, distorted opinions that can be stereotypical and discriminatory, or exhibit views that may not be representative of the user's intent or are inappropriate for specific contexts. Hallucinations and bias are partly the result of the probabilistic nature of machine learning and partly due to the choice of data with which systems have been trained, with respect to which commercial services

do not provide clear information about the reference sources[2]. In fact, this data could be incorrect, emphasize overrepresented points of view, contain stereotypes and prejudices (for instance, gender, cultural, racial, ideological biases, etc.) or present non-updated world knowledge and awareness of events (Ray, 2023). Thus, to benefit from GAI systems it is clear that users must first of all be informed about this issue of accuracy and reliability of the sources.

2.2. Prompts and outputs

Interaction with GAI systems can be divided into the following phases:

1. The human partner formulates and forwards to the system a *prompt*, i.e., an input, typically a request with specific instructions.
2. The GAI system processes and produces an *output* in the desired multimedia format (usually GAI systems are "specialized" in producing a certain type of output).
3. The human partner analyzes and interprets the output.

Some GAI systems only operate on single queries, while allowing the output to be redefined by establishing additional parameters, generally via a visual interface with buttons and choice options. Others incorporate conversational interfaces (these fall within the CAI category) that replicate human dialogue and therefore cyclically link prompts and output. In these cases, they make use of a local memory to remember previous exchanges, both in input and in output, allowing GAI systems to provide contextually relevant responses. Examples include services such as OpenAI's ChatGPT, Google Gemini (formerly Google Bard), and Microsoft Copilot.

Prompts must be formulated using clear, precise, and unambiguous language. The more structured the prompt, the more effective the output will be. It is thus a question of knowing the specific vocabulary of the cognitive domain being investigated and identifying a list of useful variables in order to obtain an appropriate result. Learning objectives, prerequisites, times, recipients, and settings are valid variables for formulating prompts in the context of teaching and learning. To formulate the prompt, it is possible to implement one or more communication strategies — the same ones that pertain to the "*pragmatic competence"* of oral and written communication. In linguistics, this competence "*underlies the ability to use (...)* [grammatical]

[2] A quick search on scientific databases such as Scopus is sufficient to identify a mass of these contributions from 2023 aimed precisely at assessing the trustworthiness of these systems. The author believes that the issue of accuracy and reliability will only be partially resolved by GAI systems that have limited and verified knowledge bases. Indeed, the randomness in the automatic generation process – along with the consequent risk of error – will persist, as it is an intrinsic characteristic of this technology. To definitively overcome doubts about quality, will it be necessary to ascribe *a priori* a trusted and respected authority — an *auctoritas* — to GAI systems?

knowledge along with the conceptual system to achieve certain ends or purposes" (Chomsky, 1980, p. 59), including "knowledge of conditions and manner of appropriate use [of language]" (ibid., p. 224).

The simplest *prompting strategies* are aimed at using the system as an executor, a tool for obtaining a specific output. It is therefore a matter of asking direct questions, equipped with the appropriate variables and possibly accompanied by examples, positive or negative, useful for directing the result. Or again, these are requests for revision and manipulation of contents, on the level of signified or signifier, which may include reformulation, paraphrase, reorganization, replacement, completion, expansion, or summary. It is clear that the prompt must also be structured according to the desired format, whether for example a text or an image.

Output analysis implies what is described in the previous paragraph, i.e., the need to verify the quality and conformity of the generated content. In the event of undesirable results, it is possible to ask to regenerate the content, in whole or in part, or progressively refine the prompt so as to make it more specific and suitable for achieving the objectives.

In the case of conversational interfaces, it is essential to put into practice prompting strategies capable of activating what will later be described as an *active partnership* with the machine, i.e., the valorization of the system's contribution to the construction of knowledge (see Section 3). For example, it is possible to ask for clarification on the output provided or activate a sort of self-criticism on the part of the system so that the system critically evaluates its own responses. Or again, guide the system in processing answers through sequences of logical steps typical of problem solving, ask it to generate prompts itself, or invite it to ask questions to reduce possible guesses regarding variables not explicitly declared. It should be underlined that the conversational context, i.e., the production of a local memory relating to the information exchanged, could lead the GAI system to offer results limited to a specific, partial experience of the world, or to align itself with the human user's perspective even when that perspective lacks objective correctness. This latter behavior, not dissimilar to *filter bubbles*[3], has been observed and described as *persona sycophancy* (Sun et al., 2024)[4].

