Teachers Competencies in the Era of Artificial Intelligence (AI)

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Abstract. Artificial intelligence (AI) is gradually becoming omnipresent in education, manifesting itself through various tools such as intelligent tutoring systems, automatic assessment systems, collaborative learning environments, and educational games.

UNESCO advocates the use of AI to empower teaching and learning, in particular by assessing and developing the multiple dimensions of competencies in teachers and students.Through an extended literature review. this study presents a framework that defines the knowledge, skills and attitudes that educators must possess to use AI in their practices ethically and effectively.

Keywords: Educator, Competencies, Artificial, Intelligence, Ethics.

1 Introduction and background

Across the globe, the increasing use of Artificial Intelligence (AI) systems has become ubiquitous among learners and teachers, sometimes without even being fully aware of it. Search engines, virtual assistants, chatbots, automatic translators, navigation apps, online video games, and many other applications integrating artificial intelligence are now integral parts of our daily lives.

The term "Artificial Intelligence" was introduced in the 1950s to refer to machines able of performing tasks beyond routine. With the increase in computing power, it has been associated with machines capable of learning. Although there is no single definition of AI, it is generally understood that AI-based machines, or "cognitive computing," have the potential to mimic, or even surpass, some human cognitive abilities such as detection, language interaction, reasoning and analysis, problem-solving, and even creativity. In recent years, Artificial Intelligence has attracted unprecedented interest due to significant technological advancements, particularly in the field of machine learning.

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These advancements extend the capabilities of computers and enhance their performance in various areas such as language processing, speech understanding, image recognition, robotics, and more.

International institutions such as the OECD [1] and UNESCO [2] have published reports attempting to examine technological developments such as the emergence of the next generation of the internet, new generations of virtual worlds, and AI technologies, particularly generative AI. Indeed, the latter, which is an evolved form of artificial intelligence, automatically generates content in response to written prompts in natural language conversational interfaces. Generative AI refers to tools such as BingChat (copilot), ChatGPT, Gemini, Midjourney, and DALL-E, which can produce new content in various forms such as conversations, narratives, images, videos, music, and software code. ChatGPT, which was officially launched in November 2022, has become the fastest-growing application in history. According to UNESCO [3], ChatGPT reached 100 million monthly active users worldwide in January 2023.

So, Generative AI appears to have considerable potential to enhance the education and training of learners, teachers, and educational institutions. Zastudil et al. (2023) [4] and Kadaruddin (2023) [5] confirm this trend, although challenges persist in terms of methodology and ethics. In fact, only one country had published its regulations on generative AI by July 2023. In the same vein, a recent survey conducted by the same organization among more than 450 schools and universities worldwide revealed that less than 10% of them have institutional policies and/or formal guidelines regarding the use of generative AI applications, mainly due to the lack of national regulations.

2 Artificial intelligence in education

According to the European Commission (2022) [6], AI systems used in teaching, learning, assessment, and school administration are classified into three distinct categories: learner-centric systems, teacher-centric systems, and system-centric systems. Four use cases of AI systems by teachers and learners are identified as following:

Table 1. Use Cases of AI Systems in Education

– Teaching to the learner	• Computer-based learning environment • Dialogue-based tutoring systems • Language learning assistance applications
– Learner support	• Exploratory learning environments • Formative assessment of writings • AI-assisted collaborative learning
– Teacher support	• Summative assessment of writings, essay grading • Monitoring of learner forums • AI-based pedagogical assistants

	• Recommendation of educational resources
— System support	• Exploration of educational data for resource allocation • Diagnosis of learning difficulties • Guidance services

In parallel, The Department of Education at the University of Oregon examined in 2023 [7] each level of Bloom's Taxonomy to identify how learners could use generative AI. Thus, teachers eager to incorporate AI in the classroom will be better prepared to plan and integrate the chosen generative AI and define the skills learners need to develop based on the taxonomies levels of the activity in question (See Fig.1).

This department recommends:

- Rethinking assessment and clarifying the standards/skills addressed.
- Creating more learning situations that require problem-solving, analysis, synthesis, and sharing reflections in class.

