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Framing Generative AI applications as tools for cognition in education

Enmarcando las aplicaciones de IA generativa como herramientas para la cognición en educación

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ABSTRACT
Generative AI applications enable different useful functions for learning based on the generation of content. This paper aims to offer a theoretical framework to understand them as tools for cognition (TFC), framed in the perspective of sociocultural theory and activity theory and distributed cognition. This perspective exemplifies how thought is not only packaged inside the individual's mind, but is distributed among subjects, objects, and artifacts, where tools mediate human activity and help in the executive functions of thought. The perspective of TFC embodies an educational socio-constructivist vision where learners build their knowledge with these tools, taking advantage of their affordances. It is the concept of learning "with" technology instead of the traditional vision of learning "from" technology, where technological applications are limited to providing information and evaluating the students' responses. Finally, we describe Generative AI applications as TFC following David Jonassen's pragmatic and pedagogical criteria, i.e. the capacity of knowledge representation of different subjects, the facilitation of critical and meaningful thinking (based on questioning and prompting) and how they enable complex thinking among students when used in learning tasks, only when executive functions are on the side of the learner.

RESUMEN
Las aplicaciones de IA generativa permiten funciones útiles para el aprendizaje basadas en la generación de contenidos. Este artículo ofrece un marco teórico para entenderlas como herramientas para la cognición (HPC), enmarcado en la perspectiva de la teoría sociocultural, la teoría de la actividad y la cognición distribuida. Esta perspectiva ejemplifica cómo el pensamiento no sólo está empaquetado dentro de la mente, sino que se distribuye entre sujetos, objetos y artefactos, donde las herramientas median la actividad humana y ayudan en las funciones ejecutivas del pensamiento. Encarna una visión en la que los alumnos construyen su conocimiento con ellas, aprovechando sus posibilidades. Es la concepción de aprender "con" la tecnología en lugar de la visión tradicional de aprender "de" la tecnología, donde las aplicaciones tecnológicas se limitan a proporcionar información y evaluar las respuestas de los estudiantes. Finalmente, describimos las aplicaciones de IA Generativa como HPC siguiendo los criterios pragmáticos y pedagógicos de David Jonassen, como la capacidad de representación del conocimiento, la facilitación del pensamiento crítico y significativo (basado en preguntas y *prompts*) y cómo permiten el pensamiento complejo entre estudiantes cuando se utilizan en tareas de aprendizaje, solamente cuando las funciones ejecutivas las realizan ellos.

KEYWORDS / PALABRAS CLAVES
Artificial intelligence; cognition; learning processes; critical thinking; computer uses in education - Inteligencia artificial; cognición; procesos de aprendizaje; pensamiento crítico; usos de los ordenadores en educación.

1. Introduction

Generative AI (hereinafter, GAI) applications have an increasing interest in educational research and are presented as an opportunity for personalizing learning, as a means of personal assistance, and as cognitive supports for higher order thinking, but also as a source of ethical problems and biases, lack of academic integrity, privacy issues and dissemination of false information (Crompton & Burke, 2024; Mishra et al., 2024; Walter, 2024).

According to UNESCO, GAI is " (...) an artificial intelligence (AI) technology that automatically generates content in response to prompts written in natural-language conversational interfaces" (Miao & Holmes, 2024, p.8). Moreover, it uses various AI technologies to create content across various media formats (Schellaert et al., 2023). This capacity to generate content that is plausible to people is what makes GAI different from past AI technologies, along with the social dimension that derives from its own interface: that is based on natural language, and we communicate with it through chatboxes or directly with our own voices. It appears as a human agent with whom users relate using such a human feature as language (Author, 2018; Mishra et al. 2023).

There are several GAI applications that enable different useful functions in education based on the generation of content (such as ChatGPT, Copilot etc.), either to create, structure, synthesize, reformulate texts or ideas, by students and/or by teachers, individually and/or collectively. There are GAI applications that guide us in the search of literature (Perplexity), in summarizing content (Scribe, Claude) in breaking down complex tasks in steps (Goblin Tools), that help with code writing (GitHub Copilot, AlphaCode), generate content in multiple media (DALL-E, Sora, Synthesia), among others.