[3] A situation where a search on the Internet produces mostly information that conform to and reinforce the user's own beliefs, due to the search algorithm and the keywords used.

[4] Sometimes it is the user who chooses to orient the conversation towards specific needs, providing the system with a list of useful information to frame his profile, for example professional.

2.3. The metacognitive attitude

Formulation of the prompt and output analysis are two activities that require not so much the *action* of *asking* and *analyzing*, but the *ability* to *know how to ask* and *how to analyze*. GAI systems continually connect the *human partner*, i.e., the interacting subject, with knowledge. More specifically, they force a reflection on knowledge and consequently, the assumption of a *metacognitive attitude*. The human partner can formulate an effective prompt only if he knows what he is asking (*signified*) and knows how to ask it (*signifier*), just as he can analyze the output only if he is able to decode it (*signifier*) and to evaluate its content (*signified*). Competence in the domain of knowledge pertaining to the field of inquiry is required, also in the form of the critical ability to appraise what is (still) not known.

3. THE TRANSITIONAL SPACE

In the previous section, emphasis was placed on how interaction with GAI systems impels the subject to adopt a metacognitive attitude, i.e., continuous comparison with his own knowledge. Why then should an individual who already knows and indeed, is even metacognitive, need such interaction? Furthermore, why should a human choose to turn to a technology that also produces content containing hallucinations and bias?

Here the author chooses to answer the first question starting from an image taken from psychoanalytic theory, that of *transitional space*. Donald Woods Winnicott (1953; 1958; 1971) used this term to refer to an intermediate, liminal area of experience to which both the internal reality of the subject and the external one, shared with others, contribute. This is a crucial area for the development of a sense of self, a space for imagination and play, thus of creativity, where fantasy and reality overlap. The transitional space is activated by the subject in childhood, starting from specific *objects* or *phenomena* that can be imbued with subjective meaning while still being recognized as part of external reality. Examples might be a bundle of wool, the corner of a blanket, a word, or a mannerism, which are never totally under the child's "magical control" (i.e., internal) nor totally out of his control, therefore external. "*The transitional object and transitional phenomena start each human being off with what will always be important for them, i.e., a neutral area of experience which will not be challenged*" (Winnicott, 1958, p. 239). Object relations, the problem of what is objectively perceived yet subjectively conceived, self or not-self, represents a lifelong human concern. Winnicott himself stated that the transitional space is also omnipresent in adults' everyday social lives, when some experiences appear simultaneously from within and from without: "*This intermediate area of experience* […]

throughout life is retained in the intense experiencing that belongs to the arts and to religion and to imaginative living", and – not least – "*or creative scientific work*" (ivi, p. 249).

In her seminal work *The Second Self: Computers and the Human Spirit*, Sherry Turkle (1984) took up Winnicott's theories in her observation of human relationships with technology. Focusing on how people relate to computers and other digital devices, she supported the transitional nature of the latter, configuring them as *evocative objects*, i.e., capable of provoking self-reflection: "*I look at the computer in a different light, not in terms of its nature as an "analytical engine", but in terms of its 'second nature' as an evocative object, an object that fascinates, disturbs equanimity, and precipitates thought"* (ibid., p. 13). By projecting their thoughts, feelings, and human qualities onto machines, individuals transform these devices into tools through which they think about themselves, expression of a part of the self, *mirrors* of the mind. Digital devices allow one to objectify and observe from the outside many aspects of oneself that had always been perceived only from within.

A few years later, in *Life on the Screen: Identity in the Age of the Internet*, Turkle (1995) explored how cyberspace also has a transitional nature. Observing mediated interactions such as those occurring within Multi-User Dungeons (MUDs), she described how this virtual realm provides a *psychosocial moratorium* (Erikson, 1968), a safe environment, a sandbox for self-discovery in which individuals can experiment with their identities with minimal real-life consequences, supporting their own growth. She wrote "*virtual spaces may provide the safety for us to expose what we are missing so that we can begin to accept ourselves as we are. Virtuality need not be a prison. It can be the raft, the ladder, the transitional space, the moratorium, that is discarded after reaching greater freedom. We don't have to reject life on the screen, but we don't have to treat it as an alternative life either. We can use it as a space for growth*" (Turkle, 1995, p. 263).