- Integrating formative assessment throughout the process to have a more precise understanding of learners' writing skills over time.

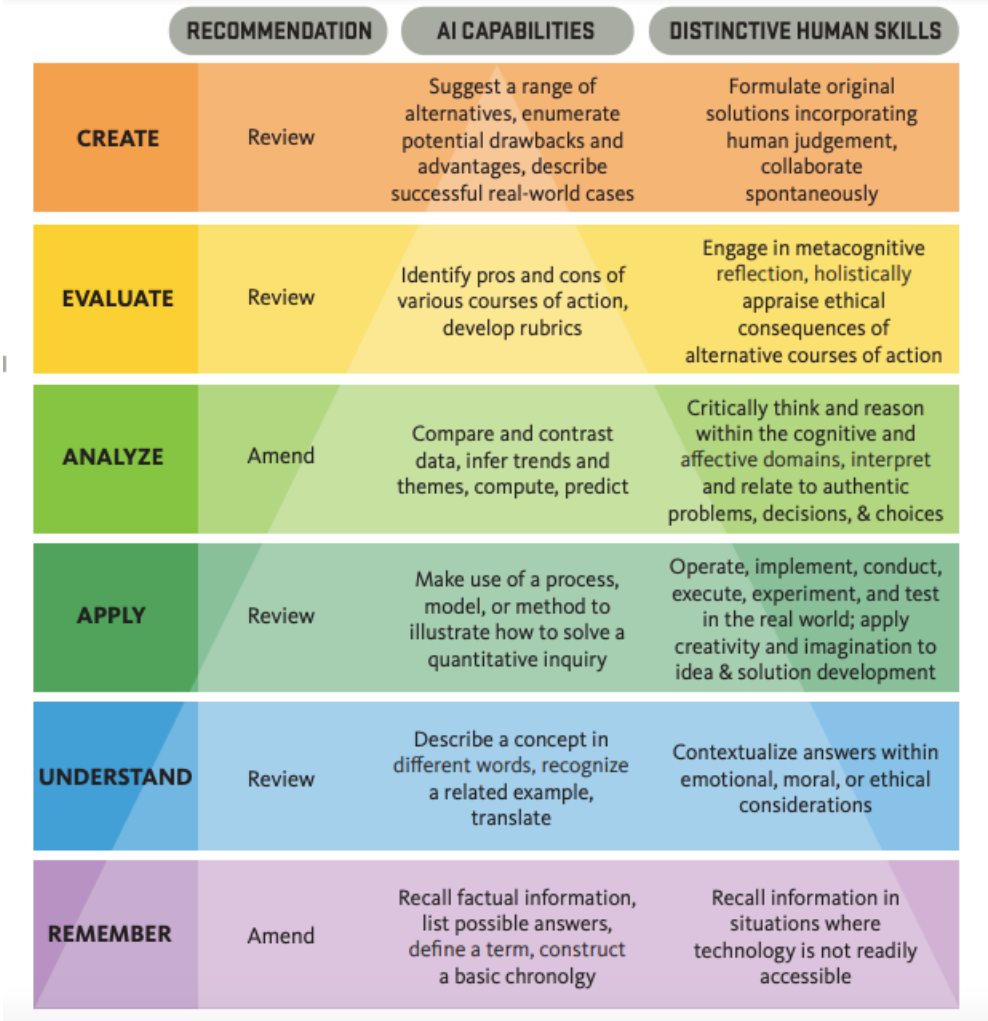


Fig. 1. Revisited Bloom's Taxonomy in the era of AI

In this line, A set of questions arises: what skills and competencies should our educational systems promote?. What changes are necessary, in schools and beyond, to help educators prepare for a future in which human intelligence and artificial intelligence will likely become increasingly intertwined and mutually supportive?.

For example, The Quebec Innovation Council, in its final report "Ready for AI" [8], urges the Quebec government to ensure the timely adaptation of education programs to strengthen AI literacy of students including increasing their ability to use AI effectively. The same report recommends to the Quebec government to support the development of an AI competency framework to be used to develop school, post-secondary, and professional training.

