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Guidelines for online and blended learning:

Design, delivery, assessment, evaluation of study programmes.

Premises of academic curriculum digitalisation

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- "Digital Challenge in Higher Education" project, output of WP5, version 6 -

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Introduction – A call for a new pedagogy

Digital technologies are constantly proving their potential to open up education, to transform it, showing plausible directions for "reinvention" on foundations not only technological but (rather) cultural, social, professional, economic, and mostly humanistic.

Whilst there is a recognised need to redesign educational situations and learning paths, the ingredients for the new recipes seem unbalanced and the result uncertain. Early warnings regarding the changes that digital technologies were bringing in personal, social, professional and cultural life were not sufficient to support the need for a new educational paradigm. Lately, in the light of the new AI-caused disruptions in many domains, we tend to agree that the education should shift to embrace the new realities, but it is not yet clear what should be the fundaments for this change.

Should a new (digital) pedagogy emerge?

Is there a new taxonomy of the educational processes?

The generative AI output is a mirror image of ourselves. When we generate art or scientific texts using AI tools, we get interesting, plausible content, sometimes with errors and biases – we actually see ourselves with our achievements and our limits. But AI is also a mirror to our future, and we have to understand what makes us humans, what makes us authentic, competitive, better.

This is why we are searching for a new pedagogy to better explain and adhere to the new present and future reality. However, it seems that digital technology, the cause for disruption, is also part of the solution.

As specialists in education, we are in search for this new pedagogy. *Or is it really a new pedagogy?* To some extent, we are actually getting back to the basics, rediscovering the benefits of storytelling, brainstorming, exploratory conversations, games and so on. A dose of AI is nowadays in each of it, to make it more fun, if we would know how to capitalize on it.

The real shift seems to be towards a pedagogy of creativity, a pedagogy of humanism, a pedagogy of meaning. Using the digital as evidence and as an opportunity, the following guidelines organise some avant-garde ideas within the science of education.

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This Guide is developed within the WP5 of the Erasmus+ project "Digital Challenge in Higher Education" – D-ChallengHE (2022-1-IT02-KA220-HED-000087029). The aim of the activity is to formulate guidelines and public policy proposals for the amelioration of online and blended learning in higher education.

WP5 addressed challenges, obstacles and opportunities for applying quality practices in teaching at a national and institutional level, by addressing specific needs of the stakeholders involved (policy makers, academic/ teaching staff, students, administrative staff, technical staff, content designers and developers, education experts and instructional designers). Thus, the outcome of WP5 could be a reference point for an European framework for the culture of quality in online learning.

The principal target of this WP result are the academic bodies that seek to improve their quality assurance macro and micro-policies, in both digital learning environments/ tools and professors' professional development.

The 5th WP regards an important outcome of the project, aimed to define the part of a quality assurance framework for online and blended education, with particular focus on e-learning quality assurance standards and changes/ new requirements in teaching professionalisation:

- capitalising upon the educational experiences during Covid-19 and post-pandemic period
- building on the direct experience of online training of teaching staff (WP3)
- taking into account (and showcasing) the results/ possibilities revealed in WP4
- as a first step of collaboration among the members of the D-ChallengHE HUB (WP2).

The outcome will help decision-makers and educational institutions by providing useful frameworks of intervention/ amelioration strategies, in order to design attractive, relevant, qualitative education and training programmes, in line with actual possibilities and opportunities, aligned with current learners' needs and expectations.

According to the project proposal, the Guide is in particular focused on the quality dimensions of teaching in the digital era, the emerging teaching skills for digital environments and resources, the methodology and tools for assessment of online teaching and learning environments in HE.

The Guide promotes and continuously improves an open, generative set of pedagogical principles, allowing direct punctual feedback from visitors/ specialists. The "Guidelines" Report, developed in A1-A2-A3 (and especially the web-based version) is one of the main instruments to ensure the sustainability (visibility and usability) of the D-ChallengHE project. Beyond the project's lifespan, the continuously improving Guidelines will contribute to improvement of online and blended learning in HE.

The Guide is in open access format. An interactive format is also available online, allowing continuous punctual feedback from any stakeholder/ visitors of the pages. The pages also allow public annotations using specialised apps such as Diigo and Hypotesis. Updated (reversioned) guide will be issued every two months.

The web version of the Guide is available at https://digital-pedagogy.eu/guidelines.

1. Digital technologies in education – An overview

In the ever-evolving landscape of the modern era, the rapid advancements of technologies have had a profound and far-reaching impact on various aspects of our personal, professional, economic, social, and cultural lives. Strongly interrelated, the education area has been significantly impacted. These digital tools and resources have transformed the learning environment, making it more engaging and accessible (Didmanidze, 2023). They have also been found to accelerate the rate of learning (Voykina, 2019) and to enhance the teaching methodology.

1.1. Digital tools and technologies for education

The landscape of education is as well undergoing a transformative shift with the integration of digital technologies. This shift is not just a trend, but a comprehensive overhaul of how teaching and learning are approached, facilitated, and delivered. Digital technologies in education encompass a broad spectrum of tools and practices, accompanied by theoretical explanations, including computer-assisted instruction, e-learning, online learning, digital pedagogy, open educational resources (OER), open educational practices (OEP), and digital assistants. These components complement to create a dynamic and interactive educational environment that allows teachers to extend, augment and diversify education situations beyond traditional boundaries.

Computer-Assisted Instruction (CAI) represents the early stages of educational technology, where computers were utilized to support and enhance the learning process. Its main advantage was considered providing personalized learning experiences, allowing students to progress at their own pace – to this end, it includes drill-and-practice programs, tutorials, and simulations that provide students with immediate feedback and tailored instruction. It often incorporates multimedia elements, such as videos and interactive simulations, to enhance engagement and understanding. The productivity of digital technology education research has grown significantly since the turn of the century, reflecting the increasing importance of CAI in educational settings.

E-learning encompasses a broad range of learning experiences delivered through digital platforms. It includes online courses, virtual classrooms, and mobile learning applications. Online learning specifically refers to educational programs that are conducted over the internet, enabling learners to access materials and participate in discussions from anywhere. Both modalities offer flexibility and accessibility, catering to diverse learning needs and schedules.

Digital pedagogy goes beyond the mere use of digital tools; it encompasses the study and design of educational experiences that leverage digital technologies to foster interactive and engaging learning environments. It seeks to understand how digital technologies can be best utilized to support teaching and learning in various contexts, including face-to-face, hybrid, and fully online settings.

Open Educational Resources (OER) are teaching, learning, and research materials that reside in the public domain or have been released under an intellectual property license that permits their free use and re-purposing by others. OER includes textbooks, course materials, and multimedia content that are openly licensed, allowing educators to adapt and share resources. UNESCO's efforts in promoting OER have been significant, emphasizing the importance of open resources in democratizing education and fostering lifelong learning (UNESCO, 2024).

Open Educational Practices (OEP) involves the use of OER to raise the quality of education and training and innovate educational practices on institutional, professional, and individual levels. OEP are about collaboration, sharing, and the open dissemination of knowledge, which aligns with UNESCO's commitment to transparency and accountability in education (UNESCO, 2024).

Digital assistants in education, such as AI tutors and chatbots, are becoming increasingly sophisticated, providing personalized learning experiences and support for students. Chatbots can answer questions, provide feedback, and assist with administrative tasks, enhancing the learning experience by offering immediate assistance. They are increasingly used in digital learning environments to facilitate communication and support self-regulated learning.

Pedagogical trends

Integrating *multimedia elements* into (digital) educational products is no longer an option today, but a necessity. At the theoretical level, it is contracted from *multimodal pedagogy*, which gains scope primarily because of the current social and technological changes that destabilize the dominance of text-based practices. Issues of accessibility and inclusiveness in education are also factors that put pressure on and accelerate innovation – text needs to be complemented or interspersed with multimedia elements, in a trend called "ensuring redundancy". This trend can be seen in current currents such as Universal Design for Learning (UDL) and "*curriculum decolonization*", which advocate multiple means of representation to enable diverse ways of knowing and learning. Even more recently, academic integrity is a growing concern as advances in AI-based technologies make cheating an accessible, hard-to-detect, tempting, relatively common practice.

That's why, in the whole of digital education, multimodal pedagogy comes with relevant, useful, pertinent proposals, primarily offering those who learn adequate, attractive, effective opportunities for academic development.

Without majorly deviating from the used processes of instructional design and training implementation, the current approaches still have some particularities, in accordance with the technical possibilities and practices in similar fields such as film scripts, indications and recommendations for the effective conduct of videoconferences, etc. It is about what the theory gathers under the name of *entangled pedagogies* – an integrative or intertwined pedagogy. This vision treats technologies, teaching methods, teachers, students and other stakeholders as elements that are not separate and isolated, but interconnected in an educational situation, contributing to the success of learning. Instructional design takes into account increasingly complex environments, taking into account the interaction of many new, novel elements within these environments. The proliferation of open educational resources and open educational practices indicates the strength of this trend and its value to education.

No less relevant, *pedagogy based on AI tools* proposes consistent and necessary innovations in both teaching and learning and assessment. They must be incorporated into any educational course, often

completely changing the objectives, the way of approaching the content and the type of work load, the way in which the student's effort is assessed. For various disciplines and various levels of education, these ideas of introducing AI take different forms, with psycho-pedagogical arguments.

Online learning

In a systematic review of literature, comprising a total of 251 articles analysed, Johnson et al. (2023) identified three common foundational contextual conditions that support student learning in online settings:

- Educators' knowledge and preparation for online instruction. Research emphasizes the importance of teacher preparation for online teaching through preservice teacher training and professional development. Successful online teaching requires specific characteristics and skills, and teachers often lack adequate preparation to teach online effectively.
- Technology infrastructure and support. Having the necessary technology infrastructure and support systems in place is crucial for successful online instruction. This includes access to reliable internet connections, appropriate devices, and technical support for both educators and students.
- Students' developmental needs and abilities. Understanding students' developmental capacities and learning styles is essential for designing effective online instruction, therefore instructional design decisions should consider students' developmental needs and abilities to ensure that the content and delivery methods are appropriate for their age and stage of learning.

These foundational contextual conditions provide a good basis for designing and implementing online instruction that effectively supports student learning. Furthermore, the same systematic analysis highlighted seven pillars of instructional practice that contribute to student learning in online education (Johnson et al., 2023):

1. Evidence-based course design: designing online courses based on evidence-based practices to ensure effective learning experiences for students

2. Connected learners: fostering a sense of connection and community among online learners to enhance engagement and collaboration

3. Accessibility: ensuring that online learning materials and activities are accessible to all students, including those with diverse learning needs

4. Supportive learning environment: creating a supportive online learning environment that promotes student well-being, motivation, and academic success

5. Individualization and differentiation: tailoring instruction to meet the individual learning needs and preferences of students in online settings

6. Active learning: engaging students in active learning experiences that promote critical thinking, problem-solving, and application of knowledge

7. Real-time assessment: implementing real-time assessment strategies to monitor student progress, provide timely feedback, and support continuous improvement in online learning

These seven pillars serve as a conceptual framework for designing and delivering effective online instruction in higher education, with a focus on enhancing student learning outcomes and experiences in virtual learning environments. However, the study highlights the importance of understanding educators' limited experience with online teaching, the need for technology infrastructure and support, and consideration of students' developmental needs and abilities in designing effective online instruction. It underscores the need for teacher training and professional development in online instruction, as well as the importance of incorporating self-regulated learning instruction and supports into online courses. The findings suggest that translating research into practice is crucial for enabling teachers to successfully transition to online teaching and provide robust and engaging learning experiences for students.

Continuous Professional Development

In addition, the emphasis on continuous professional development in digital competencies is crucial, as many educators express a desire for further training in utilizing information technologies effectively within their teaching framework, highlighting a gap between current skills and the evolving demands of the educational landscape (Cook et al., 2023; Gómez-Pablos et al., 2022; González et al., 2023; Grassinger et al., 2022).

1.2. The role of digital technologies for professional, social, cultural and personal life

The digital transformation has significantly altered the way we communicate, work, and interact within society, emphasizing the need for individuals and organizations to adapt to and harness these technological advancements effectively, as these changes continue to shape everyday life in ways previously unimaginable. Moreover, the acceleration of digital technologies has fundamentally changed consumer behaviours, expectations, and interactions, positioning adaptability as a critical component for thriving in an increasingly digital world. In this context, the shift towards digital interaction and the integration of technology into daily routines highlight the necessity of fostering digital literacy and innovative thinking to navigate the complexities and challenges arising from this transformation. This is why the digitization of education and training (both in terms of process and content) is one of the most prominent examples of the transformative power of technology in the modern era, and the changes reflect the wider challenges brought about by the evolving individual, social and professional circumstances.

Digital technologies have significantly impacted various aspects of life, including interpersonal relationships, social and humanitarian spaces, and the cultural industry. Many studies envisaged the positive relationship between these aspects and the development of technology (Satata et al. 2023, Grigorev 2020, Jiang 2023, Todorova 2023, Anista 2023, Statsenko 2020, Atkinson & Castro 2008):

- Technology facilitates social interaction by overcoming time and distance barriers
- Integration with information technology enhances economic efficiency, competitiveness, and educational processes.

- The mutual influence of the digital economy and value-normative transformations contributes to new production methods and social relations.
- Digital technologies impact ordinary citizens by creating new values and meanings that influence worldviews, goal-setting, and economic activities for current and future generations.
- Digital technologies improve process management, optimize public space, and bring practical benefits in various aspects of human life.
- Digital technology has significantly facilitated the development of the cultural industry and empowered various stakeholders.
- Digital technology has reshaped the structure of the cultural industry, leading to changes in cultural consumption, production, and market dynamics.
- The integration of digitization and technology can foster diverse and vibrant cultures and create high-quality cultural works.
- Digitalization is a driving force that ensures efficiency in the economy, society, and improves life standards.
- Digital communication technologies must be widely introduced and accessible to both professionals and ordinary citizens.
- Digital ecosystems are innovative and relevant, providing a favorable environment to solve multiple problems.
- IT has been the principal driver of increased economic growth since the mid-1990s in the United States and many other nations.
- IT is at the core of dramatic improvements in the quality of life for individuals around the world.
- IT enables key innovations and improvements in education, health care, the environment, and security.

Digitalization is a driving force that improves efficiency in the economy, society, and quality of life, but requires widespread accessibility and development of digital skills, as well as the formation of innovative digital platforms and ecosystems (Statsenko 2020).

Regarding the personal life, the advancements in digital technologies have profoundly influenced and transformed various aspects. From daily tasks and communication to social interactions and personal learning experiences, the integration of these technologies has reshaped how individuals engage with the world around them, ultimately enhancing their efficiency and connectivity in ways that were unimaginable in the pre-digital era (Veldhoven & Vanthienen, 2021). Moreover, the accessibility of information and resources has empowered individuals to pursue personalized learning opportunities, fostering a culture of continuous self-improvement and adaptability in an increasingly complex environment (Nugumanova et al., 2020; Tomar, 2019). In this context, the personalization of educational experiences, driven by digital platforms, not only meets diverse individual needs but also encourages learners to explore innovative methods of interaction and engagement, paving the way for a more dynamic educational landscape that transcends traditional learning boundaries (Srivastava, 2023; Nugumanova et al., 2020).

The widespread adoption of digital technologies has brought forth a range of challenges that must be addressed to ensure equitable access and optimal integration into personal lives. This includes the necessity of bridging the digital divide, as disparities in access to technology can hinder some individuals from fully benefiting from the opportunities presented by digital advancements, thereby perpetuating existing inequalities in education and beyond (Srivastava, 2023). To effectively navigate these challenges, it is crucial to foster an inclusive approach that not only enhances technological

resources but also prepares educators to embrace digital tools and methodologies, ultimately ensuring that all learners can thrive in this evolving landscape (Srivastava, 2023). The role of educators becomes increasingly vital as they navigate the complexities of digital integration; their engagement with technology directly impacts how effectively educational transformations are realized, emphasizing the importance of their own digital literacy and innovative potential in shaping student experiences and outcomes. Additionally, as the educational environment becomes more digitized, cultivating a supportive infrastructure for both teachers and students is essential to maximize the benefits of these technologies; thus, initiatives aimed at promoting digital equity and providing targeted training for educators can significantly enhance the learning experience and foster a more inclusive and accessible educational landscape (Judge et al., 2004; Srivastava, 2023). As educational institutions leverage adaptive learning technologies to address varied learning styles, they can create environments that not only cater to individual strengths and weaknesses, but also enhance overall engagement, knowledge retention, competence development among students, making it imperative to uphold ethical norms and a humanistic approach.

While the digital technologies have improved efficiency and facilitated global connectivity, it is considered that they have also led to mental and psychological illnesses, social inequality, and a decline in communication skills (Satata et al. 2023; Todorova 2023).

The use of digital technology may influence human brains and behaviour in both negative and positive ways. In a synopsis of 10 scientific articles, Hoehe & Thibaut (2020) argues that scientific evidence does not support common concerns about digital technology causing mental health problems, and that research and interventions should focus on the individual user and how they use technology, which can be both positively and negatively, especially during and after the COVID-19 pandemic.

On the other hand, innovations in digital technology have the potential to address some of the challenges in mental health care and research, such as overcoming the limitations of self-reporting data and facilitating remote access to services. These advancements foster new opportunities for mental health interventions, allowing for tailored self-management strategies and creating pathways for efficient communication between providers and patients, thereby enhancing the overall quality of care provided (Aguilera, 2015). In addition, ongoing research is essential to better understand the causal relationships between technology use and mental health outcomes, as well as to explore the implications of these digital tools on the traditional roles within healthcare settings, which could ultimately reshape the provider-patient dynamic and raise ethical concerns regarding privacy and data usage.

The digital era has brought about significant changes in traditional values, social norms, and communication patterns. For example, Anista (2023) analyses the impact of technological advancements and social media development on cultural transformation. She argues that technology and social media have reshaped social interaction and communication, making digital communication more dominant, with an effect in diminishing the traditional cultural values, such as face-to-face communication.

Social media has blurred the boundaries between private and public life, transforming personal identity and communication patterns, with unforeseeable effects on the way we live together. As technologies continue to evolve, they reshape how individuals engage with content, influence the dissemination of cultural narratives, and alter the audience's perception of traditional media formats, ultimately contributing to the emergence of a new digital culture that is both interactive and participatory.

The most notable impacts of digital technologies on cultural life is the way they have reshaped social interaction and communication patterns. Digital platforms have facilitated a shift from direct, face-to-face communication to more mediated forms of interaction, resulting in a fundamentally different social landscape where virtual connections often take precedence over physical ones. This shift has not only redefined personal relationships but also influenced the formation of communities and the sharing of opinions, leading to an ever-expanding network of interconnected individuals shaped by technology's pervasive presence in everyday life (Kaul, 2012). The proliferation of digital media has created an environment where exposure to diverse cultural expressions and popular imagery has increased dramatically, particularly among younger audiences, thereby affecting their perceptions and experiences of art and culture. In addition, the nature of fine arts is evolving in response to these technological influences, as the rapid reproduction and circulation of images have transformed how culture is represented and apprehended, prompting changes in art education that seek to align curricula with this new visual culture (Wang, 2018; Boughton, 2005).

The emerging digital culture has also blurred the boundaries between private and public life, with social media platforms playing a significant role in this transformation. These platforms have enabled individuals to curate and project their personal identities in a public sphere, leading to a heightened degree of self-expression and self-awareness that was previously less prominent. This phenomenon, while fostering a sense of community and connectivity, also raises concerns regarding the commodification of personal experiences and the impact of consumerism on self-identity, with digital media art often reflecting a blend of entertainment and cultural capitalism that can both enrich and challenge traditional cultural values (Kaul, 2012; Wang, 2018).