These GAI application affordances have been appraised in the educational field. For instance, a UNESCO report from April 2023 identified its use in Higher Education as an aid in refining ideas, as an expert tutor, etc., for students' learning and teaching (Sabzilieva & Valentini, 2023). Crompton and Burke's (2024) systematic research review identified teachers' uses such as for teaching support, task automation, and for student learning such as accessibility, explaining difficult concepts, acting as a conversational partner, providing personalized feedback, providing writing support, self-assessment, and facilitating student engagement and self-determination.

Given the importance they have in the current educational debate, this paper aims to offer a theoretical framework to understand the GAI applications as *cognitive tools*, *mindtools* or *tools for cognition* (TFC from now on) -which stems from the vision of Gavriel Salomon, Roy D. Pea, Howard Rheingold, David Jonassen, among other introducers of the concept at the end of the 20th century-, framed in a perspective of sociocultural theory, activity theory and distributed cognition. Eventually, theoretical frameworks for the integration of GAI in education are needed to scaffold research efforts that can help evolve these theories of AI in Education (Dawson et al., 2023), but they should also structure a view of education that places the student at the center of the learning process, that enhances his/her agency, autonomy in the executive functions of cognition and critical thinking, and not to become just an artificial teacher or a tutorial-based educational system. This, we find, would be a limiting perspective. We intend to provide theoretical knowledge that informs how to effectively integrate GAI applications in our educational practice. The awareness of educational philosophies that help shape our own views provides us with a consciousness of the best technological choices for the greatest outcomes for our learners. This is what underlies our views of education and technology and what brings coherence and consistency to them (Kanuka, 2008).

2. Learning *with* technology: the perspective of TFC in education

The use of digital technologies in education for enhancing teaching and learning processes has been studied since their appearance and dissemination. Derry and Lajoie (1993), Salomon et al. (1991) and Jonassen (1996) distinguished two ways of technology integration in education: learning *from* technology and learning *with* technology, and as simple it may seem, the difference is huge between these two prepositions. With the first computers, Computer-assisted instruction (CAI) and Intelligent tutoring systems (ITS) were developed. They followed behaviorist approaches (based on stimulus-response and reinforcement of behavior), and cognitivist approaches (considering how our thinking process is related to working memory, long-term memory, schemata in our previous knowledge, memory retrieval, and elaborated feedback and personalization of learning). This learning approach is based on the learning *from* technology approach, where technology has the role of a teacher who gives the input and the feedback, accordingly, reproducing the traditional education approach -teacher-centered-, where the students' learning agency is low.

On the other hand, the learning *with* technology approach is learner-centered, where the student uses technology as a tool, aimed at doing something with it, not as a tutor. Thus, from this perspective, cognition is on the side of the learner, who takes advantage of the digital tools' affordances to do something with the tool that would not be possible (or at least it would be harder) without it. This perspective is rooted in the constructivist approach of teaching and learning where teachers design student-centered activities with preestablished pedagogical aims in which students have to construct their own learning. According to Iiyoshi et al. (2005), this is carried out through five different cognitive processes: information search, information presentation, knowledge organization, knowledge integration and knowledge generation. Derived from this, teachers can also adopt a constructionist perspective, where kids' activity is oriented to the creation of artifacts, unfolding their creativity (Papert, 1982), or socio-constructivist approaches of learning, where learners interact actively with the environment and with their peers and their educators to construct their learning.