The development of teaching and training programs must therefore be based on solid foundations to develop AI competencies frameworks for teachers and learners. These frameworks will define the knowledge, skills, and attitudes that these actors must possess to understand the roles of AI in education and to use it in their teaching/learning practices ethically and effectively.

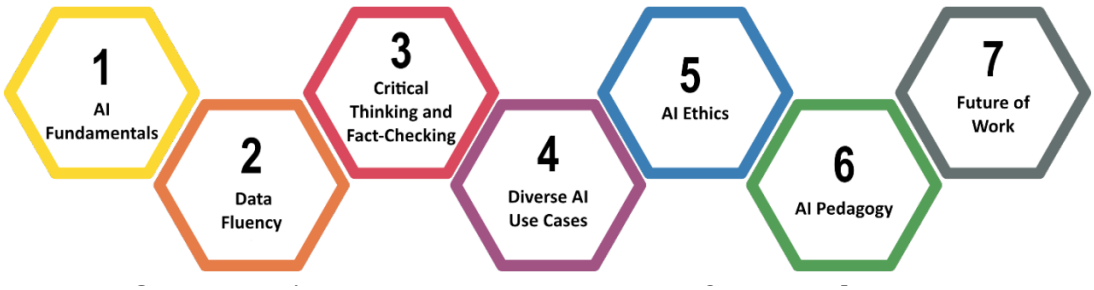
3 Theoretical Framework of the Study

Currently, there are no competencies frameworks indicating to teachers and learners which skills they should acquire or possess to become responsible developers or users of AI. Indeed, TeachAI [9] consortium led by "Code.org" plans to officially release its AI literacy framework in the summer of 2024. Similarly, UNESCO is currently developing AI competency frameworks for teachers and learners.

However, we have initiated a literature review to identify some initiatives for developing competency frameworks related to our topic. To this end, we have sought, on the one hand, to select frameworks issued by governmental bodies or organizations, as this would ensure a certain level of credibility and authority in the content of the selected frameworks. In fact, a set of frameworks will be reviewed to account for the rapid and continuous progress of AI, particularly generative AI tools now widely available. On the other hand, we have focused our selection on frameworks that have been made public after the launch of generative AI ChatGPT in November 2022. This allows us to integrate the latest developments in AI-related skills and ensure that the selected frameworks are adapted to the latest technological advancements.

The results reveal few initiatives related to our study topic. For example, in 2023, Paradox Learning [10] introduced the AI Literacy Skills Framework, intended for educators and professionals in training and development. This framework, depicted in the following figure, encompasses seven key domains, namely:

- Foundations of AI
- Data governance
- Critical thinking and fact-checking
- Various AI use cases
- Ethics of AI
- AI pedagogy
- Future of jobs



In parallel, In 2023, Digital Promise presented another AI Literacy Skills Framework [11] for teachers and learners to safely and ethically participate in an increasingly digital world. Illustrated below, this framework comprises three main dimensions: understanding AI (Technical knowledge), using AI (Interacting with AI, creating with AI, and developing AI systems) and evaluating AI systems and tools.

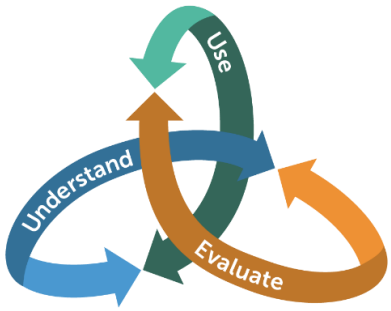


Fig. 3. AI Literacy Framework

Similarly, in 2023, the National Working Group on AI in Schools released the Australian Framework for Generative AI in Schools [12] (See Fig.4). This framework aims to guide Australian school communities (students, teachers, staff, parents) in their use of generative AI tools. It is structured around six principles:

- Teaching and learning
- Human and social well-being
- Transparency
- Equity
- Accountability
- Privacy, security, and safety

Fig. 4. Australian Framework for Generative AI in Schools

As part of the Erasmus project, AI Pioneers [13] developed the supplement to the European framework for digital competence for teachers - DigCompEdu (See Fig.5). This supplement highlights several challenges to address when integrating AI in education. These include concerns related to data privacy, algorithm bias, unequal access to AI technologies, evolving roles of educators, and the need for continuous professional development as AI evolves. The supplement emphasizes the importance of developing ethical, human-centered, and responsible AI approaches in teaching and learning.