To address the challenges posed by these digital transformations, it is crucial to reinforce the importance of understanding the nuances of this new cultural landscape and to develop strategies that can mitigate the negative impacts while maximizing the potential benefits of technological progress. This involves fostering interdisciplinary dialogues that incorporate artistic practice, technology, and social theory to critically engage with the evolving nature of cultural narratives and educational frameworks that prepare individuals for active participation in this digital milieu (Kluszczyński, 2005; Serkova, 2020). To achieve this, it is essential to create educational environments that embrace the latest digital art technologies and also critically examine their implications on cultural representation and social interaction, thereby nurturing a new generation of artists (and professionals – generally speaking) who can navigate the complex interplay between tradition and innovation in the digital age (Serkova, 2020; Choi & Piro, 2009; Kong, 2019; Kluszczyński, 2005; Boughton, 2005). This shift necessitates a curriculum reform that acknowledges the intersection of culture, art, and technology, emphasizing the importance of artistic literacy alongside technical skills to prepare students for the demands of contemporary digital media practices and to promote meaningful engagement in an ever-evolving cultural landscape.

Overall, the success of the digital economy and the development of society depend on the cultural values and the development of the social and cultural sphere. Nonetheless, the excessive use of digital technologies can have negative effects on the well-being of the working environment (Todorova 2023). Consequently, although digital technologies have brought about numerous benefits, it is essential to thoughtfully assess and manage their effects on different facets of life.

1.3. Digital competences of students, a key competence for academic and professional success

As the world becomes increasingly reliant on digital technologies, the development of digital competence among students has emerged as a crucial priority in the field of education. This competence not only impacts academic performance but also plays a significant role in the preparation for a competitive labour market, where proficiency in digital tools is often a determining factor in an individual's employability and career advancement, highlighting the necessity of integrating information and communication technologies and digital competence development into educational curricula and processes (Rambousek et al., 2015; Jurs & Bethere, 2020).

The DigComp framework, a comprehensive model developed by the European Commission, provides a clear definition of digital competence, identifying 21 competences in five key areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving (in 2.2 version). These areas encompass a wide range of skills, from information retrieval and management to effective communication and the ability to create and manipulate digital content. The mastery of these skills is not only essential for academic success but also crucial for navigating the demands of the modern workforce, where the ability to leverage digital technologies is a fundamental requirement (Fraile et al., 2018; Rambousek et al., 2015).

The framework has been adapted for various contexts, including primary and secondary education, consumers, and educators, becoming a reference for digital competence initiatives across Europe and beyond. Research has explored its application in K-12 and in higher education, and its potential for measuring digital skills (e.g. Ivanović & Simovíc, 2020). The framework continues to evolve, with updates addressing new vocabulary and streamlined descriptors, making it a valuable tool for understanding and developing digital competence in Europe.

Maybe the most important is that the DigComp framework emphasizes the importance of continuous learning and adaptation as digital technologies evolve, indicating that lifelong learning is vital for individuals to maintain their relevance in an ever-changing job market and society at large, thereby reinforcing the need for educators to create environments that foster the development of digital competence.

Existing research highlights the significant impact of digital competence on academic achievement, revealing that students equipped with robust digital skills tend to perform better in their studies and are more likely to engage in collaborative learning experiences, which are increasingly integral to modern education practices, thus under scoring the importance of integrating digital competence development into educational curricula (Zulkifli et al., 2023; Anthonysamy, 2022). Moreover, trans-national studies indicated a perceived gap between the digital competency needs of the labour market and the actual skills possessed by students (Kim & Park, 2023; United Nations ITU, 2020; Goger et al., 2022), stressing the need for educational institutions to adopt situated and problem-based learning methodologies that promote the effective acquisition of these crucial skills.

Therefore, the cultivation of digital competence among students is a crucial endeavour that extends beyond the realm of academic performance and into the realm of professional development and lifelong learning. This focus on digital skills is particularly relevant in an era where technology and innovation drive economic growth and societal advancements, necessitating that educational frameworks not only address current competencies but also anticipate future demands in the labour

market, ultimately preparing students for a dynamic and evolving landscape of professional opportunities. (González et al., 2023; Gómez-Pablos et al., 2022; Rambousek et al., 2015; Cook et al., 2023). Moreover, the rapid expansion of digital technologies highlights the urgent need for educational institutions to prioritize the systematic development of both students' and teachers' digital competencies, ensuring that they are equipped to thrive in an increasingly digital world, where the ability to adapt and utilize emerging technologies is a critical determinant of personal and professional success. This imperative aligns with the recognition that digital literacy is a requirement for success in a globalized society, as educational stakeholders increasingly invest in digital tools and resources that can enhance teaching and learning experiences, reinforcing the idea that effective use of technology is essential for academic and professional achievement.

1.4. Teachers' competences

The development of digital competence is not limited to students but also extends to the teaching profession. Teachers must have a strong grasp of digital technologies to effectively integrate them into their pedagogical approaches and serve as role models for their students. This necessity is underscored by research demonstrating that teachers' confidence in their digital competencies significantly influences their teaching effectiveness and, consequently, their students' learning outcomes, highlighting the mutual reinforcement between educators' abilities and students' academic success in digital environments.

Studies indicate that, as teachers cultivate their digital competencies, they are better equipped to foster innovative learning environments that actively engage students, thereby bridging the gap between technology and meaningful educational experiences (Cook et al., 2023; Gómez-Pablos et al., 2022). The integration of digital tools into teaching practices enables educators to create more interactive and collaborative learning experiences that have been shown to significantly increase student motivation and achievement in various educational contexts.

In this perspective, the digital skills are actually coming to complement the pedagogical ones, being relevant only in correlation, with the specification that the pedagogical competences are evolving in tandem with the new educational realities (Phillips & Fisser, eds. 2023) and are nurtured within favourable institutional contexts. In a study from 2018, Konst & Scheinin explored the implications of a changing world on the teaching profession, especially in higher education. Their research is related to the implementation and evaluation of a training programme focused on innovation pedagogy, deployed in the Turku University of Applied Sciences in Finland, emphasizing the need for teaching staff to adapt to new teaching methods and collaborative practices to enhance learning outcomes and better prepare students for future work environments. The conclusions highlighted the importance of several adjacent aspects such as: growth mindset development (promoting reflection, dialogue, and self-development), collaboration and co-teaching (creating forums for academic staff to collaborate and share ideas, leading to improved team spirit and increased co-teaching practices), curriculum changes (the shift to a module-based curriculum that emphasizes working-life relevance, built through co-planning and co-teaching among different disciplines), long-term change process (changes in education are gradual and involve multiple areas, including strategic approaches, institutional support, curriculum design, and learning environments).

Overall, whilst recognising the necessity for continuous professional development and innovative teaching practices to meet the evolving demands of education and the labour market, the initiatives aiming to improve teachers' digital skills are successful where a series of conditions are met: a favourable climate in the educational institution(s), a long term digitalisation strategy, strong emphasis on the pedagogical integration and educational use, availability of digital resources, equipment, and technical support. More often than not, the most effective teacher training is the one that is relevant and meaningful for them, coming to fulfil their educational goals (Reyes & Cruz, 2021; González et al., 2023; Grassinger et al., 2022). Therefore, the digital competences development should rather be an integrative part of pedagogical and subject-matter training.

1.5. Developing digital competences through the whole curriculum

The integration of digital skills into various academic disciplines has become a crucial aspect of modern education. Incorporating digital skills into every subject area ensures that all students can develop the necessary competencies required to thrive in a technology-driven society, addressing the growing consensus among educators that institutions must prioritize digital literacy as a core aspect of the educational experience.

According to many studies, the integration of digital skills into various disciplines fosters nowadays a deeper understanding of content, allowing students to engage interactively with knowledge, develop critical thinking abilities, and become better prepared to meet the challenges of the times when digital literacy is anticipated to be an indispensable asset (Bhat, 2023; Khan, 2018; Nguyen & Habók, 2023).

The benefits of embedding digital skills across the curriculum are multifaceted and far-reaching. They include enhanced collaboration opportunities through digital platforms, which enable students to connect with peers globally, enrich their learning experiences, and cultivate a diverse worldview, thus preparing them for the interconnected nature of today's job market (Bhat, 2023). Moreover, by leveraging technology as a critical component of their education, students not only develop proficiency with digital tools but also cultivate essential skills such as adaptability and the capacity for lifelong learning, which are vital in a rapidly changing environment where digital competency is increasingly linked to academic achievement and career success (Nguyen & Habók, 2023). This shift towards digital literacy enhances problem-solving capabilities, encouraging students to engage collaboratively and creatively, which are vital components in addressing real-world challenges effectively. Furthermore, the emphasis on digital thinking within education cultivates essential competencies that transcend traditional learning methods, pushing students to become creators of knowledge rather than mere consumers.

On the other hand, the proliferation of technologies in the educational realm has ushered in a new era, one where the boundaries of the traditional classroom have been transcended, allowing students to access educational resources from virtually anywhere, thereby revolutionizing the learning process (Jurs & Bethere, 2020) and the expectations from the teaching staff. The concept of the "digital classroom" has emerged, empowering students to engage with content in interactive and personalized ways, fostering a more dynamic learning experience. Digital transformation has not only enhanced the potential of educational situations, but has also streamlined administrative tasks,

communication, and record-keeping, ultimately improving the overall efficiency of the educational process.

Equally important, the implementation of digital tools creates a more inclusive learning environment by accommodating diverse learning styles and needs, thereby fostering greater accessibility and engagement among students with varying abilities and backgrounds, which is essential for ensuring that no learner is left behind in the digital age (Khan, 2018; Bhat, 2023; Jurs & Bethere, 2020; Nguyen & Habók, 2023). Incorporating technology into the curriculum facilitates inclusivity and accessibility, allowing diverse learners, including those with disabilities, to participate fully in their education while fostering a habit of lifelong learning (Tinmaz et al., 2022; Bhat, 2023; Srivastava, 2023; Sentriyo et al., 2023), as students increasingly rely on digital tools to seek out new information and develop their skills.

As the integration of digital skills across the curriculum becomes a pressing necessity, it is essential to recognize and address the potential challenges that may arise. One key concern is ensuring that teachers of all subjects possess the requisite digital literacy to effectively model and guide students in the use of technology as an intellectual tool. Addressing this challenge requires a strategic investment in professional development programs that equip educators with the knowledge, skills, and confidence to efficiently incorporate digital tools and resources into their teaching practices (Jurs & Bethere, 2020; Nguyen & Habók, 2023). The evolving nature of technology necessitates ongoing training for educators to enhance their competencies, as successful integration hinges on their ability to inspire students and demonstrate the practical applications of digital skills within various disciplines, thus fostering an environment where students can thrive academically and develop the necessary digital proficiencies to navigate the complexities of the 21st century (Nguyen & Habók, 2023; Jurs & Bethere, 2020; Srivastava, 2023; Bhat, 2023). Considering this, education must prioritize not only the acquisition of technological resources, but also the simultaneous development of digital literacy among both teachers and students, thereby ensuring that the hybrid teaching and learning environments effectively facilitate academic achievement and prepare students for the demands of the digital age. It is crucial then to recognize that the successful incorporation of digital skills is contingent upon students' access to quality digital educational content and resources.

1.6. Digital citizenship- digital literacy, critical thinking, responsibility

In the digital age, individuals become more autonomous in selecting appropriate tools for specific tasks, which reinforces their ability to think critically and evaluate the impact of technology on their surroundings and decision-making processes (Karsenti et al., 2020). This autonomy, coupled with the necessity to assess technological innovations critically, underscores the importance of integrating digital literacy into educational frameworks, thus preparing individuals to adapt to ongoing changes while maintaining a high level of responsibility in their technological engagement. This integration not only enhances individual capabilities, but also emphasizes a broader societal responsibility towards promoting digital literacy, which ultimately contributes to social inclusion and professional development in an increasingly knowledge-driven economy (Milenkova & Lendzhova, 2021; Rambousek et al., 2015). In this context, the cultivation of digital literacy serves as a fundamental requirement for effective citizenship and participation in the knowledge society, illustrating that

access to technology and the ability to navigate it responsibly are essential for personal growth and societal advancement.

The concept of digital citizenship is encompassing the knowledge, skills, and responsibilities necessary for individuals to engage effectively and ethically within the online realm. Digital citizenship involves an awareness of one's online presence and the ability to employ behavioural norms that govern the appropriate use of technology, ensuring that individuals can navigate potential risks while respecting the rights of others in the digital environment (Rostain, 2019; Imer & Kaya, 2020). It emphasizes critical thinking and responsibility, enabling individuals to assess information judiciously and make informed decisions that reflect ethical considerations in their interactions with others online and offline. This multifaceted approach to digital citizenship highlights the importance of cultivating a sense of personal, community, and global responsibility, as individuals learn to balance their rights with the ethical implications of their digital actions.

Digital citizenship education has emerged as a crucial aspect of modern learning, encompassing the areas of digital literacy, critical thinking, and responsible online behaviour. It aims to prepare students for active participation in an increasingly digital world (Bombardelli, 2020; Gazi, 2016). While some educational approaches focus on personal responsibility and online safety (Mattson, 2016; Berson & Berson, 2003), others advocate for a more comprehensive understanding that includes ethical considerations, media literacy, civic engagement, and critical resistance to digital capitalism (Choi, 2016; Pötzsch, 2019). The integration of digital citizenship into curricula at all educational levels is recommended to address social inequalities and promote inclusive practices (Monteiro et al., 2022). Critical digital literacy is emphasized as essential for developing informed and empowered citizens capable of navigating the complexities of the digital age (Voronkova et al., 2023). Overall, digital citizenship education is viewed as a multidimensional concept that extends beyond user competence to encompass broader societal implications and democratic values.

In this context, educators play a vital role in fostering digital literacy through new pedagogical practices that encourage students to engage with technology in a manner that is both responsible and informed, ultimately preparing them to participate meaningfully in the global digital community (Mossberger et al., 2007). In addition, the integration of digital citizenship into educational curricula can equip students with essential skills to navigate hybrid online-offline environments, promoting not only technical proficiency but also a strong ethical foundation for their future interactions in an increasingly interconnected world. This educational emphasis on digital citizenship is especially pertinent in a time when the lines between online and offline interactions are increasingly blurred, necessitating a comprehensive understanding of digital rights and responsibilities that extends beyond mere technological use to encompass ethical decision-making and social engagement (Srivastava, 2023; Rostain, 2019; Cortesi et al., 2020; Mossberger et al., 2007). As digital media increasingly permeates daily life, fostering a robust understanding of digital citizenship is essential for youth to develop resilience against misinformation, engage thoughtfully with diverse perspectives, and advocate for their rights and those of others within the digital landscape (Cortesi et al., 2020; Cortesi et al., 2020; Melnyk et al., 2022; Mossberger et al., 2007; Rostain, 2019). To achieve this, we should define clear frameworks and objectives that guide the development of digital citizenship education, ensuring that young individuals not only acquire the necessary skills but also understand the broader implications of their digital actions on society at large. To this end, collaborative efforts among various stakeholders—including government and educational institutions—are needed to shape and implement effective digital citizenship programs that not only teach technical skills but also foster a commitment to ethical behaviour and social responsibility among youth as they navigate the complexities of the digital world.

In parallel, it is important that we recognize the varying degrees of digital competencies that exist among educators and students alike, as these disparities can significantly impact the effectiveness of digital citizenship initiatives and the overall ability to create a digitally literate society capable of addressing the challenges of the 21st century. In this regard, professional development opportunities for teachers must be prioritized to enhance their digital literacy, ultimately enabling them to serve as digital role models for their students and fostering a culture of critical engagement with technology within educational settings, which is essential for preparing students to become responsible and engaged digital citizens (Melnyk et al., 2022; Cortesi et al., 2020). Moreover, an intentional focus on mental health and well-being within educational programs can further enrich the development of digital citizenship, as supportive learning environments are essential for fostering the critical thinking and responsible behaviours that characterize effective digital engagement in today's challenging landscape (Srivastava, 2023). This holistic approach not only addresses the technical aspects of digital literacy but also emphasizes the significance of emotional intelligence and social awareness in cultivating mindful digital citizens who are capable of advocating for themselves and others in an interconnected digital society.

As we advance toward a more digital society, it becomes increasingly important to integrate digital citizenship principles into the educational framework, thereby empowering youth to navigate the complexities of the digital world with the confidence, critical thinking skills, and ethical understanding necessary to thrive as responsible, engaged, and productive members of the global community (Srivastava, 2023; Moralista et al., 2022). This necessitates ongoing research and dialogue among educators, policymakers, and mental health professionals to establish best practices for promoting digital citizenship and support systems that nurture students' ability to think critically about their online interactions, reinforcing the importance of both individual and collective responsibilities in the digital world.

2. The role of teachers' digital competences

The teaching profession is evolving rapidly in the 21st century, requiring educators to develop new competencies and adapt to changing roles. Teachers need to acquire personal and social-emotional skills, as well as technical, financial, managerial competencies – they must be prepared to face challenges of globalization, including diverse classrooms and evolving societal expectations.

New teacher roles are emerging, requiring a redefinition of classical roles to meet contemporary demands (Świątek, 2023). Among others, professional development should focus on technological advancements, inclusive learning environments, and fostering an open mindset toward change (Āboltiņa et al., 2024). K-12 and higher education institutions need to implement competence-based curricula and develop innovation competencies, in a competitive landscape, with various demands from diverse students, with different requirements from society and labour market. The shift towards these diverse educational frameworks necessitates that teacher training not only focuses on the foundational digital skills but also emphasizes the pedagogical application of these technologies, ensuring that teachers can effectively integrate digital tools into their instructional design and delivery, thereby fostering meaningful and engaging learning experiences for their students. This also implies ethical considerations and data protection to foster a safe learning environment for all students – the responsibility of educators extends beyond delivering content; they must also ensure that their practices safeguard students' privacy and uphold ethical standards, particularly in an age where the collection and use of data are prevalent in educational settings.

The digital competences of teachers extend far beyond their immediate classroom responsibilities, playing a crucial role in their ongoing professional growth and the broader development of educational institutions. As education systems increasingly integrate technology, teachers must cultivate a diverse set of digital skills to thrive in this evolving landscape.

Continuous professional development (CPD) has become inextricably linked with digital competence. Teachers who effectively leverage digital tools for their own learning demonstrate a commitment to lifelong learning and model this behaviour for their students. Online platforms, webinars, and massive open online courses (MOOCs) offer unprecedented access to global expertise and cutting-edge pedagogical practices. The ability to navigate these resources, critically evaluate their relevance, and integrate new knowledge into practice is a fundamental digital competence for modern educators.

Collaboration and communication with colleagues have been revolutionized by digital technologies. Teachers with strong digital competences can effectively participate in virtual professional learning communities, contributing to and benefiting from collective expertise. These skills enable educators to transcend geographical boundaries, engaging in cross-cultural exchanges that enrich their professional perspectives. Digital platforms facilitate the sharing of resources, lesson plans, and best practices, fostering a culture of open education and collaborative innovation.

Furthermore, digitally competent teachers play a pivotal role in institutional development. They can contribute to the strategic implementation of technology within their educational institutions, serving on committees that shape digital policies and infrastructure decisions. These educators often become change agents, mentoring colleagues and promoting an institution-wide culture of digital literacy. Their expertise is invaluable in evaluating educational technologies, ensuring that investments align with pedagogical goals and institutional needs.

Digital competences also empower teachers to engage more effectively with administrative tasks and data-driven decision-making processes. Proficiency in data analysis tools allows educators to contribute meaningfully to discussions about student performance trends, curriculum effectiveness, and resource allocation. This data-informed approach to institutional development can lead to more targeted interventions and improved educational outcomes.