3. Sociocultural theory as an overarching theory for TFC

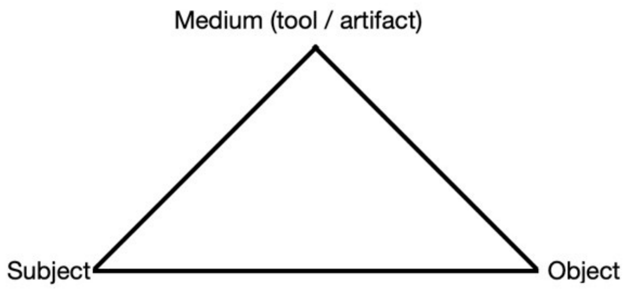
The learning *with* technology perspective is also rooted in sociocultural theory, created by Vygotsky, Leontiev and Luria during the 1920s in the Soviet Union. It assumes that the historical development of human culture is different from human biological evolution because it has its own rules (Vygotsky, 1978). Cultural development is based on the use of tools, created by humans, to act on the environment. They can be physical tools (e. g., a hammer or a screwdriver), but also symbolic tools (e.g., language). Symbolic tools are decontextualized from the environment – nature, biology – since the symbols they manipulate are increasingly less dependent on the space-time context in which they are used. A person without tools, only considering his/her biological evolution, cannot evolve; without tools, the qualitative cognitive leaps that Vygotsky relates to the transition from elementary cognition – that which is related to the primary and natural – to higher cognition – the "cultural" and the social – do not occur (Wertsch, 1995).

This influence also has an effect on building new tools that will affect the physical and cultural environment that will, in turn, also affect culture. This means that these tools make us, and they are not just a matter of the present time, but they come from our ancestors, and they will have an impact on the future. It focuses on activity as a culturally mediated action (Engeström & Sannino, 2021). From this perspective, the question revolving around whether to use or not to use digital tools in our human activity -and here we really mean "in education"-, is a false debate as tools are part of us. Without human beings there is no human culture, but without culture -and cultural tools- there are no human beings as we know them.

Sociocultural theory is based on culturally mediated action and is normally represented in the form of a triangle with three actors in each vortex (see Figure 1): In the lower part, the *Subject* and the *Object*, there is no mediation. The *Medium* in the upper vortex is the artifact (the tools) that mediates the subject's action on the object (the environment, the other subjects). This is a representation of what is often called the first generation of Activity Theory (Engeström & Sannino, 2021).

Figure 1

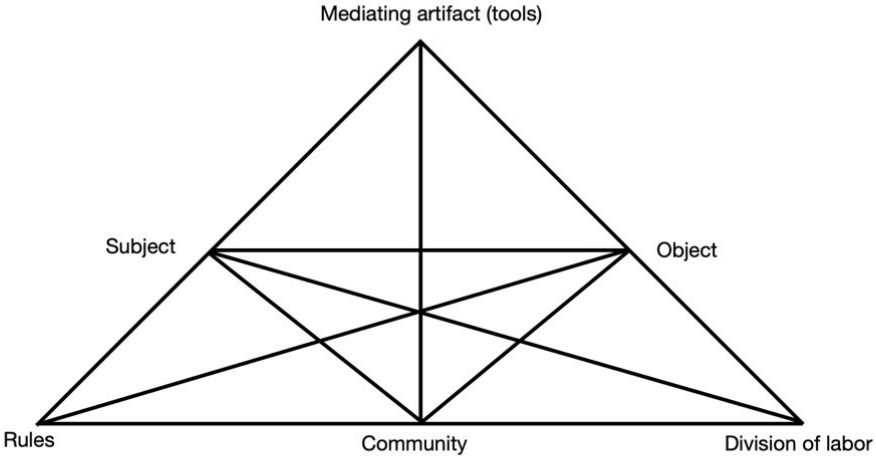
The triangle of culturally mediated action



In a second generation of Activity theory, the interactive triangle in Figure 1 was expanded to represent Leontiev's (1978) idea of activity (not just a sole action), which helps represent a larger mediation (Cole & Engeström, 1993). In Figure 1, the interaction is based on the individual action of the subject, mediated by the Medium, but in the second generation (see Figure 2), the main unit of analysis is the activity, that involves a community (the social dimension), carried out following a set of rules (on the left side). In the right vortex of the base, we find the "division of labor" where the activity is divided between participants and tools (Bakhurst, 2009).