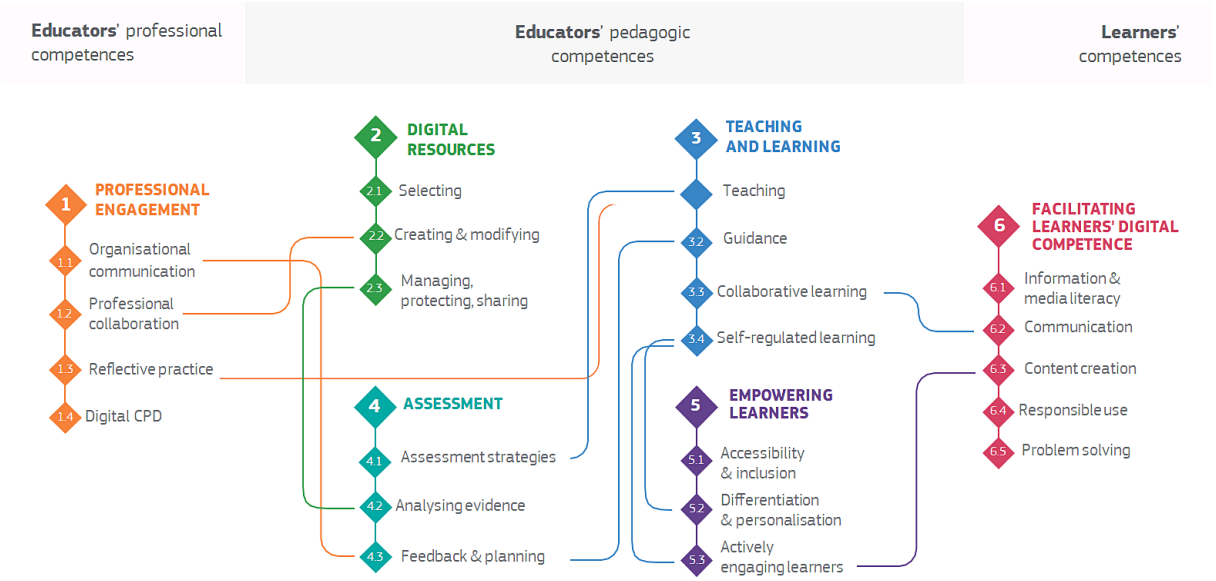


Fig. 5. Overview of the DigCompEdu framework

We also considered the Digital Competency Framework [14], even though AI is absent in it's components. In fact, this framework, part of the digital action plan in education and higher education in Quebec, encompasses dimensions deemed essential for learning and evolving in the 21st century, for both learners and teaching or professional staff (See Fig.6).

This framework follows the competency-based approach, defined as "complex action knowledge based on the effective mobilization and combination of a variety of internal and external resources within a family of situations". It was developed based on a thorough analysis of over seventy digital and informational competency frameworks from the 21st century worldwide, while also considering emerging trends in the digital education domain. It breaks down into the following twelve main dimensions, among which "Acting as an ethical citizen in the digital age" and "Developing and mobilizing technological skills" are central axes around which the other dimensions are articulated.

- Acting as an ethical citizen in the digital age
- Developing and mobilizing technological skills
- Exploiting the potential of digital tools for learning
- Developing and mobilizing information literacy
- Collaborating using digital tools
- Communicating using digital tools
- Producing content with digital tools

- Leveraging digital tools for inclusion and meeting diverse needs
- Adopting a perspective of personal and professional development with digital tools in an empowerment posture
- Solving a variety of problems using digital tools
- Developing critical thinking regarding digital tools
- Innovating and demonstrating creativity with digital tools

Fig. 6. Digital Competency Framework

4 Research methodology

Our conceptual approach to identifying the skills that teachers must possess in the era of AI consists on mapping and confronting the Quebec Digital Competency Framework with the four AI frameworks. A thorough analysis of the descriptors of these frameworks will allow us to identify possible synergies in emerging AI skills and traditional teaching requirements (See Fig.7).