2.1. New competences for teachers. The DigCompEdu framework

A quick overview of the new types of educational situations teachers must design and implement more and more often leads to the conclusion that the integration of digital competencies should be a central part of teacher education and continuous professional development, as such competencies enable educators to effectively engage students and enhance learning outcomes in the digital age. The categories of situations are diverse, ranging from classroom-based computer assisted instruction to independent individual or collaborative learning tasks at home, from blended learning models to entirely online or remote teaching scenarios, all of which require specific digital competencies (Kgosi et al., 2023). For example, there have been attempts to identify specific competencies for synchronous online teaching through videoconferencing (Grammens et al., 2022) – these encompassing instructional, managerial, technical, communicational, and social roles:

Description of roles	*Examples of associated competences that are specific to online synchronous teaching through videoconferencing (apud Grammens et al., 2022)*
Instructional: Concerned with knowledge of the basic elements of designing effective instruction, and provides the pedagogical foundation of teachers' work	- Select techniques and tools that facilitate active engagement during the online videoconferencing class (Reinholz et al., 2020) - Be able to track student progress during videoconferencing to continue teaching in a differentiated way (Martin et al., 2009; Stefaniak, 2021)
Managerial: Focuses on the practical organization of learning and establishing protocols and rules	- Teaching while managing different communicational channels, equipment, and potentially technical obstacles (Cornelius, 2014; de Jong et al., 2018; Develotte et al., 2010; Guichon, 2010) - Have good time management skills while running classes through videoconferencing (Cakiroglu et al., 2016; Moore-Adams et al., 2016; Phelps & Vlachopoulos, 2020) - Setting rules to coordinate students' input (e.g. hand-raising feature, use of the microphone and camera)
Technical: Geared toward handling the technical aspects of the synchronous online videoconferencing environment	Develop a high level of consciousness regarding all the information they are transferring while interacting with the students through videoconferencing technology (Guichon & Wigham, 2015) - Having the technical skills needed for selecting appropriate digital tools (Compton, 2009; Parrish & Linder-VanBerschot, 2010)

Communicational: Centers on the facilitation of clear and smooth communication	Having a clear, appropriately paced, engaging and articulate speech trough the microphone (Phelps & Vlachopoulos, 2020) - Encouraging students to take part in classroom conversations, and support them in expressing their opinions through the various communication channels in the synchronous online videoconferencing environment (Alvarez et al., 2009; Cakiroglu et al., 2016; Golding & Bretscher, 2018; Guichon, 2009) - Being proficient in the pedagogical use of the communication tools (e.g., microphone, webcam or chat) through which they deliver their instruction (Moore-Adams et al., 2016). - Being able to determine, often ad hoc, which communication channel (e.g. audio, video or chat) needs to be selected for a specific learning scenario (Phelps & Vlachopoulos, 2020)
Social: Aims to facilitate social interaction and the development of durable relations, taking into account cultural differences between students	Create a psychologically safe environment by allocating time and space for students to interact with the other students and the teacher, and to develop social norms and shared rules (Moore-Adams et al., 2016; Nonthamand, 2020; Racheva, 2018; Zhang et al., 2018) - Monitoring and reacting to the emotions that students display across communication channels (Rehn et al., 2018)

It becomes clear that, in today's digital world, teachers must possess a broad range of digital competencies to effectively support students in developing the knowledge, skills, and attitudes they need to thrive. A quick overview of the new types of educational situations teachers have to design and implement more and more often leads to the conclusion that the traditional teacher competence profiles are becoming increasingly insufficient (Fraile et al., 2018; González et al., 2023; Gómez-Pablos et al., 2022; Falloon, 2020).

As educational frameworks evolve to include digital competence as a key component of teacher training, there is a pressing need for adequate strategies that prepare educators to utilize technology and to innovate within their teaching practices, to foster student engagement and lifelong learning capabilities. The most prominent initiative in this matter is the European Framework for the Digital Competence of Educators – DigCompEdu – developed by the European Commission, an overarching taxonomy for educators to develop and assess their digital skills in various aspects of their professional practice. The DigCompEdu framework offers a comprehensive and interdisciplinary approach to defining the digital competence, emphasizing the necessity for teachers to be proficient in employing technology and also in understanding its implications on pedagogical methodologies, which ultimately facilitates enhanced learning outcomes. Additionally, the framework highlights the importance of ongoing professional development and collaboration among educators, urging them to continually refine their digital skills and pedagogical strategies to keep pace with rapid technological advancements and varying student needs.

The DigCompEdu framework delineates various dimensions of digital competence, including the ability to adapt teaching methods to incorporate digital tools effectively, evaluate the impact of technology on learning, and facilitate student-centred learning experiences that promote digital literacy and responsible online behaviour, which underscores the necessity for educators to engage actively with digital competences beyond merely technical abilities, as these competences play a critical role in preparing students for success in a digitally mediated world. The model outlines six key areas of digital competence for educators, each containing several specific competences (European Commission et al., 2017):

1. Professional Engagement

1.1. Organisational communication
1.2. Professional collaboration
1.3. Reflective practice
1.4. Digital Continuous Professional Development (CPD)

2. Digital Resources

2.1. Selecting digital resources
2.2. Creating and modifying digital resources
2.3. Managing, protecting and sharing digital resources

3. Teaching and Learning

3.1. Teaching
3.2. Guidance
3.3. Collaborative learning
3.4. Self-regulated learning

4. Assessment

4.1. Assessment strategies
4.2. Analysing evidence
4.3. Feedback and planning

5. Empowering Learners

5.1. Accessibility and inclusion
5.2. Differentiation and personalisation
5.3. Actively engaging learners

6. Facilitating Learners' Digital Competence

6.1. Information and media literacy
6.2. Digital communication and collaboration
6.3. Digital content creation
6.4. Responsible use
6.5. Digital problem solving

Overall, the DigCompEdu framework represents a critical step in redefining teacher competence profiles, acknowledging the evolving roles and responsibilities of educators in the digital age. This shift enhances the effectiveness of teaching practices and significantly contributes to the holistic development of students, equipping them with the essential skills needed to navigate and thrive in a technology-driven world. Moreover, a thorough understanding of digital competence frameworks can substantially inform curriculum design and teacher training programs, which are essential for ensuring educators are not only able to utilize technology but also adept at fostering critical thinking, creativity, and collaboration among students in digital contexts (Gómez-Pablos et al., 2022; Cook et al., 2023; González et al., 2023).

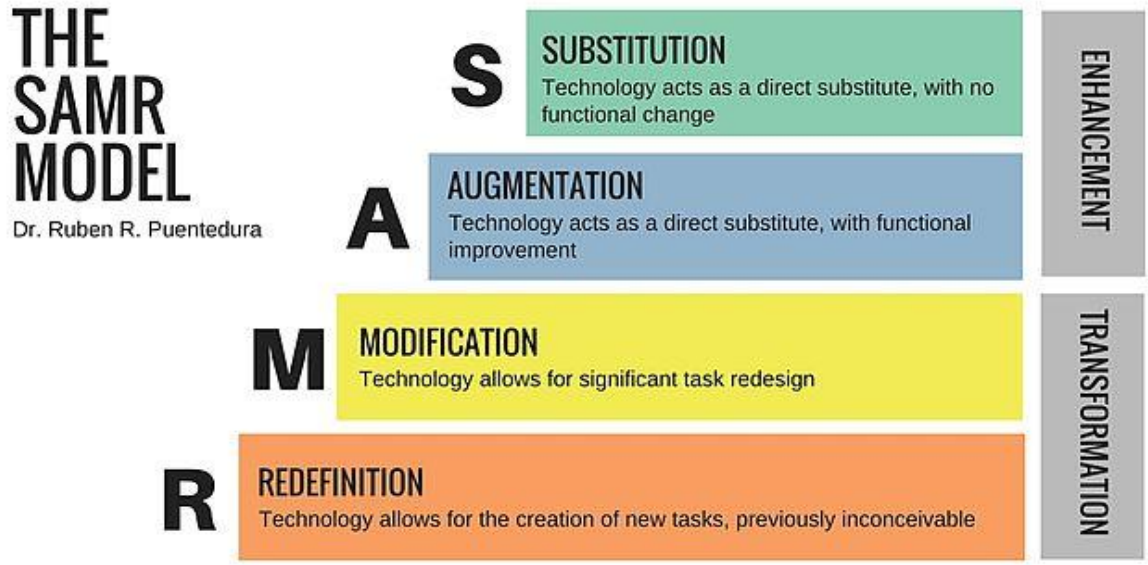
As higher education continues to embrace digital transformation, it is imperative for institutions to support the development of teachers' digital competence through targeted strategies that bridge technical skills and pedagogical knowledge, thereby enhancing the overall quality of education offered to learners in a rapidly evolving landscape. Schools and universities must prioritize the integration of digital competence into their professional development initiatives, ensuring that all

members are equipped with the necessary skills to adapt to changing educational paradigms and enhance student learning experiences through innovative use of technology. This includes fostering environments that facilitate meaningful experiences in digital technology, which can significantly enhance both teaching effectiveness and student engagement in learning processes that are relevant to today's workforce demands (Falloon, 2020). Furthermore, collaboration among faculty to share best practices and resources can lead to the development of a community of practice that actively addresses the challenges posed by digital education, ultimately fostering an environment of innovation and adaptability in teaching methodologies (Istrate, 2022). To this end, ongoing evaluation and adjustment of digital competence frameworks are necessary to ensure they remain relevant in addressing emerging technologies and pedagogical theories, thereby empowering educators to continually refine their skills and adapt their teaching methods to meet the demands of a dynamic educational landscape. This iterative process reinforces educators' resilience in the face of technological change, cultivating a proactive approach to integrating digital tools that support enriched learning experiences and enhanced student outcomes, ultimately aligning with the evolving expectations of both the education sector and the labour market.

2.2. The digital competences and the continuous professional development

When considering the pathway to meaningful integration of technology in education process, two frameworks are insightful, offering as well useful landmarks for continuous professional development: SAMR and TPACK and. SAMR evaluates levels of technology integration, while TPACK focuses on teachers' technological, pedagogical, and content knowledge. Studies have shown that these models can effectively guide technology implementation in various educational contexts.

The SAMR model, proposed by Ruben Puentedura in 2010, provides a framework for teachers to reflect on how they integrate technology into their practice (Puentedura, 2016), encouraging progression from merely substituting traditional methods to redefining learning experiences through technology. It outlines four levels of online learning, arranged by their complexity and transformative potential: *substitution, augmentation, modification,* and *redefinition*. When transitioning to online format, educators often concentrate only on the initial two stages, which involve substituting traditional materials with digital equivalents. This might include converting lessons and worksheets into PDFs for online access or recording lectures on video for asynchronous learning.



The SAMR Model on the use of technology to enhance and to transform teaching.

The modification phase comprises a significant redesign of the task, as the technology allows for substantial changes in how the task is performed. An example would be students collaborating on a shared document in real-time, allowing for immediate feedback and collaborative learning.

At the highest level, technology allows for the creation of new tasks that were previously inconceivable. For example, students could create a multimedia project that includes video, audio, and interactive elements, in an asynchronous collaborative environment, and then share it with a global audience.

The SAMR Model can be mapped onto various educational theories and research methodologies:

- Behaviorism: At the substitution and augmentation levels, technology can be seen as a tool to reinforce learning through repetition and immediate feedback.
- Constructivism: The modification and redefinition levels align with constructivist theories, where learners actively construct knowledge through collaboration and creation.
- Bloom's taxonomy: The SAMR model can be analysed in relation with Bloom's Taxonomy, with substitution and augmentation corresponding to lower-order thinking skills (remembering, understanding), and modification and redefinition aligning with higher-order thinking skills (analysing, evaluating, creating).

Research on the SAMR model suggests that effective technology integration requires thoughtful planning and reflection by educators. By progressing through the levels of SAMR, teachers can enhance their pedagogical practices and provide more engaging and meaningful learning experiences for students.

Similarly, **the TPACK model** (Technological Pedagogical Content Knowledge) is a framework for describing the types of knowledge that teachers need to effectively integrate technology into their teaching practices. It has emerged as a relevant and useful model for understanding the intricate relationships between technology, pedagogy, and content knowledge in the context of education.

TPACK is an extension of Lee Shulman's concept of Pedagogical Content Knowledge (PCK), being introduced by Punya Mishra and Matthew J. Koehler in 2006, to address the increasing role of

technology in education. The model is based on the idea that effective technology integration in teaching requires a complex, situated form of knowledge that is context-dependent and involves understanding the dynamic relationships among these components.

The model consists of three primary knowledge domains and four intersecting domains:

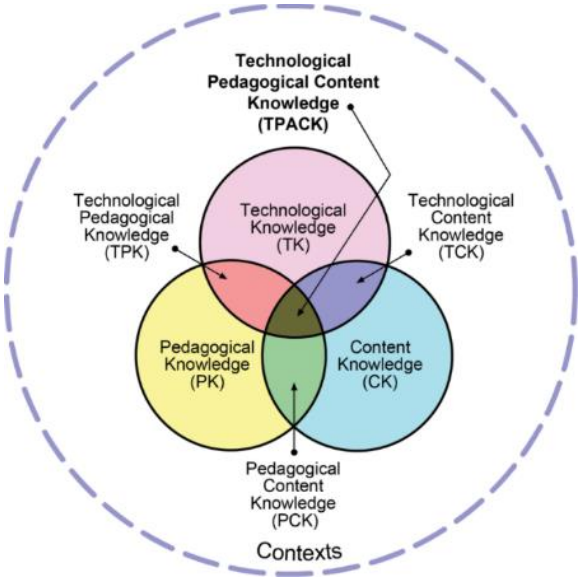
a) Primary domains:

- Content Knowledge (CK): Subject matter expertise
- Pedagogical Knowledge (PK): Understanding of teaching methods
- Technological Knowledge (TK): Proficiency with relevant technologies

b) Intersecting domains:

- Pedagogical Content Knowledge (PCK)
- Technological Content Knowledge (TCK)
- Technological Pedagogical Knowledge (TPK)
- Technological Pedagogical Content Knowledge (TPACK)

TPACK is typically represented as a Venn diagram with three overlapping circles, each representing one of the primary knowledge domains. The intersections of these circles represent the integrated forms of knowledge.



The TPACK model. Reproduced by permission of the publisher (© 2012 by tpack.org)

The TPACK framework serves as a foundational basis for research aimed at enhancing technology integration competencies among teachers, illustrating its relevance in contemporary educational discourse. Employing mixed-method approaches, including surveys and questionnaires to assess teachers' self-reported TPACK, classroom observations to evaluate TPACK in practice, content analysis of lesson plans and teaching materials, and interviews with teachers to explore their decision-making processes, numerous studies have provided evidence for the validity and reliability of TPACK as a construct. For example, Schmidt et al. (2009) developed and validated a survey instrument to measure TPACK, and Archambault and Crippen (2009) applied TPACK to online teaching contexts.

Despite its limitations and critiques, such as (1) difficulty in precisely measuring and distinguishing between the different knowledge domains, (2) challenges in operationalizing the construct for

research purposes, and (3) potential oversimplification of the complex nature of teaching with technology, the TPACK model has been used as a useful instrument in different contexts:

- to design and evaluate teacher education programs
- to assess teachers' technology integration skills
- to guide professional development initiatives
- to inform educational technology policies.

Certainly, the practical applications of the TPACK model in education are extensive and varied; the examples on how TPACK is applied in educational settings are edifying regarding its value:

1. Curriculum design and lesson planning. Teachers use TPACK (principles) to create technology-integrated curricula that align content, pedagogy, and technology, ensuring that technology use enhances rather than detracts from learning objectives. In their lesson plans, they efficiently integrate sequences and resources such as interactive timelines, virtual museum tours, and collaborative digital storytelling projects, hands-on experiments, computer simulations, and data analysis software.

2. Adaptive teaching. Teachers use TPACK to make informed decisions about when and how to adapt their use of technology based on student needs and learning contexts (e.g. adjusting the use of online collaboration tools based on students' digital literacy levels and the complexity of the task).

3. Assessment design. Educators apply TPACK when creating technology-enhanced assessments that align with learning objectives and instructional methods. For example, developing a project-based assessment that requires students to create multimedia presentations demonstrating their understanding of complex scientific concepts.

4. Blended and online learning design. TPACK informs the development of blended and fully online courses, ensuring a balance between technological tools, content delivery, and effective teaching strategies. (E.g. designing a flipped classroom model that effectively combines online lectures with in-class problem-solving activities.)

5. Professional development. Ministries, HEIs, training institutions and schools design teacher training programs based on TPACK to improve technology integration skills, approaching each component through courses/ workshop series that focus on subject-specific technology tools and how to effectively incorporate them into existing teaching practices. For pre-service training, the model can help in designing courses that require student teachers to create and implement technology-enhanced lesson plans in their teaching practice in classrooms.

6. Teacher evaluation. TPACK can be used as a framework for assessing teachers' effectiveness in integrating technology, by developing, for example, observation rubrics that include criteria for appropriate technology use in relation to content and teaching methods.

7. Educational technology selection. TPACK guides the process of choosing educational technologies that best support specific content areas and pedagogical approaches.

8. Educational research/ educational policy development. Researchers use TPACK as a theoretical framework for studying the effectiveness of technology integration in various educational contexts (e.g. investigating how different TPACK profiles among teachers correlate with student learning outcomes), using the results to feed the educational policies and for creating standards and guidelines for technology use in schools.

These practical applications demonstrate how TPACK serves as a versatile framework for improving teaching and learning with technology across various aspects of education, and especially for guiding teachers' perspective on digital skills and their value in everyday teaching practice.

However, in the last years, the professional development was benefiting from the expansion of the Internet, leaving no doubt about what the digital environment offers for education. In this regard, three major sources of inspiration are bringing about changes in teaching practice: digital resources, professional virtual learning communities, and online courses.

Digital resources offer rich opportunities for teacher CPD, simultaneously developing subject knowledge, pedagogical skills, and digital competences. Usually residing in curated libraries or referenced by specialised portals, they comprise scientific articles, blogs, websites, open educational resources - OERs, and various types of digital resources for teaching, learning, and assessment, providing teachers with up-to-date information on educational trends, research, and best practices.

The open access movement has dramatically increased teachers' access to current educational research. Platforms like ERIC (Education Resources Information Center), ResearchGate, and Google Scholar provide teachers with free access to a wealth of peer-reviewed studies. This access allows teachers to base their teaching practices on evidence-based research, to understand the theoretical foundations of various pedagogical approaches, and to stay informed about emerging trends and findings in education.

The effective use of these digital resources for CPD requires and continuously support certain skills and approaches:

- Digital curation. Teachers need to develop skills in finding, organizing, and sharing digital resources. Tools like Wakelet or Pinterest can help educators curate and manage their digital resource collections.
- Critical evaluation. With the abundance of online resources, teachers must cultivate strong critical thinking skills to evaluate the quality, relevance, and reliability of digital materials.
- Adaptive expertise. As highlighted by Hatano and Inagaki's concept of adaptive expertise (1986), teachers need to develop the ability to flexibly apply their knowledge in new situations, a skill particularly relevant when working with diverse digital resources.
- Networked learning. The concept of connectivism, as proposed by G. Siemens, emphasizes the importance of building and maintaining a professional learning network (Siemens, 2005). Digital platforms like Twitter (with educational chats) or LinkedIn can facilitate this networked approach to learning.
- Digital citizenship. As teachers engage more deeply with online resources and communities, they need to develop and model good digital citizenship, including understanding copyright, digital etiquette, and online safety.

Professional **Virtual Learning Communities** (VLC) have emerged as powerful tools for teacher professional development, online spaces where education professionals can connect, share experiences, and collaboratively solve problems. In an increasingly interconnected world, the establishment of professional VLCs allows educators to engage in collaborative learning experiences that enhance their knowledge and instructional practices within their specific contexts, ultimately contributing to more effective teaching strategies tailored to the diverse needs of their students.

According to a study by Trust and Prestridge (2021), participation in VLCs can significantly enhance teachers' professional growth and digital competences, providing opportunities for:

- just-in-time learning – teachers can seek immediate help for classroom challenges;
- diverse perspectives – exposure to a wide range of teaching contexts and methodologies;
- sustained engagement – ongoing professional conversations that extend beyond traditional PD sessions.

The use of technology to create digital spaces for collaborative learning among teachers has been shown to enhance their professional knowledge base and facilitate the development of teaching skills (Kopish & Marques, 2020). In particular, these virtual communities serve as a vital resource for educators who may feel isolated in their teaching environments, offering avenues for the exchange of ideas, resources, and support among peers, thereby fostering a sense of belonging and shared purpose within the profession (Reinman, 2015). Additionally, the flexibility of online platforms enables educators to participate in discussions and collaborate on projects at times that suit their schedules, ensuring that engagement is not hindered by geographical or temporal constraints, thus broadening their professional networks and support systems across diverse educational landscapes (Kowalski et al., 2017).

Not less important, VLCs also foster the development of digital skills as teachers learn to navigate online platforms, share digital resources, and engage in virtual collaboration tools.