Figure 2

A representation of the second generation of Activity Theory



What we want to stress is that this mediation places people's cognition within social and cultural contexts of interaction and activity (Salomon, 1993). We can say that this triangle is a map of a distributed cognition, between people, community, and cultural tools and artifacts. In this action system (Figure 1) and activity system (Figure 2), our mind is distributed with the tools -creating a distributed cognition- that we use to act on the environment (Cole & Engeström, 1993). This is why it is important to understand how these tools can offer different forms of mediation, and GAI applications can have a role in human action and collective activity as other digital tools also have.

4. Distributed cognitions with tools

With the first computer applications it was possible to imagine a collaboration between users and digital tools for a better performance (Salomon, 1993). These tools help us in tasks, guiding the activity and augmenting our capabilities, but also affecting our cognition, when we internalize these new forms of action (Vygotsky, 1978). The concept of distributed cognition was studied from different perspectives (see Salomon, 1993), and it implies that the activity needs to adapt the means to the ends. It leverages the tools' affordances, which are the actual and perceived properties of tools (Gibson, 1979), but more particularly as possible actions that users can develop with tools. It is not just what the user perceives in a tool that will allow certain operations in a social activity or in an individual action, but all the possible actions we could undertake with a tool (Norman, 1999) (for instance, with GAI applications). Affordances are not always evident and therefore must be learned (Gibson, 1989).

It is worth mentioning that these tools contain an intelligence within their designs, what Lave (1988) describes as "mythical" artifacts because they are already a part of our consciousness and we are not aware of what they are, they become invisible, like a speedometer in a car or a house thermostat. According to Dubé & McEwen (2017), when we are using tools, we perceive the symbols for the communication of affordances (for example, identifying a chatbox, a history log in certain GAI applications), the actual affordances themselves, and affordances that may be perceived by users based on their cognitive abilities.

As Clark and Chalmers (1998) described, there is an active effective externalism of our cognition where the environment has an active role in our internal cognitive processes. When we use digital tools to manipulate information through their options, they afford cognitive processes, augmenting our cognitive capacities, such as when a player rotates Tetris figures to make them fit in the spaces using the videogame affordances and not just by rotating them mentally. The rotation affordance lets the player visualize more quickly the action to be undertaken than if it had to be done just mentally. As described by Kirsh and Maglio (1994), these are the "epistemic actions", that help uncover information that is hard to process and which contribute to simplify problem-solving tasks. They are different from pragmatic actions, which help reach a physical goal.

Technologies are part of activity systems (Scribner & Cole, 1981), so when taking GAI applications into account, we must elicit the activities they afford. The nature of the activity will affect the cognitive processes, not just the tool per se (Salomon & Perkins, 2005). Sharples (2023) identified possible interactive and social learning uses between students and GAI applications, e.g., to explore possible scenarios, as a Socratic "opponent", as a co-designer, as a help for data or information interpretation, and so on.

When performing an activity, cognition may be distributed between the person and the tool, and here we find two quite different perspectives (Salomon et al., 1991). Firstly, the systemic one, which is an aggregated performance of the person-tool (this is Pea's position). Distributed cognition is not a matter of sharing or reallocating intelligence between mind, context, and tools, but of stretching intelligence during the activity (Pea, 1993). Secondly, the analytic perspective considers the specific contributions of the person and the tools (that would be Salomon's choice), where the person has a predominant role, most importantly because the tool really does not understand anything during the distributed cognition, just the individual does. When talking about GAI applications such as ChatGPT, this has been a critic from the beginning as Chomsky et al. (2023) have pointed out. The system does not understand language, so it is not real intelligence that is stretching over between person and tool. But it does not mean that these tools are not helping in off-loading a cognitive load in a task and that the tools themselves have intelligence of a social origin, as cultural tools.