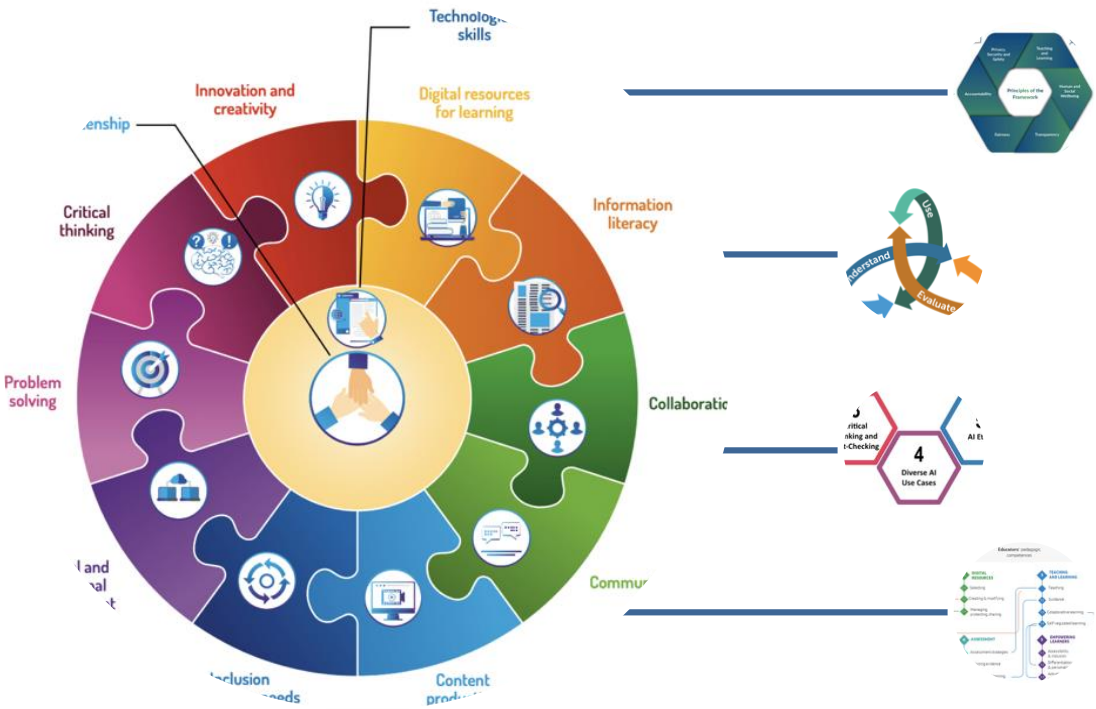


Fig. 7. Mapping Quebec Digital Competency Framework with AI frameworks

5 Results and discussion

Initially, we focused on analyzing the applicability of the twelve dimensions of Quebec's Digital Competency Framework to the context of AI usage by educators. The dimensions "Developing and mobilizing information literacy" and "Problem-solving" were merged with that of "Content production." This choice is justified by the fact that AI models can be used for problem-solving tasks that require new solutions or ideas, often involving a process of content production.

The dimension of "Developing and mobilizing information literacy" is a skill that manifests and develops during content production. The other two dimensions, "Com-

municating using AI" and "Collaborating using AI," were not considered, as AI applications primarily do not facilitate communication and collaboration with other individuals. Thus, only eight dimensions out of the twelve in this framework were retained:

- Acting as an ethical citizen in the era of AI
- Developing and mobilizing technological skills in AI
- Harnessing the potential of AI for teaching/learning
- Content production and problem-solving using AI
- Leveraging AI as a means of inclusion and meeting diverse needs
- Adopting a perspective of personal and professional development with AI in an empowerment posture
- Developing critical thinking regarding AI
- Innovating and demonstrating creativity with AI