GAI systems connect the subject with his own knowledge, stimulating the metacognitive attitude (see Section 2). From this perspective, they take on the role of mirrors of the self, of evocative objects. Moreover, their transitional nature lies in the fact that they stand for the "external" knowledge, that of the corpus of training data, only indirectly, i.e., through standing for an "internal" knowledge, that of the human partner. The creative interplay activated during content generation is a knowledge management process that belongs simultaneously to the self and to the outside world. The concept of author, whether human or algorithmic, loses value and fades away, giving centrality to collaboration and the co-construction of knowledge. The GAI system, in fact, can:

- concretize the ideas that the human partner possesses, thus becoming in part the intermediary and in part the author of their manifestation (e.g., the idea of a fantastic landscape that becomes the tangible image of a fantastic landscape);
- support reconfiguring or completing the human partner's ideas;
- allow the development of new ideas, i.e., not known to the human partner before the interaction.

This last case, certainly the most interesting, occurs only where the subject manages to establish an active and continuous partnership with the GAI system through dialogue. The conversational context can support the progressive development of the knowledge initially put into play by the subject, which is shaped by the responses generated from time to time by the GAI system, which in turn are however the result of the encounter with the inputs previously provided by the subject.

Interaction with GAI systems represents a transitional space, a liminal area of creativity and possibility that is neither internal nor external to the subject. In this space, individual knowledge hybridizes with that offered by the machine in a dynamic process, providing the metacognitive subject with an opportunity for intellectual growth. In the event that the latter engages his social identity (and thus a competence relating to a specific expertise, pertaining to the working sphere), a professional development is implemented. This experimental laboratory takes place when the subject actually has a desire to gain and produce new knowledge, that is, when he is driven by a *sense of curiosity*. This sense of curiosity is based on the metacognitive attitude and represents the awareness of an internal limit and at the same time the will to explore and transcend this limit. Individuals who choose to interact with a GAI system "*know that they do not know*", as Socrates puts it.

Interaction with GAI systems is part of an unprecedented communicative landscape. For the first time, interlocutors (i.e., a human and an algorithm) do not interpret knowledge "*in the same way*". However, despite the algorithm intrinsic inability to assimilate or "understand" the informational content it is tasked to manipulate or generate in a human way, the purpose of the communicative exchange is always achieved since the significance of the data generated is cognizable and relevant to the human partner (Esposito, 2022). But why turn to a GAI system, a technology, an interlocutor who doesn't "understand" in order to grow? Especially if, as previously mentioned (see Section 2), the content generated can be a carrier of hallucinations and bias?

To answer this second question, it is interesting to recover the construct of the Zone of Proximal Development (ZPD) developed by Lev Semënovič Vygotskij (1978). The ZPD represents the distance between the child's actual developmental level, determined by

autonomous problem-solving, and the potential developmental level, achievable through problem-solving under adult guidance or in collaboration with more capable peers. In this area, which has been assimilated by some to the transitional space (Naranjo Orozco, 2021; Parola, 2023), the adult or the more capable peers are described as the More Knowledgeable Other (MKO), that is, figures who provide the structure to support the child in achieving new competencies. Stojanov (2023) observed how GAI systems, in that specific case ChatGPT, may serve a function similar to that of Vygotsky's MKO since they possess an expansive range of multidisciplinary knowledge to which they have been exposed during training. However, given the susceptibility of these systems to hallucinations and biases, the scholar recommends using them with caution to scaffold knowledge. Here it therefore seems more useful to describe a GAI system as a More Experienced Other (MEO), a kind of traveler who has had the opportunity to visit many places and who, when questioned, begins his narrative. This definition perhaps better highlights the breadth of the system's exposure to various data rather than actual competence.

It is therefore assumed that the choice to relate to the GAI as MEO is a self-education choice intentionally made by the subject who, being metacognitive and therefore aware of his own relationship with knowledge, wants to attribute an educational value to technology. This value could indeed reside in the possibility of a critical comparison with a large amount of data, but also in the aspect of unpredictability, i.e., in the fact that the systems generate different content from time to time and consequently keep one's sense of curiosity active potentially indefinitely.