Similarly, the rise of **online courses and MOOCs** has provided teachers with flexible, accessible, and personalized opportunities for professional growth. These courses enable educators to engage with a plethora of resources and expert-led sessions that would otherwise be inaccessible, enriching their professional learning experiences and enabling them to integrate innovative practices into their teaching methodologies. Moreover, the flexibility and convenience of these digital learning platforms allow teachers to balance their professional obligations with personal commitments, ensuring that their professional growth is not hindered by the constraints of time or location (Kowalski et al., 2017).

A meta-analysis by Fishman et al. (2013) compared online and face-to-face professional development, finding that online courses can be equally effective when well-designed. Key benefits include:

1. Self-paced learning: Teachers can engage with material at times that suit their schedules.

2. Scalability: High-quality PD can reach a larger number of educators.

3. Multimodal content: Integration of video, interactive elements, and collaborative tasks.

Focusing on the value of MOOCs for teacher professional development, Vivian et al. (2014) highlighted several other advantages:

1. Access to expertise: Teachers can learn from leading educators and researchers worldwide.

2. Community-building: Global networks of educators form around shared interests.

3. Experiential learning: Teachers experience online learning firsthand, informing their own practice.

Engaging in online courses and MOOCs also contribute to the development of digital competences by exposing teachers to cutting-edge educational technologies and pedagogical approaches in online environments.

The relationship between digital competences and CPD is bidirectional. As teachers engage in these online professional development opportunities, they naturally enhance their digital skills. Conversely, stronger digital competences enable more effective participation in online CPD activities.

While the potential of online CPD is significant, researchers like Macià and García (2016) have noted challenges such as ensuring sustained participation and transferring online learning to classroom practice. Future research and development in this area may focus on:

- personalization: tailoring online CPD experiences to individual teacher needs and contexts.
- integration: blending online and face-to-face PD for optimal impact.
- assessment: developing effective ways to measure the impact of online CPD on teaching practice and student outcomes.

Nowadays, digital resources, professional virtual learning communities, and online courses play a crucial role in modern teacher CPD, simultaneously developing educators' professional knowledge and digital competences. As the educational landscape continues to evolve, these types of instruments will likely become increasingly central to teacher professional growth and institutional development.

2.3. Institutional development. Organizational communication and professional collaboration

The concept of digital competence in teaching should encompass a comprehensive understanding and proficient execution of all tasks associated with the teaching profession (Tammaro & D'Alessio, 2016; Gómez-Pablos et al., 2022). This broader perspective acknowledges the multifaceted nature of teaching, which integrates pedagogical strategies, critical thinking, and the ability to adapt to various learning environments. Even more, the institutional climate, collaboration within the teaching staff, cooperation with other institutions and professionals proves often to have a major contribution to the overall performance of the educational institution.

The first area of DigCompEdu, *Professional engagement*, is related to institutional development, as it focuses on educators' use of digital technologies in professional interactions. The DigCompEdu proposal is highly relevant to institutional decision making and to educators alike. As stated in the Spanish adapted version of DigCompEdu, *"The professional engagement of teachers is expressed through the development of the intellectual, physical and psychological development of pupils, their participation in the school, their collaboration with families, and their own professional development. Therefore, digital competence in teaching should not only refer to the ability to use digital technologies to enhance teaching and learning, but it should also refer to the proper performance of all tasks related to professional practice."* (Spanish Framework for the Digital Competence of Teachers, 2022, p. 23).

The European Commission, through the Joint Research Centre, included four competences in the first area of DigCompEdu, Professional development: organisational communication, professional collaboration, reflective practice, digital CPD.

***1.1 Organisational communication**. To use digital technologies to enhance organisational communication with learners, parents and third parties. To contribute to collaboratively developing and improving organisational communication strategies.*

Effective digital communication within educational institutions streamlines processes, improves information flow, and enhances overall efficiency. When educators are proficient in digital communication tools, it leads to better coordination, faster decision-making, and more transparent institutional practices.

Examples of activities (from DigCompEdu):

- To use digital technologies to make additional learning resources and information available to learners (and parents).
- To use digital technologies to communicate organisational procedures to learners and parents, e.g. rules, appointments, events.
- To use digital technologies to inform learners and parents on an individual basis, e.g. on progress and issues of concern.
- To use digital technologies to communicate with colleagues in the same organisation and beyond.
- To use digital technologies to communicate with third parties relevant to the educational project, e.g. experts to be invited, places to be visited.
- To communicate via the organisation's website or through corporate digital technologies, platforms or communication services contracted.
- To contribute with content to the organisation's website or virtual learning environment.
- To contribute to collaboratively developing and improving organisational communication strategies.

***1.2 Professional collaboration**. To use digital technologies to engage in collaboration with other educators, sharing and exchanging knowledge and experiences and collaboratively innovating pedagogic practices.*

Digital tools enable educators to collaborate beyond physical and temporal boundaries, sharing knowledge and best practices. Enhanced collaboration fosters innovation, cross-pollination of ideas, and the development of a learning community within the institution.

Examples of activities (from DigCompEdu):

- To use digital technologies to collaborate with other educators, on a dedicated project or task.
- To use digital technologies to share and exchange knowledge, resources and experiences with colleagues and peers.
- To use digital technologies to collaboratively develop educational resources.
- To use professional collaborative networks to explore and reflect on new pedagogic practices
- and methods.
- To use professional collaborative networks as a source for one's own professional development.

***1.3. Reflective practice**. To individually and collectively reflect on, critically assess and actively develop one's own digital pedagogical practice and that of one's educational community.*

Digital tools provide new ways for educators to reflect on and evaluate their teaching methods and professional growth. A culture of reflection leads to continuous improvement, adaptability, and responsiveness to changing educational needs.

Examples of activities (from DigCompEdu):

- To critically reflect on one's own digital and pedagogic practice.
- To identify competence gaps and areas for improvement.
- To seek the help of others in improving one's digital and pedagogical practice.
- To seek targeted training and use opportunities for continuous professional development.
- To seek to continuously expand and enhance one's repertoire of digital pedagogical practices.
- To help others in developing their digital pedagogical competence.
- At the organisational level, to reflect on and provide critical feedback on digital policies and practices.
- To actively contribute to further developing organisational practices, policies and visions on the use of digital technologies.

1.4. Digital Continuous Professional Development (CPD)*. To use digital sources and resources for continuous professional development.*

Digital CPD allows educators to stay current with educational trends, technologies, and pedagogical approaches. When educators continuously upskill, the institution as a whole becomes more competent, innovative, and capable of meeting evolving educational challenges.

Examples of activities (from DigCompEdu):

- To use the internet to identify suitable training and professional development opportunities.
- To use the internet to update one's subjectspecific competences.
- To use the internet to learn about new pedagogical methods and strategies.
- To use the internet to search for and identify digital resources which support professional development.
- To use the exchange in digital professional communities as a source of professional development.
- To use online training opportunities, e.g. video tutorials, MOOCs, webinars etc.
- To use digital technologies and environments to provide training opportunities for colleagues and peers.

Overall, these competences contribute to institutional development by:

- Creating a more agile and responsive educational environment
- Fostering a culture of continuous improvement and innovation
- Enhancing the institution's ability to adapt to technological changes
- Improving the overall quality of education through better-equipped educators
- Building a stronger professional community within the institution.

By focusing on these areas, educational institutions can leverage digital technologies to create more effective, collaborative, and forward-thinking learning environments.

2.4. Ethical aspects, limits and challenges of using digital technologies in education. Safety and data protection

A thorough, multifaceted approach to digital competence necessitates a departure from traditional pedagogical methods, encouraging educators to embrace a collaborative and integrated framework that prioritizes continuous professional growth, adaptability, and a focus on ethical implementation of digital tools in their teaching practices. (Cook et al., 2023) (Srivastava, 2023) (Falloon, 2020) (González et al., 2023)

Generally speaking, the penetration of new technologies brought upfront a series of aspects that require rigorous examination and new educational policies and curriculum approaches, concerning education decision makers, HEIs leadership, researchers, as well as teachers at all educational levels.

1. Curriculum alignment. Ensuring that digital technologies are aligned with curriculum goals and learning outcomes is a challenge, as many educators struggle to integrate technology meaningfully into their lesson plans.

2. Policy implementation. The effectiveness of policies regarding the use of digital technologies in education can vary widely, with some regions lacking clear guidelines or support for implementation.

3. Changing pedagogical approaches. The need to rethink traditional pedagogical approaches in light of new technologies can be daunting for educators, particularly those who are less digitally literate. Similarly, developing effective assessment strategies that incorporate digital technologies while ensuring fairness and validity remains a significant challenge for educators.

4. Teacher burnout and workload. The rapid shift to online and hybrid learning models during the pandemic has contributed to increased stress and burnout among teachers, impacting their ability to effectively use digital tools.

5. Professional development/ Digital competence of educators. Many teachers lack the necessary skills and confidence to integrate digital technologies into their teaching practices, leading to a reliance on traditional methods. Furthermore, there is often a lack of ongoing professional learning opportunities for teachers to develop their digital skills and pedagogical strategies for using technology effectively.

6. Access to technology. Disparities in access to devices and reliable internet connectivity can hinder the ability of both teachers and students to engage with digital learning tools.

7. Equity and inclusion. The digital divide exacerbates existing inequalities in education, as students from disadvantaged backgrounds may not have the same access to technology and resources as their peers.

8. Ethical use of technology. Educators face challenges in understanding the ethical implications of using digital technologies, including issues related to data privacy, security, and the responsible use of generative AI.

For education professionals, this multifaceted responsibility calls for a thorough understanding of the potential implications of technology on student learning and well-being, highlighting the necessity for training that emphasizes both the advantages and the potential risks associated with digital tools in education. Thus, educators must be equipped with strategies to address the challenges posed by

digital platforms, ensuring that they not only enhance learning, but also prioritize student safety and privacy; establishing robust frameworks for ethical data use is essential to maintaining trust and integrity within the educational ecosystem. Nowadays, teachers must ensure that their practices safeguard students' privacy and uphold ethical standards, particularly in an age where the collection and use of data are prevalent in educational settings (Bhat, 2023). Consequently, educational institutions and technology providers must collaborate to create and implement robust frameworks that protect students' data while also promoting the ethical use of technology, thus ensuring that the digital classroom can serve as a space for equitable access, engagement, and personalized learning (Bhat, 2023; Srivastava, 2023).

Educators have a huge responsibility to use data ethically in educational settings, balancing the benefits of learning analytics with student privacy concerns (Mandinach & Jimerson, 2022; Reidenberg & Schaub, 2018). This requires data literacy and knowledge of relevant laws like FERPA (in US), the "Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence" Executive Order (in US), and the EU AI Act (in the European Union).

According to Hakimi et al. (2021), ethical considerations include four areas: (1) privacy, informed consent, and data ownership; (2) validity and integrity; (3) ethical decision making; and (4) governance and accountability. The authors emphasize the need for more rigorous evidence-based practices, and a more unified approach that incorporates ethical theory and addresses both immediate and long-term concerns within the broader learning and educational ecosystem. A privacy-compliant framework for capturing, storing, and using student data is essential.

Overall, educators must couple data literacy with ethical practices, using the right data for the right purposes to benefit students (Mandinach & Jimerson, 2022). Beyond regulations and top-down recommendations, this requires ongoing attention to evolving technologies and their implications for student privacy and autonomy.

Of increasing importance are the aspects of plagiarism, especially in the context of proliferation of AI-based assistants. The integration of AI and human interaction in the academic context raises significant questions regarding ownership, attribution, copyrights, and authorship. As students grapple with these issues, distinguishing between legitimate AI assistance and academic misconduct becomes increasingly complex, thus necessitating educational interventions that incorporate discussions about what constitutes literary theft and the importance of maintaining individuality in their writing. For very good reasons, while there may be small variations and nuances across various legislative bodies, educational institutions, publishing houses and journals, the consensus is that AI or AI-assisted tools cannot be credited as an author or co-author – authorship is strictly a human responsibility. Current attitudes toward AI usage are evolving, and regulations are still developing, particularly as AI detection technology remains in its early stages and often produces false positives. Consequently, AI detection is primarily used to identify AI involvement in texts, necessitating further examination rather than a simple pass/fail based on AI usage percentages. While AI-generated ideas can expedite the writing process, scholars and students must not use AI outputs verbatim, as this constitutes plagiarism. Instead, AI tools should be employed to assist with tasks like article recommendations, summaries, and brainstorming, with the original academic narrative crafted by the author themselves.

Authors share a responsibility to avoid misconduct, with institutions like Cambridge University emphasizing the importance of proper referencing. Even more, the educators have a more prominent role in engaging students in meaningful discussions about the line between assistance and appropriation, emphasizing proper attribution and the importance of preserving academic

integrity in the face of AI advancements. They must evolve their teaching strategies to address the ethical implications of AI usage, fostering a nuanced understanding of what constitutes plagiarism and ensuring that students are equipped with the knowledge to navigate these new challenges responsibly (Chan, 2023). Moreover, institutions should consider incorporating curricular components that specifically address the implications of AI on authorship, exploring issues of originality and the moral responsibilities of using such technologies in academic contexts, thereby preparing students for the ethical dilemmas they may encounter in the evolving landscape of professional creativity and professionals' responsibility. Schools and universities have to create supportive environments that highlight the potential risks of AI use and promote critical thinking and ethical decision-making among students, ensuring they understand the long-term consequences of cheating and its implications in professional and societal contexts.

3. Digital technologies for active learning

Integration of ICT tools into teaching brings a number of benefits, including increasing motivation for learning, increased access to information presented in various forms, facilitating understanding, more possibilities for application (direct or mediated) and potential to achieve, to a greater extent, engaging, participative, collaborative learning activities, based on the interest and capacities of each student (Istrate, 2010). However, the experience of the last decades shows that, in practice, the advantages of using new technologies do not have the desired extent, and although intuited, they are not (adequately) aligned with the goals of a ICT-based educational situation (Velea, 2011). According to Okoye et al. (2022), the pace of pedagogical transformation remains slow – educators need time to accept and to incorporate the challenges and roles associated with emerging technologies to increase student engagement and create impactful learning experiences.

As the digital technologies evolves, so does their potential to enhance active learning by promoting student engagement and transforming traditional pedagogical approaches. Studies show that when implemented effectively, digital tools can encourage students to participate in more constructive and interactive learning activities (Wekerle et al., 2020; Cardullo et al., 2018). These technologies support various active learning strategies, such as flipped classrooms and project-based learning, which empower students and improve learning outcomes (Pinto & Leite, 2020; Cardullo et al., 2018).

3.1. Designing participatory learning

In a study investigating the effects of technology-supported versus non-technology-supported teaching on the types of learning activities that students feel encouraged to engage in, Wekerle and collaborators (2020) looked as well upon the associations between these learning activities and students' acquisition of domain-specific knowledge and cross-domain skills in higher education. The main theoretical basis was the ICAP framework of Chi and Wylie (2014), stating four types of overt learning activities with their associated knowledge-change processes: passive (receiving information/ material), active (manipulating course materials), constructive (generating new information content) and interactive (dialoguing with peers to co-create more information content). Among findings,

- Students felt more encouraged to engage in passive, active, and constructive learning activities when technology was used in the course, compared to when no technology was used.
- The use of technology did not affect students' engagement in interactive learning activities.
- Engagement in interactive and constructive learning activities, whether technology-supported or not, had the strongest positive associations with students' acquisition of domain-specific knowledge and cross-domain skills.

The analysis of various learning activities revealed significant differences in their impact on students' learning outcomes. Specifically, Wekerle's study found that interactive learning activities

demonstrated the most robust correlations with students' acquisition of both domain-specific knowledge and cross-domain skills. In contrast, passive learning activities showed no discernible relationship with any of the measured learning outcomes. This suggests that engaging, participatory learning methods may be more effective in promoting student learning across different areas of knowledge and skill development. As authors stated, ”higher education teachers [should] design their courses in ways that encourage their students to particularly engage in (technology-supported) interactive learning activities in contrast to the predominantly observed engagement in (technology-supported) passive learning activities”.

Designing participatory learning experiences is a crucial aspect of creating relevant, meaningful and effective educational situations.

In order to achieve this, it is essential to implement a blend of pedagogical, social, and technical strategies that cater to the diverse needs of students, ensuring that they are both behaviourally and cognitively engaged throughout the learning process (Wang, 2019). Incorporating elements that facilitate autonomy, competence, and relatedness can significantly enhance collaborative learning, allowing students to feel more connected and immersed in the activities they participate (Mentzer et al., 2023). Additionally, designing learning activities that encourage students to express their creativity and engage in meaningful contributions can lead to deeper understanding and more significant personal investment in the learning outcomes, ultimately enriching their educational experience and fostering a sense of community within the learning environment (Halverson, 2012). This can be achieved by creating rich learning activities that not only situate students within compelling narratives but also provide opportunities for reflection and peer critique, thereby encouraging them to engage in deeper collaborative processes that address complex real-world problems. Moreover, it is important to create a comfortable and supportive atmosphere where students feel empowered to share their ideas and learn from one another, as this emotional engagement is vital for fostering a participatory learning culture that resonates with their experiences and aspirations.

In this regard, the integration of technology can play a pivotal role in facilitating such environments, allowing for seamless interaction among learners while minimizing technical barriers that may hinder participation, thus ensuring that all students can fully engage with the tasks at hand (Wang, 2019). To further enhance this participatory approach, educators should focus on the design of activities that not only encourage teamwork and collective problem-solving but also challenge students to develop a rich understanding of the subject matter, thereby cultivating an intellectually stimulating environment that embodies the principles of social constructivism and active learning (Serva & Fuller, 1997; Mentzer et al., 2023; Ulinnuha & Indartono, 2019; Hafner & Ellis, 2005). By incorporating collaborative learning strategies and facilitating regular feedback opportunities among peers and instructors, students can actively participate in the learning process, ultimately increasing their retention and application of the material learned. This approach aligns with the findings that emphasize the importance of interaction and community in enhancing learning outcomes, particularly in collaborative settings where students can engage more meaningfully with the material and with each other (Ahmed & Lataifeh, 2024; Hathorn & Ingram, 2002). This collaborative model also encourages the development of critical skills such as communication and problem-solving (Hafner & Ellis, 2005; Hathorn & Ingram, 2002).

To achieve a successful implementation of these strategies, it is crucial for educators to find a balance that accommodates both individual learning styles and collective engagement, as this dual focus can significantly enhance the overall learning experience and prepare students for collaborative work environments they will encounter after graduation (Jeong & Hmelo-Silver, 2016).

Cultivating a reflection-rich environment allows students to connect their prior knowledge with new concepts, ultimately leading to the construction of deeper understanding and enhancing their ability to apply learned content in various contexts.

3.2. Models of ludic learning design

Game-based learning approaches, such as gamified learning designs and digital learning games, have shown promise in motivating students and improving attitudes towards subject matter (Weitze, 2016; Liu et al., 2013). The integration of play principles with experiential learning frameworks can foster intellectual, physical, spiritual, and moral development (Kolb & Kolb, 2010).

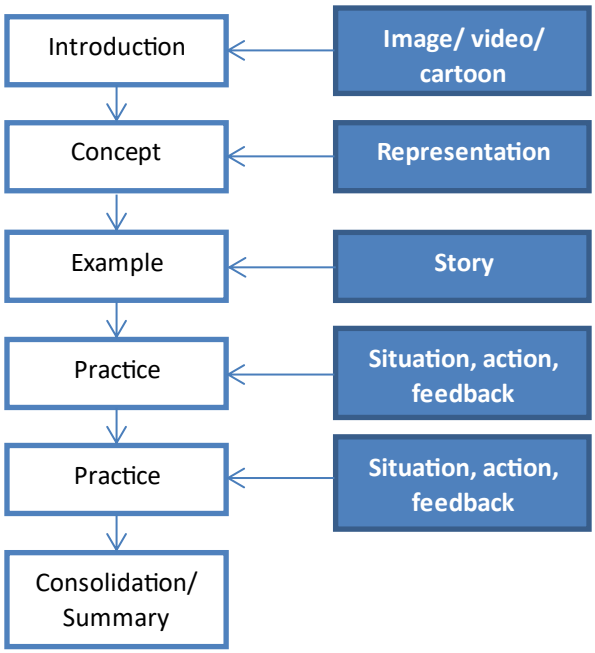
For didactic purposes, we will go through several models of organizing learning activities, built to support the design of digital educational games (Quinn, 2005), which can be used to understand how we can transform an educational activity into an attractive moment, similar to play activities. We present a selection of three models – mini-scenarios, chained scenarios, conditional scenarios – ranked progressively according to their ability to increase the engagement and attractiveness of learning activities.