Our framework of AI competencies for teachers is presented as follows:

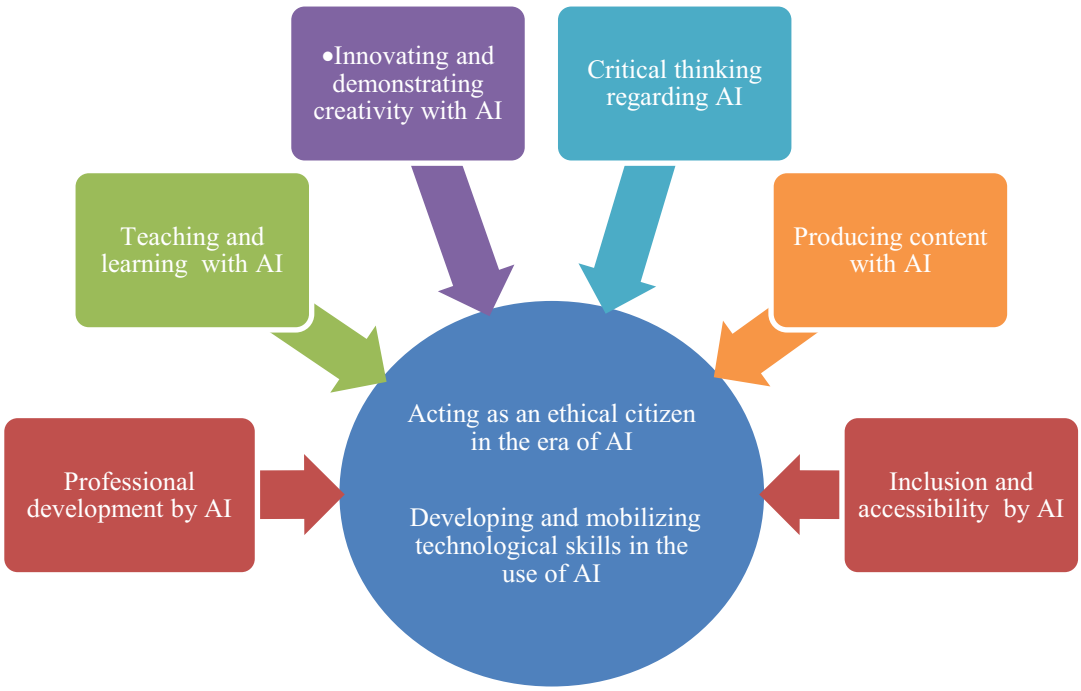


Fig. 8. Framework of the study

In a second step, we compared the competencies framework of the study with the descriptors of the other referenced frameworks listed in the previous section, namely:

- The AI literacy framework for educators and professionals in training and development (Paradox Learning)

- The AI literacy framework (Digital Promise)
- The Australian framework for generative AI in schools
- The supplement to the European framework for digital competence for teachers (DigCompEdu)

This exploration process allowed us to identify 47 set of sub-competencies stemming from the eight dimensions, as presented in the following table.

Table 2. Dimensions and AI competencies elements

Dimensions	Competencies elements
Acting as an ethical citizen in the era of AI	• Being aware of the impact of one's use of AI on their physical and psychological well-being. • Recognizing the central role of humans in the stages and considerations of AI development. • Developing a comprehensive understanding of AI and its impacts on education, culture, and society. • Understanding the issues related to the commodification of personal information. • Engaging in ethical reflection on laws and regulations concerning AI, including those related to copyright. • Using AI in accordance with human rights and individual dignity. • Promoting a culture of responsible and ethical use of AI among learners.
Developing and mobilizing technological skills in the use of AI	• Understanding the fundamentals of AI. • Understanding which data and methods have been used to train the AI tool. • Developing computational thinking, particularly by enhancing understanding and skills in computer programming. • Securing personal data using appropriate resources, considering the risks associated with the use of AI. • Mobilizing the technological skills necessary for using various AI applications. • Designing an AI.
Harnessing the potential of AI for teaching and learning	• Selecting and appropriately using AI applications that support teaching and learning situations. • Designing teaching and learning scenarios based on AI.