4. WHAT KNOWLEDGE FOR THE TEACHER?

Considering the figure of the teacher and reflecting upon the teaching process, three main areas of professional practice can benefit from interaction with a GAI system. These correspond to the *preactive, interactive*, and *postactive* teaching task domains, i.e., the cyclical phases of *analysis* and *design*, *implementation* (also known as *execution*), and *evaluation* (Jackson, 1966, 1968; Clark & Peterson, 1986).

Examining preactive tasks, GAI systems can support teachers in creating tools for analyzing educational needs, in shaping a course structure (*macro design*), or in detailing lesson plans and specific interventions (*micro design*). For instance, they can assist them in identifying teaching methods or frameworks, formulating syllabi and learning goals, developing evaluation strategies, and readjusting their planning to align with established pedagogical approaches or objectives.

GAI systems can facilitate the creation of material, whether in digital format or for print reproduction, that can be used during the interactive stage of teaching. This can encompass the

production of textual or visual materials to be presented during a lesson, such as discussion prompts or images, storyboards for video lessons, scripts for podcasts, or other content that meets specific criteria (for instance, for individuals with special educational needs). GAI systems can also simulate dialogue with professional figures or historical characters, to be managed in the classroom together with the students (Iannella, 2020; Iannella et al., 2021). In addition, they can support the assessment of learning by designing authentic tasks and evaluation rubrics, establishing protocols to foster metacognitive attitudes, and generating objective tests and exam questions.

Moving to postactive tasks, GAI systems can correct, evaluate, and grade student work according to specific guidelines, or provide feedback aimed at encouraging specific behaviors. They can also help produce tools that assist teachers in reflecting on their own actions and on students' results in order to improve teaching and support continuous professional development.

Despite the specificities of each task domain, it seems clear that within the context of teaching, a prompt and/or an output cannot fail to contain at least two pieces of information: one relating to the content, i.e., knowledge (for example that of a specific discipline), and one relating to pedagogy, i.e., the aspects that situate and make possible the transfer and acquisition of that knowledge (for example the learning objectives, the architecture of instruction, the strategies...)[5]. To these *content-related* and *pedagogical* dimensions, a third is always added, the *technological*. The latter refers not only to the tools (analogue or digital) to be used to facilitate specific pedagogical practices in a specific discipline (for example an evaluation rubric or a clicker), but especially to the circumstance that is examined here, i.e., the fact that the teacher is using a technology for a teaching purpose, the GAI system. A prompt like "*Generate a checklist to explore first-year university students' attitudes towards Mathematics*" contains and interrelates these three dimensions (Mathematics, explore first-year university students' attitude, checklist) and is obviously activated in the third (interaction with GAI).

From this perspective, an active partnership with GAI systems on the part of the teacher assumes, or rather requires, his integral training, such as that proposed by models that work on these three aspects, among which the Technological Pedagogical Content Knowledge (TPACK) framework (Koehler & Mishra, 2005). TPACK refers to knowledge regarding the complex relationships between technology, pedagogy, and content that enable teachers to develop appropriate and context-specific teaching strategies. To experience and benefit from the

[5] Jeon & Lee (2023) observed the centrality of pedagogical knowledge in the interaction between the teacher and GAI systems.

transitional space, teachers should be metacognitive professionals trained both in the uniqueness and in the interrelationships of these three dimensions.

Mishra, Warr and Islam (2023) observed that the advent of GAI raises questions about the relevance and the value of the TPACK framework. They argue for the importance of a fourth kind of knowledge, called Contextual Knowledge (XK), which pertains to the awareness of broader systemic factors that can empower or constrain GAI systems' use, such as state-level policies or standards. Teachers must not only understand how GAI works and its impact on teaching practices but also how it is creating a new ecosystem and, consequently, is changing individuals and society.

4.1. The relationship between GAI systems and students

What has been illustrated so far pertains to the area of teachers' professional development and therefore to that *teaching with AI* proposed by the EDEH's Squad on Artificial Intelligence in Education (see Section 1), which consists in the use of technology to achieve teaching and learning objectives.