In practice, when we plan didactic activities in the classroom ("conventional") or when we create a learning path in a virtual educational platform, we can combine these approaches, depending on the objectives we set, the complexity of the topic, the time and the resources available, how the students in the class work and respond to such 'challenges'.

What the sequence of models below suggests is to note that, supported by the infusion of new technologies, educational situations are transforming (or should be transformed) from conventional, teacher-centric, linear situations into student-centred and learning-centred situations, constructivist, personalized and adaptive.

The mini-scenario is a simple activity model, also frequently used in traditional training, suitable for a deductive teaching strategy.

We have an introduction (or attention-grabbing moment, which can be, for example, an image, a short film or a cartoon sequence), the presentation of the concept (representing the problem, key information or situation in didactic terms), the example (perhaps a story or an application-type scenario), based on which we create contexts for decision-making - practice. It concludes with a moment of fixation on the key elements learned.

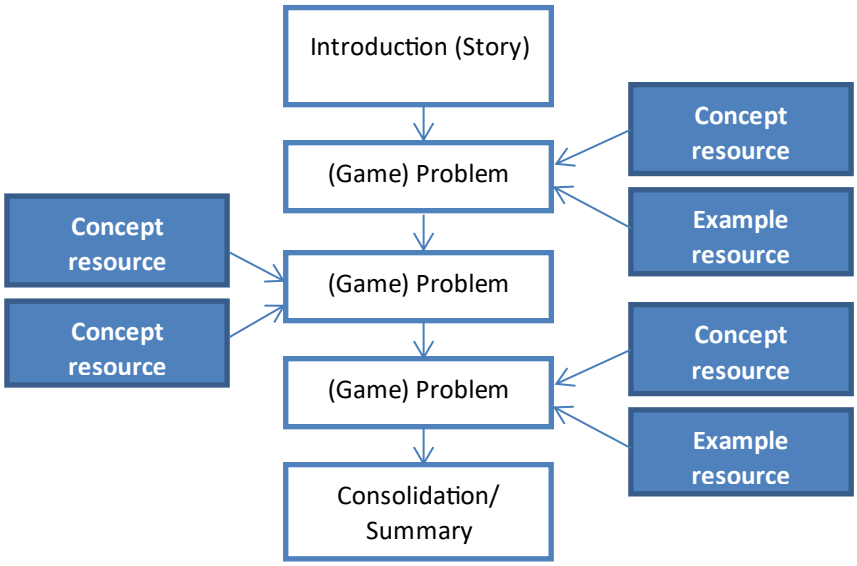


The mini-scenario (apud Quinn, 2005, p. 77)

Alternatively, the model of the nine events of instruction, developed by Gagné, can be used.

The linked (chained) scenarios establish a suite of decisions corresponding to key moments of learning content (which may consist of information, skills, attitudes), assembled as possible paths subsumed under the same theme.

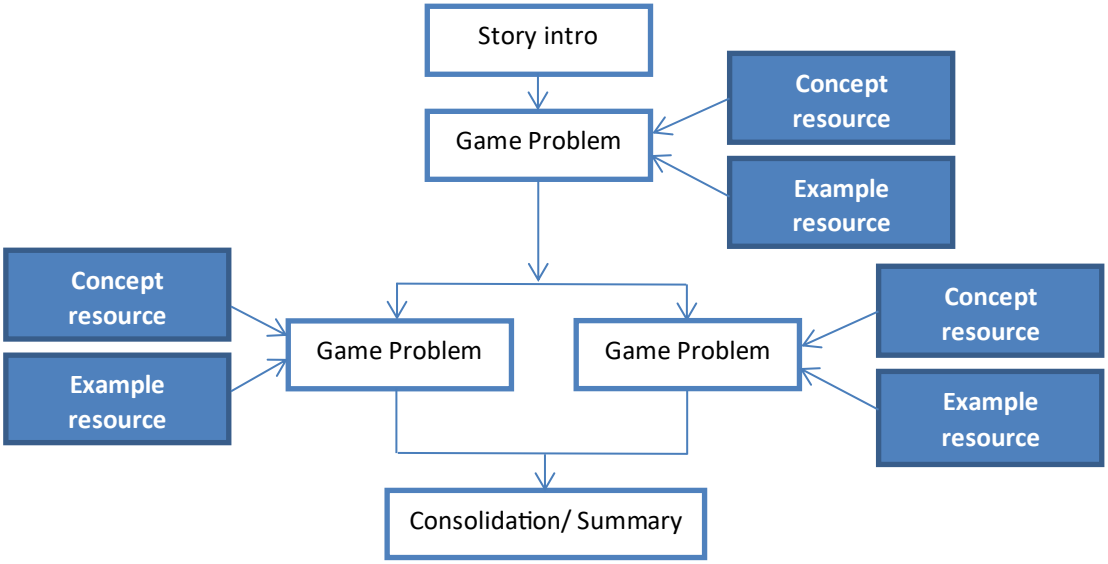
Each problem-situation that requires a decision on the part of the learner has information (explanatory), on the basis of which the option can be made, and an example (applicative).



The linked scenario (Quinn, 2005, p. 87)

It can be seen that the model is linear, thus being suitable for certain topics where learning proceeds from close to close, for each level (problem/scenario) the previously acquired information and capabilities are required. Also notice that, unlike the first model, this one allows for an inductive didactic approach.

Contingent (or branching) scenarios allow exploring the consequences of decisions – the path is no longer linear, but can branch endlessly. Students can make mistakes (intentionally or not), retake the course as many times as they want, and learn from the alternatives they choose.



The branched/ contingent scenario (Quinn, 2005, p. 95)

The learning experience is all the more meaningful, enjoyable and realistic the more decision moments and alternative paths are available to the learner.

For better management of the paths - which can branch endlessly, sometimes, to capture all possible situations - the teacher can divide the scenario into linearly assembled sequences (chained activity), projecting, on each sequence, multiple alternatives (conditional activities).

In all the above cases, in order to make learning attractive, participatory, motivating, the introduction can consist of presenting an imaginary situation in which the student will be the main character, having to make decisions and find answers to the presented problems. The activity thus takes a playful form.

Recent research explores models for ludic learning design, emphasizing the creation of playful learning spaces that promote deep, engaging educational experiences. They build upon pedagogical principles related to the role and effects of simulations, video games, didactic games, and gamification of educational situations.

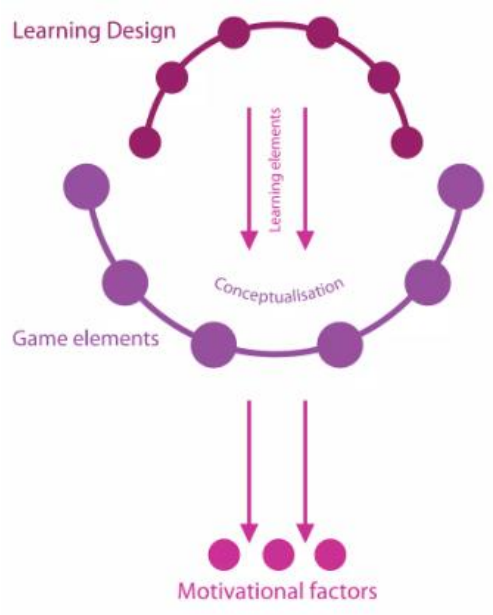
Ludic engagement designs can support flexible, open-ended learning environments that accommodate diverse learners and emergent interactions; in his study, E. Brooks (2013) presents a basic model for designing interactive spaces for playful learning, centred on the conditions for play activities, which has broader applicability in education settings. In a ”situated activity”, we have the ”goal of action” equidistantly positioned between the learner, the outside agent (teacher/ designer of the situation) and the technology setting. The interactive environment specific attributes are:

- Non-invasiveness
- Open-endedness
- Gestural affordances
- Volumetric space

- Creative actions
- Symmetry and asymmetry
- Intuitiveness
- Ease of use
- Immediate feedback

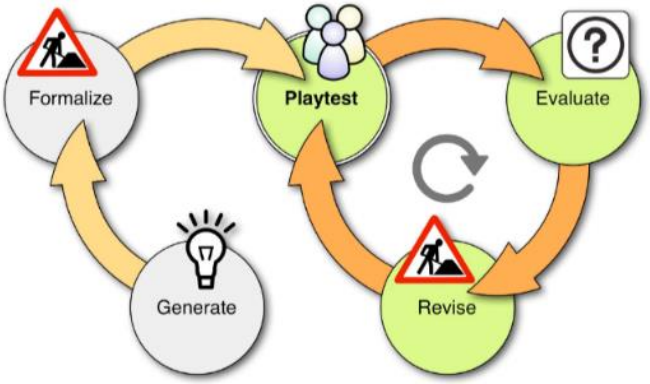
Upon Brooks, from the learning outcomes pedagogical perspective, the learning experiences should consider and enable several key-aspects: self-achievement, exploration, play, interest, curiosity, engagement, mastery, competence growth, and "aesthetic resonance" (that refers to a compatibility between the subject and what is proposed, supporting interactions such as instrumental exploration and surprise exploration).

The Smiley Model and other frameworks provide scaffolds for designing engaging learning experiences in games. In an investigation in 2016, Weitze reported that student game designers successfully integrated learning scenarios into digital games, fostering deeper levels of understanding. As a result, students encountered motivating learning experiences and enhanced social and collaborative learning processes within the classroom (Weitze, 2016).



Parameters in a motivational and engaging game for learning
(apud Weitze, 2016)

Lately, surpassing "classical" approaches such as ADDIE – analyse, design, develop, implement, evaluate – there have been imagined new ways of designing learning paths. Combining elements from instructional design and commercial game development, *iterative design methodologies* offer novel approaches to serious game development. Instead of relying on a predefined learning outcome and a pre-set instructional methodology to achieve it, following the game design model, the iterative didactic design starts from a playable prototype that can be tested immediately (playtest) and then the result can influence any part of the game, leading to a gamified learning path that can deviate substantially from the original game concept.



Iterative design model
(Wagner & Wernbacher, 2020, p. 3, https://osf.io/preprints/osf/jqd64)

In any case, according to Wagner & Wernbacher (2020), in order to get an efficient learning situation, learner's autonomy should supported, the learning progress should be mapped by (knowledge/ skills) points, the activities should be authentic/ realistic, the learning goals should be as closely connected to the game objectives as possible.

The same authors come with some interesting additional observations:

- Teachers play an essential role in the effectiveness of digital game-based education, as they manage the learning process and ensure all students achieve the desired learning outcomes.
- Teachers do not need to be gamers themselves to effectively use digital games in the classroom.
- Students who regularly play digital games in their free time tend to benefit more from digital game-based education compared to those who do not have much experience with games (Wagner & Wernbacher, 2020).

Learning should be an enjoyable and rewarding experience for students, fostering their curiosity, playfulness, and active participation with peers and teachers. To create such engaging learning activities, teachers require availability, openness, student knowledge, pedagogical tools, creativity, and significant effort.

In today's digital age, a wealth of instructional resources is readily available online, offering a diverse array of activity ideas, learning platforms, and information in various formats (text, image, audio, video) across disciplines and educational levels. Research has demonstrated the benefits of utilizing digital resources in enhancing student motivation, attention, understanding, and the relevance of learning content (Istrate, 2010).

However, it is crucial to recognize the value of traditional activities for specific learning outcomes and content units. While digital resources offer numerous advantages, a balanced approach that incorporates both conventional and innovative methods is essential for effective teaching and learning.

Creating effective educational experiences is a challenging task, no matter if they incorporate digital technologies or not. Designing high-quality educational situations requires an even greater effort that merges elements of traditional pedagogy with those that promote active participation, often through play, to engage all students (or each individual student). An explanatory model for the various instructional design elements emphasizes the connection between the "learning" and "fun"

aspects (Quinn, 2005), thereby providing a valuable framework for developing participatory educational activities in a playful manner.

Aspects of participatory and engaging instructional design (Adapted from: Quinn, 2005, pp. 54-63)

Learning conditions	**Conditions for attractive and engaging activity**	**Synergy, implications, explanations**
Contextualisation	Thematic coherence	1. **Theme**: Participatory activity must have a context, a theme, a "story" – it is possible to use characters and situations known to all students, eg Wild West, dinosaur age, NASA, trip on the Moon, group expedition, celebrities in music, politics, science etc. Even the feedback needs to be grafted on the chosen topic, as a dialogue, appreciation or advice in that context.
Precise objectives	Precise purpose	2. **Purpose**: The goal must be clear and made known from the beginning, so that the student can make informed choices throughout the course. It is the motivation for action and gives the measure of progress. Ideally, the goal should be naturally integrated into the context/ theme of the activity.
Adequate challenge	Ballanced challenge	3. **Challenge**: An engaging experience must have a proper challenge against student's age or interest horizon, appropriate to the level of knowledge in the field – it must suit his/ her zone of proximal development. It should also result in a succession of balanced and weighted tasks as level of difficulty (from simple, beginner levels, to complex, advanced levels) to adequately accompany student's progress.
Anchored in the study subject	Relevance of action for the domain	4. **Link between action and subject-matter content**: Situations of the activity scenarios should require application of knowledge and exercise of the capacities targeted by the learning objectives.
Relevance	Relevance of the problem for the learner	5. **Connection between the proposed problem/ situation and the learner**: Another criterion for the choice of the theme is the connection with the interests of the student (or of the class group) – he/ she can react better to certain emotional and motivational factors, to certain cognitive approaches, to competitive or collaborative tasks etc. In addition, if you know his/her problem-solving style, what preconceived prejudices or ideas he/she has, you can better design your activity' tasks, or you can detect along the way the source of potential mistakes.
Open/ free characteristic. Possibilities for exploring further	Choices of the course of the action	6. **Activism**: An effective learning activity offers possibilities of (cognitive) interaction with the content of learning and of construction of own understanding based on this interaction. The student must be active in making decisions, and the scenario must contain enough ramifications to keep him engaged in activity.

Learning conditions	Conditions for attractive and engaging activity	Synergy, implications, explanations
Active handling	Direct handing	7. **Direct interaction**: It is preferable that the student is able to act (physically) on the representations of learning contents. In a conventional situation, for example, it is better to provide cards with descriptions of options than to be presented orally. Clicking, scrolling a list, pressing a key, turning an explanation card, starting a simulation and stopping it when needed – these are as well elements of the unmediated interaction.
Appropriate feedback	Association	8. **Feedback**: Any decision has a consequence with a certain significance for the learning path. The consequences of the choices must be presented, preferably embedded in the play/ activity scenario, on that choice branch, until a new decision is being made, so that the student builds his/ her own understanding on the undertaken sequence. "The story" takes priority – the student does not have to be "pulled out" from the scenario, because the activity would lose its immersive, engaging attribute – a character (verbal feedback) or a situation in the same thematic context has to provide feedback. In complex scenarios, feedback can occur later, after the student has made other related decisions that converge to a consequence.
Gaining attention	New information and events	9. **Affect**: Each sequence of the scenario must be unpredictable to the greatest extent possible. From time to time, the choices can be made ”by chance” by the learner, the information available for decisions not being complete or sufficiently structured – therefore the learning path becomes more interesting, dramatic, de-stressed and at the same time providing chances to all students to achieve the didactic goal at the same time. In addition, especially with respect to digital materials, special attention is needed to visual and auditory elements of context: colours used, fonts, addressing mode, sound effects must not be distractors, but must be in tune with the chosen theme and scenario, to strengthen the message and to contribute to the feeling of realism.

These ludic learning designs blur the boundaries between learning and play, reflecting new communicative conditions and learner roles (S. Selander, 2008). It is true that the new technologies provide the opportunity to create a participatory and engaging learning experience by developing and utilizing various interactive resources within a learning environment. The models presented offers valuable insights into the essential elements of effectively designing a learning pathway supported by the digital media. Equally important, it indicates what an online or hybrid learning scenario should avoid. Many constraints and conditions that apply to "conventional" face-to-face teaching and learning activities are enhanced in the realm of computer-assisted education.

3.3. Accessibility and inclusion: Universal design for learning

Originating from neurocognitive science, the concept of "universal design for learning" (UDL) has gradually gained traction in the field of education. Recognizing the unique nature of each student, instead of imposing a one-size-fits-all solution for the entire class, we should offer a variety of learning experiences tailored to individual needs, thereby maximizing the potential for progress (Istrate, 2018).

The purpose of the universal design is to design a learning activity in order to:

- provide multiple ways of **representing** the content, mainly referring to the multiplication of the formats in which information is accessible (visual, auditory, kinesthetic), but also to the degree of difficulty, logical succession or complexity, giving the student the opportunity to choose the way of presentation or the route that suits it more to decode the message;
- provide multiple modes of **action and expression**: various types of student interaction with the content of learning and alternative possibilities to demonstrate that he/ she has learned;
- provide multiple ways of **participation**, in order to motivate, support their interest and engage as many students as possible – through interactivity, relevance of proposed scenarios, real life connections, gamification, dynamism.

The universal design approach encourages educators to thoughtfully consider learning activities that genuinely support students in a particular class to engage with and master the instructional content being presented:

- always prepare a visual support (cardboard, cards or digital media) for the presentations we do;
- integrate, as much as possible, short relevant videos, digital quizzes, interactive lesson sequences, collaborative exercises etc. – both in what we call 'teaching activity' and in learning and assessment activities;
- vary the teaching strategy and change the approach we use the most often, by conducting more lessons on the inductive strategy, in the lab or in the real-world settings, dividing students into various types of groups etc.
- assess the student not only in "conventional" situations and at the end – by accounting the way he/she works, by appraising various products of the activities (whether digital/ online), changing the format of the test, taking into account the assessments of his colleagues or the significance of his contribution in a working group etc.
- always keep in mind students' motivation and engagement – if we manage to make them participate voluntarily, we have designed and developed a good educational activity.

Computer-assisted learning aligns well with universal design principles, as this concept has been largely influenced and driven by the educational possibilities offered by emerging technologies. We've moved past the era of limited teaching resources and rigid curricula. Today, educators have access to a wide array of complementary tools, including online applications, educational software, digital resources across various disciplines, and virtual learning platforms. These can be readily incorporated into the classroom, allowing teachers to provide students with options that best suit

their individual levels, abilities, and aspirations. This approach enables a more personalized and inclusive learning experience, in line with the core tenets of universal design in education.

4. The new digital pedagogy, a field of opportunities and challenges

The ”new” technologies will become, over time, part of the conditions in which learning takes place in and out of educational institution, surpassing the stage of being novel, surprising and attractive in itself, taking its place of a natural support that favours learning. For the time being, it seems that digital tools and resources contribute to revitalizing the education science and to anchoring it in teaching practice. In instructional design, teachers have to make more often connections with the pedagogical repertoire, due to the fact that, in order to motivate and engage, they integrate into the educational situation a number of elements such as films, educational software, visual media (multimedia) for presentations they hold, virtual labs, virtual visits to museums etc. (Noveanu & Istrate, 2005). These must be placed in a (new) pedagogical approach: they must be meaningful in the perspective of the precise role that justifies their use in a particular moment of the lesson, they must be subsumed to a strategy (which they often determine), they must contribute to improving the learning outcomes of the study discipline.

In essence, it is about the pedagogical foundation of the didactic approach, with or without new technologies. An engaging, attractive, motivating learning activity is an activity that has been, above all, well designed. Even more today, in the front of the "native digital" students, a good design of educational situations is an essential condition for a better implementation and development of learning activities, resulting in a wider participation of students to activities and in better academic performance. The conceptual platform offered by the "universal design for learning" and the inspiration from the "mechanisms" and routes proposed by the digital applications or games are strengths, prerequisites and (already) certainties of a substantive transformation of the education process (Istrate, 2018).

4.1. Digital pedagogy – definition and conceptual area

The investigation into digital pedagogy should be viewed as an extension of traditional pedagogical approaches, encompassing both the scientific and artistic aspects of education. Experience has demonstrated that the efficacy of digitally-enhanced educational scenarios is largely context-dependent. Such scenarios tend to be most successful when they are built upon a solid foundation of instructional design, incorporated into a blended or hybrid learning framework, and utilize a combination of digital and non-digital resources and tools. This holistic approach recognizes that digital elements alone do not guarantee educational effectiveness, but rather their thoughtful integration within a broader pedagogical strategy is key to maximizing their potential benefits.