During a cognitive partnership, the person will have the effects of using tools in the cognition, at least in three forms: the *effects with* technology, where using a technology enhances the cognitive processing and performance (this is an augmentation), the *effects of* technology where technology use leaves a "cognitive residue in the form of improved competencies, which affect subsequent distributed activities" (Salomon, 1993, p.123). And finally, we find the *effects through* technology, where technology use does not just augment our intellectual processing capacity, but it also reorganizes it (Salomon & Perkins, 2005).

David Perkins advocated for the distributed cognition perspective with the concept of the "person-plus" as opposed to the "person-solo" when dealing with tasks and activity. The "person-plus" takes advantage of the tools that help with the cognition, just as a student's learning is not just in what is inside his /her head but also in the "student-notebook" system (Perkins, 1993).

When dealing with collaboration between humans and artificial agents, the concept of *integrated hybrid intelligence* emerges. It refers to increased effectiveness in human activity. However, we find that it only appraises the side of the augmentation of human capabilities (the quantitative aspect, and not the qualitative one) (Akata et al., 2020; Järvelä et al., 2023). For instance, according to Holstein et al. (2020), this collaboration in performance and mutual learning happens for an augmentation in goals, perception, action, and decision-making. We think it does not consider how this intellectual partnership happens within an action or an activity system where interaction is not limited to augmentation but as a human activity reorganization.

5. Framing GAI apps as TFC

Understanding digital tools as TFC means adopting a perspective of learning *with* tools, and not just *from* them. They have been called "tools for thought" (Rheingold, 1985), "cognitive tools" (Pea, 1985; Salomon, 1993), "tools for cognition" (TFC) (Pea, 1993), "Mindtools" (Jonassen, 1996), and "psychological instruments" (Kozulin, 2000). In the case of this paper, we chose the term "TFC" as these tools are not intelligent and because they are tools for a purpose of an activity, which engage our cognition. "Cognitive tools" would mean that they have been already created for cognition, but many of these applications have been created for open purposes, which is the case of GAI apps. They can become TFC depending on the educational purpose we give them (the learning *with* perspective). However, the meaning of the term is abstract and with a diversity of views (Kim & Reeves, 2007).

There are several classifications of digital tools as TFC (or mindtools) regarding their nature and the nature of actions they afford (Jonassen et al., 1998) or the cognitive processes they allow (Iiyoshi et al., 2005). We find Kim & Reeves' (2007) classification interesting, which considers (1) the kind of knowledge they process -albeit general, domain-generic or domain-specific-, (2) the level of interactivity between user and tool, and (3) the kind of representation they allow -from concrete (isomorphic) to abstract (symbolic)-.

All these classifications are quite dated, and they do not include GAI apps. The closest thing to AI applications we find in these taxonomies would be expert systems, but they are different to GAI applications as they function with student models and scaffold students' learning depending on how they are progressing according to such models. By contrast, GAI apps are based on content generation and prompting. It may be similar when users query a data base, but in this case, the database limits itself to a response that is already found in its memory, whereas the GAI app queries receive new responses generated automatically live, affording a chat. In any case, GAI applications can perform executive functions as creators of content, and students can just sit back and let the application do all the writing for them. But, as TFC, they must be used in a way where executive functions are on the side of the learner's cognition. And they have the unique feature that can be used in general, generic and specific knowledge domains, and their representation capacity can be either concrete or abstract.

According to Jonassen (1996) there are three basic practical criteria that TFC (*mindtools*, in his terms) should have, plus six pedagogical criteria. We discuss these criteria to frame GAI apps as TFC below:

5.1. Practical criteria

1. That they are computer-based:

This first feature seems out of date as almost three decades have passed and digital tools are now pervasive in our daily life activities. Indeed, GAI apps are digital tools that are based on Large Language Models. We can access them through cloud-based applications, using computers, smartphones and tablets.

2. That they are available as (digital) tools:

Normally, GAI applications are available after having registered to a platform. These tools have taken the form of chatbots with a chatbox interface and allow natural language use. This kind of interface is usable, ergonomic and very familiar for students as many of the communication apps are based on such interfaces.