	• Describing the pedagogical trends that are enhanced or challenged by the integration of AI. • Integrating AI into creative and innovative teaching strategies. • Using AI to stimulate learners' creativity. • Selecting and effectively applying appropriate AI tools in student learning assessment. • Evaluating outcomes while considering ethical implications, risks of bias, and issues of data confidentiality and security. • Demonstrating skillful use of data collected by AI to generate learning outcome data. • Upholding academic integrity when using AI.
Producing content and solving problems with AI	• Creating a variety of digital content using AI in teaching and learning activities. • Applying stylistic and narrative techniques to create variations of content queries for AI generative applications. • Selecting and using appropriate AI content production applications in teaching and learning activities. • Adapting AI to new teaching/learning scenarios and specific learner needs. • Evaluating, using rigorous criteria, the information generated by AI, exercising judgment in determining the credibility and reliability of sources and content. • Using AI in a way that respects and upholds privacy and data rights. • Taking necessary precautions when entering information into AI that may compromise an individual's data confidentiality. • Being aware of applicable copyright rights and obligations and taking necessary steps to comply with them.
Leveraging AI as a means of inclusion and accessibility	• Using AI to increase opportunities for inclusion, accessibility, and equity. • Selecting and using AI applications that promote the development of adaptive learning pathways. • Selecting and using AI applications that enable automated differentiation.

	• Selecting and using AI applications that facilitate automated tutoring for the benefit of learners.
Adopting a perspective of personal and professional development with the help of AI in an empowerment stance	• Understanding the potential of AI to support continuous professional development. • Harnessing AI's potential to develop pedagogical and techno-pedagogical disciplinary skills. • Creating evaluation metrics to assess the suitability and effectiveness of AI tools based on teaching and learning needs and contexts. • Critically describing the positive and negative impacts of using AI in education. • Establishing ongoing monitoring of AI developments.
Developing critical thinking regarding AI	• Critically evaluating the information and results generated by AI. • Recognizing potential biases in AI algorithms and understanding their implications in educational contexts. • Using AI to support and enhance human critical thinking and creativity rather than restrict them. • Reflecting on one's use of AI and exercising self-critique.
Innovating and demonstrating creativity with AI	• Developing the ability to innovate with AI for creative projects carried out in an educational context. • Understanding the opportunities presented by AI to develop and express one's own creativity. • Integrating AI into creative and innovative teaching strategies. • Using AI to stimulate students' creativity.

Finally, and in a spirit of continuity and operationalization of this framework, it would be desirable to establish a continuum of AI skills development to clarify the elements of the eight dimensions and position them on a progression scale. We suggest three levels for this purpose: beginner, intermediate, and advanced.

This continuum would contribute to making our framework operational by detailing specific teaching and learning situations for each level. It can be used as a basis for

designing pedagogical activities that progressively and coherently foster AI competence development across different levels of education.

6 Conclusion

Teaching in the era of artificial intelligence requires a balanced approach, emphasizing collaboration, training, and maintaining fundamental educational values. It is a journey towards educational innovation that should be guided by a constant search for balance between technology and humanity. Indeed, the evolution of AI should be accompanied by reflection ideally involving a collective and pluralistic approach to consider ethical considerations and data protection. A successful implementation of AI in education involves first ensuring equitable access to AI-based educational technologies and then training teachers and learners to effectively integrate AI into their teaching and learning practices.

However, it should be noted that it would be unrealistic to list all the necessary skills that educators need, given the continuous progress of AI we face. Therefore, it is essential to acknowledge that these skills are subject to cyclical evolution and updating. It's crucial to maintain ongoing dialogue among all stakeholders in education, policymakers, AI experts, and society at large. This will allow for adjusting policies to address emerging issues and create an educational environment conducive to the flourishing of learners.

To conclude, we invite you to keep in mind this popular anonymous quote circulating on the Internet and draw a moral from it: "AI will not replace you, but someone who uses AI will replace you.

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