Digital pedagogy fundamentally concerns itself with the core elements of education, including its guiding principles, legal frameworks, defining characteristics, and inherent limitations. What sets this field apart is its focus on the unique contributions that digital technologies make to the learning

process. This encompasses how digital tools influence teaching methodologies, assessment techniques, educational content, and the overall learning environment. Of particular interest is how these digital elements enhance the effectiveness of educational practices.

Definition

Digital pedagogy is the part of pedagogy that studies the design, implementation and evaluation of educational situations comprising a significant component of digital technologies, as well as the necessary conditions for their implementation – synchronous and asynchronous interactions in virtual and mixed learning environments, learning management platforms and tools, digital educational resources, educational usage of various digital applications and tools, virtual assistants for learning and teaching, digital competences of teachers, educational policies and specific programs. (Istrate, 2022)

(Source: https://digital-pedagogy.eu/digital-pedagogy-definition-and-conceptual-area/)

The true essence of digital pedagogy emerges when we encounter educational experiences that are fundamentally transformed by digital technologies. These are instances where the learning objectives or instructional strategies would be fundamentally altered if one attempted to replicate them in a traditional, non-digital setting. In such cases, we witness innovations that are exclusive to the realm of digital pedagogy, showcasing the field's unique potential to reshape educational paradigms.

It's crucial to understand, however, that digital pedagogy does not represent an entirely new educational science. Rather, it should be viewed as an integral component of the broader field of pedagogy, seamlessly integrated into the larger system of educational sciences. This perspective allows us to leverage the strengths of established pedagogical theories while exploring the novel possibilities offered by digital tools and environments.

The integration of digital elements into education requires careful consideration of how they interact with traditional pedagogical approaches. For instance, the use of interactive simulations in science education might allow for experiences that are impossible in a physical laboratory, thereby enhancing students' understanding of complex phenomena. Similarly, collaborative online platforms can facilitate peer-to-peer learning and global connections in ways that were previously unattainable.

As we continue to explore the potential of digital pedagogy, it's important to maintain a critical perspective. Not all digital interventions will necessarily lead to improved learning outcomes. The effectiveness of digital tools and strategies often depends on factors such as the specific learning context, the needs of individual learners, and the expertise of educators in leveraging these technologies. Therefore, ongoing research and evaluation are essential to refine our understanding of best practices in digital pedagogy.

Ultimately, the goal of digital pedagogy is not to replace traditional educational methods, but to enhance and expand them. By thoughtfully integrating digital technologies into our educational practices, we can create more engaging, personalized, and effective learning experiences that prepare students for an increasingly digital world. As this field continues to evolve, it will undoubtedly play a crucial role in shaping the future of education.

The process of envisioning and developing educational applications for emerging media technologies serves as a fertile ground for innovation within the broader landscape of educational sciences. This creative endeavour stimulates new ideas and approaches that can potentially reshape our understanding of teaching and learning.

However, to fully grasp the complexities of integrating digital technologies into education, we must ground our exploration firmly within the domain of pedagogy. This approach allows us to examine both the established truths and emerging hypotheses with the necessary rigor. By anchoring our investigations in the well-established principles of traditional pedagogy, we create a solid foundation from which to explore new possibilities. Simultaneously, we must remain open to the evolving concepts of open pedagogy, which emphasize **collaboration, sharing, and learner empowerment**. This perspective encourages us to consider how digital tools can foster more inclusive and accessible educational experiences.

Furthermore, our exploration should be forward-looking, taking into account the proposals put forth by **innovative pedagogies**. These cutting-edge approaches often challenge conventional wisdom and push the boundaries of what's possible in education.

By synthesizing these various pedagogical perspectives – traditional, open, and innovative – we can more effectively navigate the intricate interplay between digital technologies and education. This holistic approach enables us to uncover the subtle nuances and complexities that arise at this intersection, leading to more informed and effective educational practices in the digital age.

4.2. Innovative pedagogies

Innovative pedagogies refer to novel, forward-thinking approaches to teaching and learning that challenge traditional educational paradigms (Peterson et al., 2018). These methodologies often leverage modern technologies, incorporate interdisciplinary perspectives, and prioritize student-centred learning experiences (Paniagua & Istance, 2018). They are based on the contemporary perspectives on what the human being is and should be, taking into account well-being, relations with the environment, cognitive, social and emotional aspects - in the classroom and beyond. At their core, innovative pedagogies aim to cultivate critical thinking, creativity, and adaptability in learners, preparing them for the complexities of a rapidly evolving global landscape.

The role of innovative pedagogies in education is multifaceted and profound. They serve as catalysts for transforming the learning environment from a passive, lecture-based model to an active, engaging, open, and collaborative space. By emphasizing experiential learning, problem-solving, and real-world applications, these approaches bridge the gap between theoretical knowledge and practical skills. Moreover, innovative pedagogies often integrate emerging technologies, such as artificial intelligence, virtual reality, and data analytics, to personalize learning experiences and provide immediate feedback, thereby enhancing the efficiency and effectiveness of the educational process.

The benefits of implementing innovative pedagogies are numerous and far-reaching. Firstly, they foster increased student engagement and motivation by making learning more relevant, interactive, and enjoyable. This heightened engagement often leads to improved retention of information and

deeper understanding of complex concepts. Secondly, innovative pedagogies promote the development of crucial 21st-century skills, including digital literacy, critical thinking, collaboration, and adaptability. These skills are increasingly valued in the modern workforce and are essential for navigating the challenges of a rapidly changing world. Lastly, by encouraging creativity and independent thinking, innovative pedagogies help cultivate a lifelong love of learning, empowering students to become self-directed learners capable of adapting to new knowledge and technologies throughout their lives. Overall, these pedagogies aim to make learning more engaging, relevant, and impactful by connecting it to real-world issues, leveraging new technologies, promoting student agency, and providing more personalized and immersive experiences.

A group of scientists from The Open University developed a series of yearly reports, from 2012 to date, titled "*Innovative Pedagogies*" (Kukulska-Hulme et al.), in which they describe the most outstanding didactic innovations, with value for learning and for becoming, inspirational for teachers in the first place, but equally for educational managers and policy makers. The reports highlight several emerging pedagogical approaches that leverage technology and new ways of thinking about learning. For example, *hybrid models* combine face-to-face and online learning in flexible ways, allowing students to participate through multiple modes. *Dual learning scenarios* connect classroom learning with workplace experiences, using technologies like virtual and augmented reality to bridge these environments. *Microcredentials* offer short, focused learning experiences to develop specific skills, often related to career advancement. *The pedagogy of autonomy* aims to develop students' capacity for self-directed learning. Several approaches specifically leverage artificial intelligence, including *conversational AI tutors, AI-enhanced multimodal writing*, and *intelligent adaptive textbooks*.

Other innovative approaches focus on addressing key societal challenges. *Climate action pedagogy* integrates environmental topics across the curriculum and empowers students to take action on climate issues. *Pedagogies of peace* promote conflict resolution and global citizenship. *Speculative worlds* use fiction, games and technology design to imagine more equitable futures, especially for marginalized groups.

The reports also discuss ways to make learning more immersive and experiential, such as through extended reality simulations, video game-based language learning, and embodied explorations of scientific models.

The analysis of the reports from the period 2019-2024 reveals that the general trend regarding the educational process increasingly incorporates innovations that are based on digital technologies or are "determined" by them, not being possible 10-20 years ago. We synthetically take over some of these pedagogical proposals, with the conviction that they can constitute a basis for reflection for teachers and a starting point in developing their own pedagogical approaches that work effectively in particular contexts:

Learning with robots: *Helping teachers free their time for teaching (2019)*

Dialogic learning forms a cornerstone of effective education, with adept educators regularly engaging their students in meaningful discourse. While these interactions are time-intensive, the advent of intelligent software assistants and robots is reshaping the landscape of what can be accomplished in educational settings. These technological aids offer unprecedented opportunities to enhance the learning experience.

One notable application of these AI-powered tools is their ability to serve as ever-present conversational partners for learners, facilitating deeper understanding through continuous dialogue.

Additionally, these systems can alleviate the burden on teachers by swiftly addressing common inquiries and assisting with assessment tasks. This reallocation of responsibilities allows educators to focus their efforts on uniquely human aspects of teaching, such as exercising nuanced judgment and providing emotional support to students.

The potential of these technologies extends beyond mere assistance, as robots are now developing the capacity to learn through interactive exchanges with human tutors. As their ability to comprehend human communication improves, this approach could revolutionize skill-based assessments. The integration of such advanced AI systems in education not only augments the learning process but also paves the way for more personalized and efficient educational experiences, ultimately transforming the roles of both learners and educators in the digital age.

Pedagogies using AI tools: *Using AI tools such as ChatGPT to support teaching and learning* (2023)

The sophisticated generative AI systems, capable of producing human-like text and images, are being rapidly integrated into various educational settings. They can function as personal tutors, collaboration facilitators, study aids, or exploratory tools, offering individualized support, enhancing group work, aiding comprehension, and enabling data exploration.

The impact of AI in education extends beyond generative tools, encompassing chatbots and artificial assistants that can enhance language learning, offer personalized guidance, and support cognitive processes. In this context, it becomes very important to train students in their effective and responsible use, and also to reconsider traditional assessment methods to accommodate the capabilities of these new technologies.

Using chatbots in learning: *Using educational dialogues to improve learning efficiency* (2021)

Chatbots are emerging as valuable tools in education, offering text or voice-based interfaces to interact with learners. They can answer questions, guide students, and assist with problem-solving, providing support when teachers are unavailable. Advanced chatbots utilize artificial intelligence to comprehend human language, voice, and behaviour, enabling more sophisticated interactions.

These digital assistants offer several advantages, including immediate problem diagnosis and personalized interventions. They can create immersive learning environments and initiate supportive conversations tailored to individual needs. Research suggests that learners may feel more comfortable expressing themselves to chatbots, free from fear of human judgment.

Chatbots are particularly promising in addressing the challenge of maintaining high-quality education at scale. By collecting data from interactions and learner behaviours, they can offer highly personalized support. This not only enhances the learning experience but may also help reduce educators' workloads, allowing them to focus on more complex aspects of teaching.

As chatbot technology continues to evolve, it has the potential to significantly transform educational support and personalization, complementing traditional teaching methods and expanding access to individualized learning assistance.

Learning in conversation with generative AI: *A dialogic, real-time method of learning* (2024)

Generative Artificial Intelligence (GenAI) tools, exemplified by ChatGPT, Claude or Gemini, have emerged as powerful facilitators of dialogic learning, emulating Socratic questioning techniques to provide real-time guidance and answers. These AI systems effectively serve as round-the-clock virtual tutors, offering immediate assistance with academic tasks.

The conversational capabilities of GenAI have significantly enhanced interactive learning experiences through immersive simulations and role-playing scenarios. These features prove particularly valuable in areas such as language acquisition, professional skill development, and critical thinking exercises. For instance, applications like Duolingo Roleplay leverage GenAI to create realistic language practice scenarios, while similar technologies can be employed to simulate job interviews or medical diagnostic processes, providing students with practical, hands-on learning experiences.

For educators, GenAI presents a powerful tool for creating educational resources through iterative prompting and critical evaluation. The integration of GenAI in education also brings forth challenges, including varying levels of student engagement and the need for AI literacy to foster productive dialogue and critical assessment of AI-generated responses, which may occasionally contain inaccuracies or biases. Furthermore, issues of unequal access to advanced GenAI models and privacy concerns must be addressed as these technologies continue to shape the landscape of learning and engagement, calling for ongoing evaluation and adaptation in educational practices.

AI-enhanced multimodal writing: *Extending multimodal authoring and developing critical reflection* (2024)

Enabling students to seamlessly integrate diverse forms of expression like images, videos, voice-overs, and music alongside traditional text is more and more affordable, as AI tools are constantly evolving. The AI-enhanced multimodal writing is an approach that sparked new ways of thinking and planning for educators, who are exploring its potential through innovative projects such as environmental advocacy campaigns. Students are using AI to reinterpret stories or create original artworks, iteratively refining their prompts to achieve desired results. This process encourages deeper engagement with the subject matter and promotes a more nuanced understanding of how to communicate ideas across different media. Thus, the use of AI in multimodal writing is fostering critical thinking and creativity in the classroom.

However, educators must grapple with issues of equitable access to AI tools, ethical concerns surrounding algorithmic biases, and potential copyright infringements. This shift is prompting educators to place greater emphasis on reflective practices and ethical considerations when integrating AI into their curricula.

Intelligent textbooks: *Making reading engaging, 'smart' and comprehensive* (2024)

Intelligent textbooks promise to reshape education by offering more effective, personalized learning experiences, using AI to adapt content in real-time based on reader behaviour. These digital tools offer interactive features like automated question answering and adaptive content delivery, providing tailored learning paths and immediate feedback. Benefits include optimised comprehension and engagement, improved learning efficiency and student satisfaction, especially in fields like computer science, where interactive elements enhance understanding. Intelligent textbooks represent a transformative approach to education, potentially facilitating lifelong learning for diverse learners worldwide.

Multimodal pedagogy: *Enhancing learning by diversifying communication and representation* (2023)

This method has gained traction in response to social and technological shifts that have challenged the traditional dominance of text-based educational practices. The approach aims to provide students with opportunities to learn and demonstrate their learning through multiple modes, and to develop their knowledge and skills in multimodal literacy. The proposal is modelled on the current generous possibilities: a learning path should combine various formats (text, image, audio, video)

and various types of representations (e.g. schematic/ didactic versus real-life/ authentic materials). Where possible, a course based predominantly on verbal representation (oral/ written text) can have audio/ audio-video alternatives, so that the student can choose the one that suits them better. Furthermore, students develop a deeper understanding how the combination of different modes of communication like words, images, sounds, and gestures creates new meaning, and how the medium itself influences the distribution and interpretation of these modes.

By adopting multimodal pedagogy, educators can better prepare students for diverse workplace communication demands and foster alternative ways of understanding and expressing knowledge. This approach has shown promise in improving accessibility, inclusivity, student engagement, comprehension, and knowledge retention. Practical applications of multimodal pedagogy range from classroom activities that help students visualize complex three-dimensional structures to exercises involving acting out sound pathways and creating multimodal academic arguments. Multimodal pedagogy also involves the development of new assessment techniques to adequately assess multimodal learning outcomes.

Virtual studios: *Hubs of activity where learners develop creative processes together* (2019)

Virtual studios have evolved from a conceptual idea to a practical reality. They are digital environments used for creating and producing media content, primarily serving as interactive, experiential, constructive learning spaces in education. A studio is typically a hub of activity, with half-formed ideas and concepts articulated as sketches, models, and artefacts. Thus, it's crucial to recognize that virtual studios are not merely online replicas of physical spaces; they possess unique educational merits and open up novel opportunities for learning and collaboration. With the latest advancements in IA, the studio concept is undergoing a transformation, giving rise to diverse forms in educational settings.

Enriched realities: *Extending learning with augmented and virtual reality* (2021)

By providing dynamic, interactive learning environments, enriched reality technologies, particularly augmented reality (AR) and virtual reality (VR) are enhancing education and training methods, offering unique opportunities for experiential learning and skill development that were previously unattainable in traditional educational settings. The technology's accessibility has improved, with basic AR and VR experiences now possible using smartphones and reliable internet connections.

AR overlays information on real surroundings, while VR creates immersive 3D environments. These technologies enable shared experiences for remote learners, offering engaging and memorable learning opportunities beyond traditional classroom settings.

AR and VR find applications in various fields, including medical training, safety instruction, and teacher education. These enriched realities allow students to explore environments that would otherwise be inaccessible, dangerous, or impossible to visit, such as Mars or the interior of chemical substance. They facilitate interactive group work, enabling students to manipulate virtual objects and navigate settings collaboratively. This engagement aids in concept understanding, skill practice, and task performance.

Metaverse for education: *Educational opportunities through fully immersive 3D environments* (2023)

The Metaverse is an emerging concept that envisions a three-dimensional virtual reality iteration of the internet, enabling users to interact with one another through digital avatars. This immersive digital realm comprises interconnected 3D environments, such as digital campuses for learning

experiences or science labs for virtual experiments, typically accessed via virtual reality (VR) headsets, where users can gather to collaborate and engage in various permitted activities.

Exploring scientific models from the inside: *Rich embodied experiences supported by extended reality and AI* (2024)

Embodied learning integrates physical movement and environmental interaction into education, expanding students' learning resources. Extended reality (XR) technologies create immersive environments where students interact with digital representations of scientific phenomena, allowing hands-on exploration of complex models. Artificial Intelligence enhances this approach by analysing multimodal data from these interactions, providing insights into student engagement and learning processes. This combination enables teachers to offer personalized feedback and guide reflective discussions, deepening students' conceptual understanding.

Embodied learning through XR and AI creates rich, interactive environments that make abstract concepts tangible and engaging, bridging theory and practice, significantly enhancing comprehension of complex sciences.

Assessments through extended reality: *Harnessing immersion to demonstrate and develop skills* (2024)

Simulation-based learning is gaining traction as an assessment tool, offering learners the opportunity to engage with realistic scenarios and experience the immediate consequences of their decisions. Extended reality (XR) technologies, including virtual reality (VR) and augmented reality (AR), are at the forefront of this trend, providing immersive environments for evaluating and developing practical skills. These technologies create a powerful sense of presence and agency, allowing for authentic assessment of complex procedural knowledge without real-world risks or logistical limitations.

Skills assessment through XR is embraced by various industries, from healthcare to vocational training. For instance, virtual environments are being used to evaluate hazard recognition in construction or customer service skills in hospitality. Effective XR assessment design incorporates multiple data sources, begins with low-stakes activities to acclimate learners, and ensures alignment with learning outcomes.

XR assessments offer significant advantages over traditional methods, providing detailed analytics and fostering reflective learning experiences, offering deeper insights into learner performance and facilitating more comprehensive skill development.

Speculative worlds: *Imagining and designing for a more equitable future* (2024)

By employing techniques like world-building in speculative fiction and collaborative technology design, these pedagogies offer to students, and particularly to marginalized individuals, innovative pathways to engage, to reshape their worlds, and to explore alternative realities. The approach recognize that marginalized communities face significant barriers to education, which are often compounded by factors such as poor health, social exclusion, and lack of resources.

At the heart of speculative pedagogies is the idea that individuals can experiment with actions and personas beyond their everyday experiences, transcending limitations of time, space, and perspective. Technologies such as artificial intelligence and virtual/augmented reality play a crucial role in facilitating these creative processes, enabling the integration of marginalized communities' cultural backgrounds into new virtual spaces and fostering a sense of belonging.

While speculative pedagogies offer promising ways for marginalized individuals to envision equitable futures, express their identities, and explore their societal roles, implementation faces several challenges. These include digital exclusion, socioeconomic barriers, and potential biases in AI models.

Seeing yourself in the curriculum: *Pedagogies enabling students to see themselves in the curriculum* (2023)

There is a growing movement among students to see themselves, their histories, and their backgrounds represented in educational curricula, materials, and approaches. This push for representation is closely tied to the decolonial movement, which aims to address the ongoing impacts of colonialism on societies worldwide. A key goal of this movement is to transform education systems to better reflect the diverse cultures, experiences, and histories of all students.

The ”decolonial approach” in education involves a process of unlearning biases and ideas rooted in colonial history, while simultaneously incorporating knowledge from authentic local contexts. This includes integrating previously marginalized indigenous knowledge and philosophies into educational frameworks. Indigenous pedagogies embed local stories, perspectives, and knowledge into core teaching and learning practices.

In digital learning environments, various means can be used to apply this educational principle – creating avatars that embody the models/ aspirations of the main segments of the platform's audience (clothing, attitude/ behaviour, language/ manner of addressing), establishing rewards from the familiar horizon and which have meaning (similar to those in real life and/or in the games most frequented by the training participants of the respective age/ from a certain environment), and so on.

The content of learning is closer to what learners are, know, do, can do, want. Furthermore, these developments signify a call for fundamental changes in how educational institutions operate. They represent a concerted effort to address long-standing power imbalances within education systems, challenging traditional structures and methodologies to create more equitable and representative learning environments for all students.