3. That they are affordable for the public domain:

GAI tools are spreading in large numbers (Alier et al., 2024). OpenAI claims to have the mission to “ensure that artificial general intelligence benefits all of humanity” (OpenAI, 2024), and despite not being entirely sure how sincere this intention is, for now they offer some of their features for free, although others are licensed. This also happens with other GPT tools, many of them free for teachers and educators.

5.2. Pedagogical criteria

4. Knowledge representation capacity:

GAI apps have the capacity of writing with a plausible appeal as their special feature. They can summarize, translate, paraphrase in different styles and speech registers, and generate all kinds of content from their database, or introduced by the user. People can use them for tasks related to information, which are very common in educational settings. When dealing with information, there is knowledge, the representation of it, retrieval of information and construction (Perkins, 1993).

5. Generalizable to several knowledge domains:

According to Schellaert et al. (2023), there are three unique properties of GAI applications. First, there is flexibility in the input-output diversity and multimodal capacity of these systems. Second, generality, as they can be applied to a wide range of tasks. And finally, originality, as they afford the generation of new and original content. They have a knowledge base that can be very wide like the one in ChatGPT. But many of these apps can be customized adding a knowledge base.

6. They foster critical thinking:

One of the dangers that the educational community has placed on AI tools is that they can be used in a non-ethical way (Crompton & Burke, 2024; Sharples, 2023). There is a fear that the student can, and will, cheat with them and will submit assignments that have been written directly by GAI applications. If this happens, then, the student cognition engagement in the task is low (in that the student reviews minimally what the GAI app has generated) or null. This has nothing to do with critical thinking, on the contrary, it promotes a superficial processing of information.

But GAI apps have the affordance of promoting critical thinking when being used as TFC. It is important to point out that the aim is to engage and enhance the learners' cognition with this partnership. Cognition engages when learners develop an activity that entails thinking in meaningful ways, to access, represent, organize and interpret information, helping students think for themselves, making connections and creating new knowledge (Kirschner & Erkens, 2006).

To this aim, the use of GAI applications as TFC must be activity oriented, thus goal oriented. This means that the learner must provide prompts to the tool and critically refine them to get the best results. Eager & Brunton (2023) proposed a prompting process that begins with a goal setting, a specification of the form the output should take, writing the actual prompt and testing and iterating until a desired output is obtained.

Providing good prompts - prompt engineering- is a desirable skill for AI literacy and to leverage GAI apps for learning because it requires a logical chain of reasoning (Knoth et al., 2024). When having to give the app an input for prompting a response, the student must use simple and clear language, giving examples to model the desired outcome, provide context, and most importantly, refine and iterate, when necessary, also maintaining ethical and responsible behavior (Miao & Holmes, 2023).

It is important to foster AI literacy about prompt engineering to understand what works best to generate adequate responses, and this entails thinking critically and creatively. This can be done with *zero-shot* prompts -when we ask the GAI application a single and generic prompt to obtain a generic answer-, or a *few-shot* prompts -where the user refines the prompts with examples that the answer should contain until receiving an adequate answer-. These are input-output prompts, but we can also develop *chain-of-thought* prompts where we ask the program to explain the output step-by-step so that it can be thoroughly assessed and help cultivate critical thinking in education (Walter, 2024).

Moreover, when prompting, there is a need for the user to possess a fair amount of content knowledge in order to assess the obtained responses or outputs, which is in addition to the critical thinking skills required to verify them and the necessary iteration of the prompt refinement (Cain, 2024; Eager & Brunton, 2023). This is the knowledge (skills, attitudes and dispositions) required to learn facts, and it is the knowledge base for critical thinking and creative thinking (Jonassen 1996; Perkins, 1993). Complex thinking skills such as problem-solving, design and decision-making, which are executive functions of cognition, can be supported by tools (Perkins, 1993).

7. They afford a transfer of learning:

According to Jonassen (1996), the transfer of learning is directly related to problem solving, so any thinking that GAI applications promote facilitates problem solving and transfer of learning. TFC are generalizable tools and can be used in different settings to facilitate cognition (Kirschner & Erkens, 2006). GAI apps are not domain dependent, so a transfer of skills can take place between domains, and prompting to interact with these systems can be transferred to a variety of knowledge domains (Walter, 2024).