It is crucial to acknowledge that teachers typically assume a dual role during an educational event. In fact, the latter is both content-related and relational (Iannella & Pagani, 2022; Sensevy & Mercier, 2007). The content-related dimension involves the knowledge building role, while the relational one aims to foster a supportive learning environment and establish meaningful connections with students. Within this vision, the concept of *hidden curriculum* (Jackson, 1968; Snyder, 1970) becomes relevant. This refers to the unspoken or implicit rules, behaviors, stereotypes, and values learned in educational settings, outside the formal curriculum. Considering the impact of technology in education, this socialization phenomenon can also include transmission of ideas of resistance to or acceptance of innovation, not always in a critical form. Hence, the conscious and discerning use of GAI systems in the teaching process may implicitly cultivate in students a mindset attuned to seizing the opportunities presented by AI, with benefits in social, personal, and future professional scenarios.

AI literacy can be further supported by explicitly teaching the risks and opportunities of AI, an action that falls within what the EDEH's Squad on Artificial Intelligence in Education defines as *teaching for AI*. This practice presumes a Heideggerian responsibility to the students since it lays the groundwork for building their own independent judgments concerning technology. In accordance with what was stated in the previous paragraphs, *teaching for AI* would thus also mean bringing students closer to adopting the same metacognitive attitude adopted by the teacher.

Aware of his own knowledge and of the errors and biases of a relationship with the sources of knowledge that is not always transparent, the student must pay attention to how he declares his knowledge to the system (*formulation of the prompt*) and must critically observe the results generated (*output analysis*). It is as if he deals not so much with a tutor but rather with himself or with a companion who has chosen to study everything (see Section 3). In the interaction with GAI, if the teacher finds a transitional space for growth as a professional, and therefore of a competence that pertains to a specific domain of expertise, the metacognitive student, a subject in progress, finds his transitional space for growth as a knowledge manager, i.e., as a continuous learner.

5. CONCLUSIONS

AI is reconfiguring the ways in which knowledge is managed. As it becomes increasingly integrated into various aspects of daily life, it is imperative to identify how humans can steer it towards active and fruitful use. From this perspective, the literature that evaluates its use in educational contexts is underlining how critical engagement, attentive to the benefits, risks and challenges can support teaching and learning practices and lead to innovative research.

This theoretical paper argues that interaction with GAI systems can offer the individual an opportunity for growth, provided that the latter starts from an adequate amount of awareness and competence in the domain of knowledge pertaining to the inquiry. Indeed, during the interaction, GAI systems force the human partner to reflect continuously and critically on his knowledge. It is not simply a matter of asking and analyzing, but of knowing how to ask and how to analyze. From this perspective, GAI systems can be interpreted as evocative objects (Turkle, 1984). Acting as mirrors of the subject's knowledge, they provoke self-reflection. Therefore, they require (and, at the same time foster) a metacognitive approach.

The evocative nature of GAI systems refers to a transitional dimension (Winnicott, 1953; 1958; 1971) too. GAI systems are transitional objects or phenomena as they stand for the "external" knowledge, that of the corpus of training data, only indirectly, i.e., through standing for an "internal" knowledge, that of the human partner. The creative interplay activated during content generation is a knowledge management process that belongs simultaneously to the self and to the outside world. GAI systems can concretize, reconfigure, or complete the ideas of the human partner and, especially during the conversation, stimulate new ones. In this situation the concept of the author, whether human or technological, fades in value, giving instead central roles to collaboration, co-construction of knowledge and partnership. GAI systems synthesize the data they are trained with and always create new knowledge with the interacting subject, in

a situation of interdependence. From this interdependence the metacognitive subject can draw something new — a product, an idea, a solution, a process, a skill, an attitude — and can grow. Thus, interaction with GAI systems constitutes a transitional space, a liminal area of experience neither under the complete "magical" control of the subject nor totally outside his control. Those who choose to interact possess the strength of their own knowledge and a sense of curiosity that urges them to go beyond their limits. They see in a technology that presents a rich "experience" and outlines a *ludus* through its unpredictability, the possibility of creative action.

GAI systems offer professional development opportunities for teachers, but only if they are metacognitive professionals able to bring into play an integrated knowledge encompassing technology, pedagogy, and disciplinary content during the interaction. These three dimensions, the same as the TPACK Model, are in fact always present in the prompt and/or in the output, as they represent the essential conditions for fulfilling a teaching purpose.

These pages aim to encourage a willingness to contemplate the use of GAI systems through an interdisciplinary lens, weaving together insights from psychology, sociology, computer science, and pedagogy. The proposed reflection, at present theoretical, lays the foundations for future analysis and experimentation.

6. References

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