Making thinking visible: *Opening windows into student learning* (2019)

Making thinking visible is a powerful approach to enhance learning effectiveness. It encourages students to externalize their thought processes through goal-setting, problem-solving steps, and annotations. This practice aligns with the constructivist view of learning, where students actively create knowledge through interactions with tools and resources. Technology-enhanced assessment systems further support this approach by prompting students to show their work, receive automated feedback, and engage in discussions with teachers and peers during learning activities.

By making thinking visible, teachers gain valuable insights into students' conceptual understanding, progress, and potential areas of misunderstanding. This transparency allows for more targeted instruction and support. The visible records of students' personal and social learning also serve as resources for reflection, enabling both students and teachers to track progress towards mastery of a topic. Ultimately, this approach fosters a more interactive, reflective, and personalized learning experience, benefiting both students and educators.

Corpus-based pedagogy: *Using authentic language data to support (language) teaching and learning* (2021)

In recent years, corpus-based pedagogy has gained traction due to advancements in computer science that facilitate information extraction from more and more accessible, diverse, and adaptable corpora, such as examining how specific words are employed. In this approach, a large base of specialized resources (text and/or other media) are used by students in educational situations to obtain authentic data and to design and adjust real-life instructions/ tasks.

Students can independently access online corpora or do so with guidance from their instructors. They can analyse their own language use by comparing their linguistic choices with patterns and structures found in a corpus. This process of retrieving and analysing language use in context provides learners with a research-based understanding of language forms and functions.

The corpus-based approach has wide-ranging applications, including learning languages for various scientific domain-related purposes, teaching text analysis, supporting genre-specific writing, and evaluating existing textbooks to identify their characteristics and suggest improvements.

Pedagogy of care in digitally mediated settings: *Prioritising the well-being and development of students* (2023)

The pedagogy of care is an educational philosophy that emphasizes empathy and the development of learners in a nurturing, supportive, and equitable learning environment, thus contributing to students' self-esteem, well-being, and engagement. It's a holistic perspective on education that balances academic achievement with the development of empathetic, well-rounded individuals.

This approach encompasses four key elements: modelling, dialogue, practice, and confirmation. In digitally mediated settings, educators can implement a pedagogy of care through practical measures aimed at creating a welcoming atmosphere, empathizing with students, and addressing their needs effectively. Complementarily, in conventional/ F2F educational settings, teachers can use digital resources and tools to adjust the learning climate and to provide sustained, high-quality care for their students. However, educators adopting a pedagogy of care may face personal challenges, including exhaustion and burnout. This highlights the necessity of incorporating self-care practices for educators and other learning support professionals.

Pedagogies of the home: *Understanding the home as a place for cultural learning* (2022)

The Covid-19 pandemic has highlighted the significance of the home as a learning environment and its broader educational and cultural relevance. 'Pedagogies of the home' is a concept distinct from traditional homeschooling, focusing on the informal teaching and learning practices that naturally occur within domestic settings, as well as culturally specific learning methods often rooted in local communities.

With this understanding, educators should be more able to select culturally relevant materials for students, as well as to influence or to choose their learning proposals (e.g. for homework or for individual/ independent learning tasks), more or less close to students' habits and preferences. Thus, home pedagogies can also serve as a powerful tool to challenge educational norms, including prevailing perceptions about certain student groups' dropout rates or the impact of historical segregation and cultural deprivation on academic achievement.

As the boundaries between formal and informal learning continue to blur, particularly in the wake of global events like the pandemic, the concept of home pedagogies offers a fresh perspective on education. It encourages a more holistic view of learning that extends beyond traditional classroom settings and recognizes the rich, diverse experiences students bring from their home environments.

Challenge-based learning: *Rising to challenges to benefit individuals and societies* (2023)

Challenge-based learning (CBL) is an educational approach that engages learners through structured challenges, comprising three stages: engage, investigate, and act. It promotes active participation and real-world problem-solving, incorporating authentic use of technology, documenting, storytelling, and community involvement. While similar to project-based and problem-based learning, CBL has unique features that can make learning exciting and potentially impactful on society. However, it presents challenges in implementation, including time management, unpredictable outcomes, and assessment complexities. Adopting CBL may require additional resources, such as adequate staff, technical support, and collaborative spaces, which can limit its widespread application. Simplified versions of CBL can be employed by making use of (existing) digital educational resources such as escape rooms.

Relational pedagogies: *Working relationally in and across disciplinary and professional boundaries* (2023)

Inspired from the current professional settings, in which (relational) work involves communication that builds connections across diverse entities, including humans, materials, artefacts, technologies and the natural habitat, the relational pedagogies emphasize the importance of relationships in education, viewing them as essential for effective learning, teaching, and professional collaboration. Relational expertise is the ability to recognize and engage with others' knowledge while confidently applying one's own competences. This expertise is crucial in rapidly evolving fields addressing global challenges. Ultimately, relational pedagogies develop versatile capacities for relational work applicable in various contexts.

Entangled pedagogies of learning spaces: *Connecting technology, pedagogy and all elements of a learning context* (2023)

Entangled pedagogies acknowledge the complex interplay between technology, pedagogy, and learning environments, moving beyond the debate of which drives the other, focusing rather on understanding their mutual influence and interconnectedness. The concept of orchestration is key, where educators strategically integrate tools and design activities to guide learning effectively. In hybrid flexible settings (hyflex), entangled pedagogies promote collaboration across diverse learning spaces, requiring meticulous planning to address multiple contexts. The use of AI tools exemplifies this entanglement, raising ethical and critical evaluation concerns. By embracing this approach, educators are encouraged to consider the purposes and contexts of learning, recognizing how they are shaped by the intricate relationship between learning spaces, pedagogical approaches, and technological tools.

Watch parties: *Watching videos together, whatever the time or place* (2022)

Watch parties are a collaborative online learning method where participants from diverse locations collectively engage with video content that can be recorded or live (broadcasted). These events can include pre-, during, and post-viewing activities such as group discussions or learning tasks. Research indicates that watch parties can foster greater social engagement than traditional face-to-face teaching. They are versatile, used across various educational settings from formal schooling to professional development, and can be organized informally or integrated into formal curricula. Watch parties utilize various social platforms, with many online service and media providers now offering features to support this learning approach. This method effectively combines the convenience of remote learning with the benefits of social interaction, creating a dynamic and engaging educational experience for participants worldwide.

Influencer-led education: *Learning from education influencers on social media platforms* (2022)

Edu-influencers are emerging as a new phenomenon in education, adapting the social media influencer model to learning contexts. These online personalities use engaging, multi-sensory content to attract large followings outside traditional educational institutions. They're reshaping how learners choose educational content and providers, blurring lines between entertainment and learning. While edu-influencers offer free, accessible content, concerns exist about potential misinformation and exploitation of followers. Social media platforms' motivations in promoting certain content may not align with educational best interests. Despite these concerns, educators are exploring ways to leverage influencers' popularity and practices to enhance formal online education and increase accessibility.

This trend reflects a shift in how information is disseminated and consumed in the digital age, challenging traditional educational models while offering new opportunities for engagement and learning. As a handy first step, short filmed sequences with well-known personalities can be used to capture attention or as a starting point/pretext for an educational situation.

Massive open social learning: *Free online courses based on social learning* (2014)

Massive open social learning integrates social networking principles into massive open online courses (MOOCs), enhancing the value of the learning experience as more participants engage, fostering collaborative discussions and shared projects that build upon collective knowledge and experiences. If well chosen, learning pathways appropriately complement the formal curriculum, providing students with opportunities to diversify their sources of knowledge and approaches to learning.

The transient nature of online interactions poses a challenge, as learners often connect briefly and solely through digital means. To address this, several strategies have been proposed. These include connecting conversations directly to learning materials, forming ephemeral discussion groups among simultaneously online learners, and implementing peer review systems for assignments. Additionally, techniques borrowed from social media and gaming are being employed to strengthen learner connections and engagement. These methods include allowing learners to follow one another, implementing rating systems for discussion contributions, and introducing competitive elements through quizzes and learning challenges.

By incorporating these various approaches, massive open social learning seeks to create a dynamic, interconnected learning environment that capitalizes on the collective power of its participants, despite the constraints of online interaction.

Hybrid models: *Maximising learning flexibility and opportunities* (2022)

The hybrid approach blends face-to-face sessions with online learning, creating a single coherent educational experience. After the pandemics, new hybrid models are emerging, offering students the flexibility to alternate between in-person and online participation, both synchronously and asynchronously. The ”open hybrid” model emphasizes individual lifelong learning for career development, while ”flexible hybrid” models expand engagement options within institutional settings. Flexible hybrid teaching requires specific infrastructure to ensure equitable participation for both in-person and online students. While technology is crucial, pedagogical considerations are equally important, focusing on engaging students through active learning and participation. These models aim to create a dynamic learning environment that accommodates diverse student needs

and preferences, balancing the benefits of traditional classroom interactions with the accessibility and flexibility of online learning.

Dual learning scenarios: Connecting learning in classrooms and industry workplaces (2022)

Dual learning aims to synchronize classroom education with professional practices, bridging the gap between theory and workplace reality. The shift to remote work and learning during the Covid-19 pandemic has further emphasized the need for this alignment. Industry partners have critiqued traditional classroom teaching for its lack of relevance to real-world practices. To address this, educators must stay current with industry processes and technologies, while industry partners should contribute practical activities and support structures for educational institutions. A more collaborative approach to curriculum development, involving both academic and industry stakeholders, is crucial. This integration allows dual learning scenarios to offer students valuable insights into future workplace challenges and provides industry with better-prepared graduates. By fostering this close partnership between education and industry, dual learning creates a more seamless transition from academic study to professional practice, ultimately benefiting both students and employers. In certain circumstances, under the (remote) supervision of an industry professional, simulations and AR/VR can take the place of professional contexts where the theoretical course finds a practical expression.

Pedagogies of microcredentials: *Accredited short courses to develop workplace skills* (2022)

This approach envisages optional, focused, small learning tracks complement the core curriculum, for added relevance, timeliness, practical skills or a broader perspective, added to a qualification or graduates' skills profile. Microcredentials cater to diverse learners, including working professionals and those with other responsibilities. Due to their varied nature, microcredentials employ a range of pedagogical approaches, such as ePortfolios, competency-based learning, and case studies. Typically offered online, these courses must consider the needs of learners new to digital education, incorporating skills like self-regulation and effective online learning strategies alongside the primary course content.

Pedagogy of autonomy: *Building capacity for freedom and independent learning* (2022)

Autonomous learning focuses on developing educational strategies, methods, techniques and resources that foster learner independence. The pedagogy of autonomy supports individuals to develop effective study habits and techniques for self-directed learning, and to craft their own learning paths, balancing mandatory requirements with personal learning goals and strategies.

Digital tools play a significant role in enhancing learner autonomy, providing resources for students to take greater control of their educational journey. Exposed to this approach, learners can become more self-reliant and proficient in navigating their educational experiences, preparing them for lifelong learning in an ever-changing world.

Best learning moments: *Positive mental states for enjoyable and effective learning* (2021)

One of the most prominent current pedagogical recommendations, suitable in the landscape of more and more digitalised education by (re)connecting to the socio-emotional component, is the creation of opportunities for "best learning moments", resulting in relevant, efficient, useful, long-term learning.

Rooted in the psychological concept of cognitive absorption or "flow," these moments occur when learners are deeply engaged in appropriately challenging tasks, leading to full concentration and enjoyment. Such experiences can result in deep, memorable learning and high satisfaction levels.

To create these moments, educators can tap into student interests, pose challenging questions, and acknowledge individual differences. Technology-enhanced environments, including mobile devices, game-based learning, and virtual labs, can facilitate these experiences. Learning analytics can further support reflection and improve instructional design.

These optimal learning situations also present opportunities for unplanned "teaching moments", where educators can introduce new perspectives or concepts when students are most receptive. By focusing on creating and leveraging these best learning moments, digital education can become more engaging, effective, and emotionally resonant for learners.

4.3. Artificial intelligence and curriculum changes

Students and teachers are increasingly using artificial intelligence (AI) systems, sometimes without realizing it. Search engines, smart assistants, chatbots, language translation tools, navigation apps, online video games, and many other applications use artificial intelligence in our daily lives. AI systems rely on data collected in various ways (eg sound, images, text, posts, clicks), which together form our digital footprints.

AI has great potential to improve education and training for students, teachers and HEIs administrators. Today, AI systems help some teachers identify specific learning needs, provide students with unique and personalized learning experiences, and help some higher education institutions make better decisions so that they can more effectively use the teaching resources they have dispose.

As AI systems continue to develop and the use of data increases, it is very important to better understand their impact on the world we live in, especially on education and training. Teachers and leaders need at least a basic understanding of the use of AI and data in order to interact positively, critically and ethically with this technology and exploit its full potential in an appropriate way.

4.3.1. About intelligence and artificial intelligence

Access to artificial intelligence programs is easy, many of them being free. In education, they have opened up a range of possibilities, among which the most immediate relate to helping teachers create teaching materials and supporting learners to study independently. The difficult part is sometimes to understand the significance of the output, to put it in the right context, to differentiate it from human creations, to use it for the right purposes; the key here is to grasp the essence of the AI tools – what they are and how they work, what are the ethical implications of using (or not using) the AI, how and why the AI is embedded into tools that we use every day.

Intelligence has different meanings, and with the emergent artificial intelligence, new nuances have been added, in a tendency to separate „human intelligence" and to find the specific notes that make a human "humane". In short, intelligence is defined as *the (mental) capacity to learn from experiences, to adapt to new situations, to understand and handle abstract concepts, and to use knowledge to manipulate one's environment*.

In a first instance, looking at each process and thinking of the (cognitive) products or outputs of both human and artificial intelligence, we may say there is no difference between human intelligence and artificial intelligence. However,

- Human intelligence is based on cognitive processes and biological structures, while artificial intelligence is based on algorithms and mathematical models.
- Human intelligence can learn from experience, intuition, and creativity, while artificial intelligence can learn from data and feedback loops.
- Artificial intelligence can process data and perform tasks much faster than humans, while human intelligence can adapt to new circumstances and handle complex ideas.

Human intelligence is the intellectual capability of humans, marked by complex cognitive features and high levels of motivation and self-awareness. The distinction is the baseline to explain why and how we should employ the AI tools in our professional and personal tasks, what to expect from AI, and how to properly interpret the outputs that we get for various queries. A very important competence, mentioned in European Union's Competence Framework for Citizens (DigComp 2.2) refers to the *awareness that what AI systems can do easily (e.g. identify patterns in huge amounts of data), humans are not able to do; while many things that humans can do easily (e.g. understand, decide what to do, and apply human values), AI systems are not able to do*.

Of course, there are much more differences between AI and HI, and some scientists proposed criteria such as origin, speed, decision making, accuracy, adaptation, energy used. The most often mentioned difference, however, is that AI lacks the creativity, intuition, adaptability, and emotional intelligence that humans display.

Human intelligence is traditionally measured through IQ tests which typically covers working memory, verbal comprehension, processing speed, and perceptual reasoning.

The definition of an Artificial Intelligence system (AI system) proposed in the draft European Union's AI Act (2021) is "*software that is developed with one or more of the techniques and approaches (listed below) and can, for a given set of human-defined objectives, generate outputs such as content, predictions, recommendations, or decisions influencing the environments it interacts with*".

The listed AI techniques and approaches are:

a) Machine learning approaches, including supervised, unsupervised and reinforcement learning, using a wide variety of methods including deep learning;

b) Logic and knowledge-based approaches, including knowledge representation, inductive (logic) programming, knowledge bases, inference and deductive engines, (symbolic) reasoning and expert systems;

c) Statistical approaches, Bayesian estimation, search and optimisation methods.

Another well-known definition is provided by UNICEF: „*AI refers to machine-based systems that can, given a set of human-defined objectives, make predictions, recommendations, or decisions that influence real or virtual environments. AI systems interact with us and act on our environment, either*

directly or indirectly. Often, they ap-pear to operate autonomously, and can adapt their behaviour by learning about the context." (UNICEF, 2021)

ANI and AGI

A fundamental piece of information regarding AI is the distinction between Artificial Narrow Intelligence, for example today's AI, capable of narrow tasks such as game playing, and Artificial General Intelligence, i.e. AI that surpasses human intelligence, which is still a hypothetical type of intelligent agent, remaining (for now) in the science fiction domain. Like humans, AGI would need self-awareness, consciousness, and the ability to learn and act through intuition and experience.

Artificial Narrow Intelligence (Narrow AI), also known as Weak AI, refers to a type of artificial intelligence that is goal-oriented, designed and trained for a specific, limited task or a narrow range of tasks. Unlike General Artificial Intelligence (AGI), which aims to replicate the broad cognitive abilities and adaptability of human intelligence, Narrow AI is specialized and focused on performing well-defined functions.

Key characteristics of Narrow AI are:

1. **Specialisation:** Narrow AI systems are created with a narrow focus, optimized for a specific task or domain. They excel at that particular task but lack the versatility to perform other unrelated tasks.
2. **Limited Context:** These AI systems typically operate within a predefined context and have limited understanding of the broader world. They do not possess common-sense reasoning abilities or the capacity to adapt to unfamiliar situations.
3. **Task-Specific Training:** Narrow AI systems are trained using large datasets and specific algorithms tailored to their designated task. They do not possess the ability to generalize their knowledge to new tasks.
4. **No Self-Awareness:** Narrow AI lacks consciousness, self-awareness, and the ability to think or reason beyond their programmed functions. They do not possess true understanding or intentionality.

Examples of Narrow AI applications include:

- **Virtual Personal Assistants:** Voice-activated virtual assistants like Apple's Siri or Amazon's Alexa are designed to answer questions, set reminders, and perform tasks within a limited scope.
- **Recommendation Systems:** Platforms like Netflix or Amazon use Narrow AI to analyse user preferences and recommend movies, products, or content based on past behaviour.
- **Image Recognition:** AI systems like those used in facial recognition technology can identify and categorize faces but do not possess general visual understanding.
- **Language Translation:** Tools like Google Translate provide accurate translations between languages, but they lack true language comprehension.

Narrow AI has proven to be highly valuable in automating specific tasks, improving efficiency, and enhancing user experiences in various industries. However, it is important to distinguish between

Narrow AI and AGI, as the latter represents a more ambitious and complex goal of creating AI systems with human-like general intelligence and adaptability across a wide range of tasks and contexts.

Artificial General Intelligence (GAI or AGI), also known as Strong AI or Full AI, refers to a form of artificial intelligence that possesses the ability to understand, learn, and apply knowledge across a wide range of tasks and domains in a manner that is indistinguishable from human intelligence. Unlike Narrow AI, which is designed for specific, predefined tasks, AGI aims to replicate the broad and adaptable cognitive abilities of human beings.

Key characteristics of General Artificial Intelligence include:

1. **Versatility:** AGI is not limited to a single task or domain. It can perform a wide variety of tasks, adapt to new situations, and learn from experiences in a manner similar to human learning.
2. **Common-Sense reasoning:** AGI systems have the capacity to understand and apply common-sense knowledge, allowing them to make reasoned decisions and navigate the complexities of everyday life effectively.
3. **Self-improvement:** AGI systems can improve their own capabilities over time through learning and self-assessment, leading to continuous self-improvement and increased proficiency in various tasks.
4. **Contextual understanding:** They can comprehend and respond to context, taking into account the nuances, subtleties, and ambiguities present in human communication and real-world situations.
5. **Autonomy:** AGI systems can operate independently, making decisions and taking actions without constant human intervention, although ethical and safety constraints would still apply.
6. **Transfer learning:** They have the ability to transfer knowledge and skills learned in one domain to another, just as humans can apply knowledge gained in one area to solve problems in different domains.
7. **Creativity and Innovation:** AGI is capable of creative problem-solving and generating novel ideas, contributing to innovation in various fields.

Developing AGI is a complex and ambitious goal in the field of artificial intelligence. While there has been significant progress in creating AI systems that excel in specific tasks, achieving true AGI remains a long-term aspiration. Researchers continue to work on developing the necessary technologies, algorithms, and methodologies to bring us closer to the realization of General Artificial Intelligence.