When we speak of the *effects with* and the *effects of* technology (Salomon, 1993), we mean that it is desirable to achieve a transfer of skills from the cognitive collaboration where the person is becoming more autonomous with time.

8. They afford a simple, powerful formalism of thinking:

Using GAI applications as TFC means to engage in complex activities that promote deep thinking when doing tasks with them and not just base them on a stimulus-response education, or understanding them as intelligent agents (with agency). This collaboration is not only based on augmentation of action, but also on the reorganization of the activity. This is the case of the study by Nguyen et al. (2024) on the use of a GAI writing tool for PhD students, where iterations and interactions with the tool showed a better performance in their writing compared with those who just used the tool as a source of information. Also, a nursing education study (Simms, 2024) showed that students could reflect on their questioning, the obtained responses and on their decision-making in problem-solving (these are executive functions). So, it contributed to a constructivist meaning making process.

9. They are easily learnable:

GAI applications have a manageable intrinsic cognitive load that affects learning positively. In fact, when using them in a learning task, they should help increase the germane cognitive load to improve the process of acquiring new knowledge in the long-term memory. These tools follow a familiar interface in the form of a chatbox. There is not a cognitive load that affects its adoption as a TFC, just the danger of understanding it as a reliable intelligent agent to learn from. AI literacy should be added in Teaching Digital Competence frameworks such as Digcompedu (Punie & Redecker, 2017) so that both educators and students are able to leverage the benefits of GAI applications and to avoid their shortcomings.

6. Conclusions

We have offered a theoretical framework that places GAI applications under the perspective of TFC in education. TFC are not a specific kind of technology but a concept or a metaphor about how to integrate technology in teaching and learning processes to empower constructivist and/or socio-constructivist learning, where students use them as tools aimed at learning *with* them, establishing a cognitive partnership, and where they have the main role and agency, not the tool. This is the opposite view of learning *from* GAI applications.

Sociocultural theory and activity theory work as an overarching theoretical context to understand digital tools as media for distributed activity between people, context, and tools. There is a distribution of cognition between the person and the TFC so that the person can go further in a joint system of human(s)-tool(s). Without it, the task could be hard or even impossible to attain.

GAI applications meet the practical and pedagogical requirements identified by David Jonassen (1996) to work as TFC. Thus, we have updated Jonassen's earlier classification of "mindtools" adding these specific AI tools. They stand out as TFC for critical thinking based on prompting.

To become TFC, they must be set with a purpose to reach an objective, some form of motivation for the learning activity. If we want to leverage their potential in education, we must understand how TFC's affordances can promote learning. The TFC perspective redirects educational practice from the individual without tools, or from the individual using technology that acts as an artificial tutor (the traditional teacher-centered view of education), to the recognition of the cognitive collaboration between students and TFC. It is not that we have the possibility to include their use in education, but we must encourage it for a future of cognitive partnerships that will equip students with skills (that will not be person-solo based) that they are going to encounter in their future professional life (DeFalco & Sinatra, 2019; IFTF, 2017; Perkins, 1993).

Digital tools should only be used for skill mastery and not for deskilling students (Salomon 1993). TFC should help students think, not help take over their cognition by just off-loading it, or by doing the whole job. They should not perform students' executive functions (e.g., decision-making) but facilitate deeper thinking leveraging their epistemic actions (Kim & Reeves, 2007). It is fundamental that when used in educational settings, teachers design activities that integrate them but assuring that students will use them to review their inputs and outputs, to refine prompts and, eventually, improve their critical thinking skills, because the responses we obtain from GAI applications may be opaque (Bearman & Ajjawi, 2023).

We are still in the early stages of integrating GAI applications in teaching and learning and of knowing their affordances for distributed cognition. We need more research to shed light upon these possible distributed cognitions, to elicit the use of their epistemic actions.

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