The successful development of AGI would have profound implications for society, potentially revolutionizing industries, addressing complex global challenges, and posing important ethical questions regarding its governance and impact on humanity.

A glossary of AI terms

Nowadays, the digital technology is enriching with new possibilities brought by the AI, and most of them concerns all of us. Terms like ChatGPT, digital safety, diffusion, generative AI, emergent behaviour, AI hallucination, LLM, text-to-image and so on belongs to a common language and denotes a new reality in which we play a part.

The following glossary of terms has been put together to help circumscribing many fashionable buzzwords and have a structured overview on the spread and use of AI in educational settings.

AI ethics: Values, principles, and techniques to guide moral conduct in the development and use of AI, aimed at preventing AI from harming humans (e.g. determining how AI systems should collect data or deal with bias).

AI safety: An interdisciplinary field concerned with the long-term impacts of AI, especially the aspects regarding accidents, misuse, or other harmful consequences. It involves developing techniques and policies that ensure AI systems are reliable, trustworthy, and aligned with human values.

Algorithm: A process or a set of rules/ instructions that allows a computer program to solve problems and to analyse data in a particular way, such as recognizing patterns. *In educational context (EC, 2022)*, AI algorithms can uncover patterns in students' performance and can help teachers optimise their teaching strategies/ methodologies to personalise learning and improve outcomes.

Alignment: Adjusting an AI to better achieve the intended result (e.g. filtering content, ensuring friendly interactions with humans).

Anthropomorphism: Assuming a chatbot is more humanlike and conscious than it really is, like thinking it's happy, sad, or even sentient altogether.

Artificial intelligence (AI): The use of technology to mimic human intelligence, either in software or hardware. AI systems can learn, reason, understand, and interact with humans in natural ways. Some examples of are chatbots, self-driving cars, and smart assistants.

Automation. The computer system performs a function that normally requires human involvement. A system that can perform tasks without needing continuous human supervision is described as autonomous. *In education (EC, 2022)*, educational institutions and teachers can use software to perform many repetitive and time-consuming tasks like timetabling, attendance, and enrolment. Automating such tasks can allow teachers to spend less time on routine tasks and more time with their students.

Bias: Errors resulting from the training of AI system, occurred from the biases within the databases content, with effects such as falsely attributing certain characteristics to certain races or groups based on stereotypes. *In educational contexts (EC, 2022)*, assumptions made by AI algorithms, could amplify existing biases embedded in current education practices i.e., bias pertaining to gender, race, culture, opportunity, or disability status. Bias can also arise due to online learning and adaptation through interaction. It can also arise through personalisation whereby users are presented with recommendations or information feeds that are tailored to the user's tastes.

Big data: The input and raw material that artificial intelligence uses to analyse and generate insights and decisions. Big data and AI have a synergistic relationship, as AI requires data to function and big data analytics leverages AI for better analysis. Big data can help AI to detect anomalies, predict future outcomes, and recognize patterns. *In education (EC, 2022)*, through big data analysis, educators can

potentially identify areas where students struggle or thrive, understand the individual needs of students, and develop strategies for personalised learning.

Chatbot: A computer program that simulates human conversation through voice commands or text chats or both, using AI to understand and respond to human inputs, often using natural language processing (NLP) and generative AI. Chatbots can be used for various purposes, such as customer service, entertainment, education, etc. *In educational settings (EC, 2022)*, chatbots can be virtual advisors for learners and in the process adapt to their learning pace and so help personalise their learning. Their interactions with students can also help identify subjects with which they need help.

ChatGPT: An AI chatbot developed by OpenAI that uses large language model technology.

Cognitive computing: In short, this is another term for artificial intelligence. CC is a branch of computer science that uses artificial intelligence and signal processing to solve complex problems that involve dynamic, rich, and sometimes conflicting data.

Data augmentation: Remixing existing data or adding a more diverse set of data to train an AI.

Database: A computer file that stores a series of independent items, such as works, data or other materials, in an organized or logical way and allows them to be accessed individually by electronic or other means. *In education (EC, 2022),* school teaching staff and faculty board administration systems contain databases of student information in including personal profiling and learning attainment data. These are sometimes linked timetabling, assessment and learning management systems.

Deep learning: A method of AI, and a type of machine learning, that uses artificial neural networks to learn from large amounts of data. It uses multiple parameters to recognize complex patterns in pictures, sound, and text. It can make decisions and create new features based on unstructured, unlabelled data. *It can be used in education (EC, 2022)* to predict minute aspects of educational performance which can aid in the development of strategies for personalised learning.

Diffusion: A method of machine learning that takes an existing piece of data, like a photo, and adds random noise. Diffusion models train their networks to re-engineer or recover that photo.

Emergent behaviour: When an AI model shows capabilities that were not planned.

End-to-end learning (E2E): A deep learning process in which a model is instructed to perform a task from start to finish. It's not trained to accomplish a task sequentially but instead learns from the inputs and solves it all at once.

GenAI: (Generative Artificial Intelligence) A type of machine learning that uses algorithms to create new data from existing information. It is used for creating images or text, predicting outcomes, and recommending products. Most of the AI applications nowadays are genAI.

General artificial intelligence (general AI/ AGI): A type of artificial intelligence that can learn to accomplish any intellectual task that human beings or animals can perform. General AI emulates the human mind and behaviour to solve any kind of complex problem. General AI is sometimes called strong AI, as opposed to weak AI, which is limited to a single task or a narrow range of tasks.

Generative adversarial networks (GAN): A generative AI model composed of two neural networks to generate new data: a generator and a discriminator. The generator creates new content, and the discriminator checks to see if it's authentic.

Generative AI (GenAI): A content-generating technology typically uses AI/ deep learning algorithms, such as generative adversarial networks (GANs) to create text, video, computer code or images. The

AI is fed large amounts of training data, finds patterns to generate its own novel responses, which can sometimes be similar to the source material.

Guardrails: Strategies, mechanisms, and policies designed to ensure the ethical and responsible use of AI technologies. They serve as safeguards to prevent misuse, bias, and unethical practices of AI systems, and to protect user privacy, promote transparency and fairness, and respect the rights of individuals. Guardrails are especially important for generative AI models, which can create new data or content based on a given input. Guardrails can help to define the boundaries within which generative AI models may operate, and to enforce technology and security controls for all interactions. In short, they ensure that the model doesn't create disturbing content.

Hallucination: Is a confident response by an AI that does not seem to be justified by its training data. This can happen when the training data is insufficient, biased, or too specialized, or when the AI model is ”overzealous” with its storytelling. Hallucination in AI can lead to nonsensical or false outputs that do not match the real-world input and can affect user trust and model accuracy. Hallucination in AI can be prevented by using high-quality data, ensuring model transparency, and enacting effective quality control.

Large language model (LLM): An AI model trained on mass amounts of text data to understand language and generate novel content in human-like language.

Learning analytics: The process of measuring, collecting, analysing and reporting data about learners and their settings, to understand and improve learning and the conditions that enable it. *In educational settings (EC, 2022)*, learning management systems record data on student interaction with course materials, their interaction with teachers and other peers, and how they perform on digital assessments. Educational institutions can use analysis of this data to monitor student performance, predict overall performance and facilitate the provision of support through personalized feedback to each student.

Machine learning (ML): A component in AI that allows computers to learn and to accomplish tasks on its own (e.g. make better predictive outcomes without explicit programming). *In education (EC, 2022),* ML is a form of personalised learning that is used to give each student an individualised educational experience. Learners are guided through their own learning, can follow the pace they want, and make their own decisions about what to learn based on system prompts.

Multimodal AI: A type of AI that can process multiple types of inputs, including text, images, videos and speech.

Natural language processing (NLP): A branch of AI that enables computers or machines to understand, generate, manipulate, and interact with human language in text or voice form. NLP combines different techniques, such as rule-based modelling, statistical, machine learning, and deep learning models, to analyse the meaning, intent, and sentiment of language data. NLP has various applications, such as text generation, chatbots, text-to-image, spell-check, text translation, and topic classification. NLP developers need to understand the structure and rules of language before building intelligent systems. *In education (EC, 2022),* virtual tutoring system can use speech recognition to identify problems in a student’s reading ability and can provide real-time, automatic feedback on how to improve as well as helping to match the student with reading material that’s best suited to them.

Narrow artificial intelligence (narrow AI/ ANI): A type of artificial intelligence that is designed to perform a single task or a limited range of tasks, and any knowledge gained from performing that

task will not automatically be applied to other tasks. Examples of narrow AI include weather forecasting, data analysis, facial recognition, or playing games. Narrow AI is sometimes called weak AI, as opposed to strong AI, which is capable of handling a wide range of tasks and simulating human intelligence. Most of AI systems today are weak AI.

Neural network: A computational model that resembles the human brain's structure and is meant to recognize patterns in data. Consists of interconnected nodes, or neurons, that can recognize patterns and learn over time. *In educational context (EC, 2022)* a neural network can be trained to learn a new skill or ability by using the repetition method of learning.

Overfitting: Error in machine learning where it functions too closely to the training data and may only be able to identify specific examples in said data but not new data.

Parameters: Numerical values that give LLMs structure and behaviour, enabling it to make predictions.

Predictive analytics: A type of AI software that uses machine learning to predict outcomes using historical data. Predictive analytics models can find patterns, observe trends, and use that information to predict future trends. It can help businesses improve forecasting, optimize processes, and enhance customer experience. *In education area (EC, 2022),* predictive analytics can provide insight into which students require additional support, not only based on their current and historical performance, but their predicted future performance.

Prompt chaining: An ability of AI to use information from previous interactions to colour future responses. The technique is used in conversational AI to create more dynamic and contextually-aware chatbots. It is the process of using previous interactions with an AI model to create new, more finely tuned responses, specifically in prompt-driven language modelling. Prompt chaining improves the accuracy and relevance of generated content by optimizing each AI Task Card to perform a specific task, and using the output of one as input for the next.

Stochastic parrot: An analogy of LLMs that illustrates that the software is good at generating convincing language, but does not actually understand the meaning of the language it is processing. The term ”parrot” refers to the repetition of learned items, while ”stochastic” provides the randomization that can lead to potential hallucination. Stochastic parrots can have serious consequences for AI development and deployment, as well as for users who rely on these technologies for important tasks.

Style transfer: The ability to adapt the style of one image to the content of another, allowing an AI to interpret the visual attributes of one image and use it on another. For example, taking the self-portrait of Rembrandt and re-creating it in the style of Picasso.

Supervised learning: A kind of machine learning where an algorithm is trained and developed using structured datasets, which have inputs and labels. *In education (EC, 2022),* supervised learning systems are defined by their use of labelled datasets to train algorithms to classify data or predict outcomes accurately. They can help teachers identify at-risk students and target interventions. They can also improve the efficiency of teaching, assessments, and grading by helping to personalise learning.

Temperature: Parameters set to control how random a language model's output is. A higher temperature means the model takes more risks.

Text-to-speech: The generation of synthesised speech from text. The technology is used to communicate with users when reading a screen is either not possible or inconvenient. *In education process (EC, 2022)*, text-to-speech technology allows learners to focus on the content rather than on the mechanics of reading, resulting in a better understanding of the material, better retention and increased confidence and motivation.

Text-to-image generation: Creating images based on textual descriptions.

Training data: The datasets used to help AI models learn, including text, images, code, or data. Machine learning algorithms find relationships, develop understanding and make decisions from the training data they are given. *In an educational context (EC, 2022)* this data can be used to make learning more efficient, adaptable, and personalised by providing detailed analytics of past and predicted future achievement.

Transformer model: A neural network architecture and deep learning model that learns context and meaning by tracking relationships in data, like in sentences or parts of images. So, instead of analysing a sentence one word at a time, it can look at the whole sentence and understand the context.

Turing test: Named after famed mathematician and computer scientist Alan Turing, it assesses a machine's ability to behave like a human. In the Turing test, a human evaluator engages in a text-based conversation with a machine and a human, both of which are hidden from view. The evaluator's task is to determine which of the two, the machine or the human, is responsible for each response in the conversation. If the evaluator is unable to reliably distinguish between the machine and the human based on the responses, then the machine is said to have passed the Turing test and demonstrated a level of artificial intelligence that simulates human-like conversation and understanding. It's important to note that the Turing test is not a definitive measure of a machine's overall intelligence, as it primarily focuses on linguistic and conversational abilities.

Unsupervised learning. A form of training where an algorithm is programmed to make inferences from datasets that don't contain labels. These inferences are what help it to learn. *In education (EC, 2022)*, Unsupervised learning is conducted to discover hidden and interesting patterns in unlabelled data. These patterns are valuable for the prediction of students' performance analysing a range of contextual information like demographics and how these relate to overall attainment.

Virtual personal assistant: An application that can understand natural language voice commands and do tasks for the user such as dictating, reading text or email messages out loud, scheduling, making calls and setting reminders. *In education (EC, 2022)*, VPAs can enable interaction with technology using voice only thus saving time by providing instant access to information. Students can access class schedules, information and resources and communicate with teachers and peers. VPAs are also used by teachers to prepare lessons, set assignments, and provide feedback.

Zero-shot learning: A test in which a model must complete a task without being given the requisite training data. An example would be recognizing a lion while only being trained on tigers.

"*Knowing that it is essentially a synthesis and knowing that AI is equidistant, one may be tempted to consider it an objective content, or rather an objective perspective on the field; but the result generated by AI only reflects a collective subjectivity, a current trend in the field, with its hesitations, biases, and shortcomings. Basically, at this stage in the development of artificial intelligence, we are only looking in a mirror; therefore we should not necessarily seek novel answers and solutions, but*

we should rather seek to better understand ourselves, as individual contributors to a scientific domain and as a collective." (Istrate, O., Velea, S. & Ștefănescu, D., 2022)

4.3.2. AI tools and tasks

AI tools for various tasks

Natural Language Processing has advanced rapidly, supporting the creation of intelligent systems that can understand language better and more clearly than ever. ChatGPT, PaLM, DALL-E are some of the large language models that are constantly improving and achieving higher performance. These models mimic humans and help with tasks such as textual content creation, text summarization, question answering, code completion, video surveillance and more. LLMs are trained on huge amounts of data and have shown great results in almost every domain. Generative AI tools spread on many types of tasks, from being a conversation partner to creating videos based on a (short) text description. Some of the best AI tools for various tasks are:

- Text: Jasper, ChatGPT, Surfer, Grammarly, Wordtune, Hemingway
- Image: DALL·E 2, MidJourney, Stable Diffusion, neural.love, Nvidia Canvas
- Video: Descript, Wondershare Filmora, Runway, Fliki, Synthesia
- Other: Mem (note-taking), Beautiful.ai (slide decks), Otter (transcription), Looka Logo Maker (logo creation), Wix ADI (website building) and so on.

As AI technology continues to evolve, we can expect even more sophisticated tools and applications, ultimately reshaping the way we interact with and interpret data in the digital age. They are based on more and more sophisticated technologies:

Text Analysis

1. **Natural Language Processing (NLP):** NLP-powered AI tools like GPT-3 have gained immense popularity for their ability to generate human-like text, answer questions, and translate languages. They find applications in content creation, chatbots, sentiment analysis, and language translation.
2. **Text Summarization:** Tools such as BertSum and Gensim's TextRank use AI algorithms to summarize lengthy texts, making it easier to extract key information from documents and articles. They are invaluable for research, news, and content curation.
3. **Sentiment Analysis:** Tools like VADER and TextBlob utilize AI to analyse and categorize text based on sentiments, such as positive, negative, or neutral. These tools are widely used for social media monitoring, customer feedback analysis, and brand perception management.

Image Processing

1. **Computer Vision:** AI tools like OpenCV and TensorFlow offer robust computer vision capabilities, enabling tasks such as object detection, image classification, and facial recognition. These tools find applications in autonomous vehicles, medical image analysis, and security systems.

2. **Image Generation:** Generative Adversarial Networks (GANs) and StyleGAN have revolutionized image generation. They can create highly realistic images, art, and design elements, transforming the creative industries.

3. **Image Enhancement:** AI-based tools like DeOldify and Adobe's Sensei utilize deep learning to enhance and restore old or low-quality images. They are valuable in preserving historical photographs and improving image quality for various applications.

Video Analysis

1. **Video Summarization:** AI tools like VideoAI and IBM Watson Video Analyzer use machine learning algorithms to summarize video content, making it easier to extract key information and trends from lengthy videos. This is crucial for security surveillance, video indexing, and content moderation.

2. **Video Object Tracking:** AI-powered object tracking tools, such as DeepSORT, enable real-time tracking of objects within videos, facilitating applications like autonomous drones, sports analytics, and video production.

3. **Emotion Recognition:** Tools like Affectiva and Amazon Rekognition Video can recognize emotions in video content, allowing for sentiment analysis in marketing research, user experience testing, and mental health applications.

ChatGPT, Bing Chat, Claude 2

For conversations or text generation, the best-known application is ChatGPT, launched by the company OpenAI (https://chat.openai.com/chat – account required), with a slightly more advanced version embedded in Bing search engine (https://www.bing.com/search?q=Bing+AI&showconv=1 – with free access, but only through Edge browser). In a comparison with ChatGPT, Bing Chat (1) can be used without an account, (2) uses ChatGPT4, (3) you can use images along with text instructions, (4) creates images, (5) summarises web pages, (6) finds a movie or TV show and open it in the app you are choosing/ where you have a subscription.

Recently released Claude 2 (https://claude.ai – account required), a generative AI chatbot developed by Anthropic, also has some benefits over the free version of ChatGPT: (1) read, analyse, and summarize uploaded files, (2) process more words than ChatGPT, (3) provide information after 2021, (4) access links and summarize their contents.

For longer texts, such as syntheses, reports and essays on a specific topic, Playground OpenAI (an OpenAI product) or Playground AI21Studio (created by AI21) can also be used. Both require the creation of a user account and allow control of the length of the generated text by setting a maximum number of characters (maximum length). They also allow selection of a language model as needed from several predefined options. Some examples of texts developed with the Playground tool on the topic of education can be found here: digital-pedagogy.eu/ariadna-experiment-the-role-of-artificial-intelligence-in-education-sciences/#signal (December 2022).

Images and videos

To generate images, you can use, among many others, Bing Image Creator (https://www.bing.com/create), DALL-E (https://openai.com/product/dall-e-2 – account required) and Fotor (https://www.fotor.com/features/ai-image-generator/).

AI photo apps are very popular. Many tools to generate and edit photos are now available for students and teachers for free or as freemium/ free trial: Lensa AI, Voi, Remini, Pixelup, Fotor, Wonder, FacePlay, Aiby, FaceApp, Gradient, Dawn AI, Facetune, Prequel, Voilà AI Artist, New Profile Pic Avatar Maker, Meitu and so on. They can help to edit photos (remove persons and objects, change backgrounds), create avatars from pictures, turn photos into cartoons, generate similar photos etc.

As regards the text-to-video AI generators, short tutorials for 5 AI text-to-video tools are presented here: youtube.com/watch?v=8HpQgEEhbC4. The AI tools are:

1. Lucas: https://www.idomoo.com/ai-video-creator-lp/

2. Pictory: https://pictory.ai/

3. Wave Video: https://wave.video/

4. Lumen5: https://lumen5.com/

5. inVideo: https://invideo.io/

Other types of AI tools to try

PinwheelGPT (https://www.pinwheel.com/gpt - app installation needed – free for up to 20 questions a month) have kid-safe guardrails, to make sure the interaction is appropriate for kids 7-12. A history of conversations is available for parents, even if the kids deleted the questions.

Tome (https://tome.app – freemium) creates captivating visuals from any input.

Whisper Memos (https://whispermemos.com – free to start – available for iOS – app installation needed) turns your voice into transcripts. A voice memo recorder that transcribe what you say and emails it to you.

Eleven Labs (https://elevenlabs.io – free to start) is a text to speech app. It can also clone your voice (feature requiring a paid subscription starting at $1).

Copyright

A legitimate question arising when using AI tools in various activities is: *The output is mine? Should I mention the AI tool somewhere/ somehow?*

In other words, *under what conditions do works made with the contribution of AI benefit from copyright protection?*

For now, there is no clear answer to this question. Specifically, there are still some steps to be taken before the contribution of artificial intelligence is introduced into the legislation. In any case, professional ethics require mentioning the fact that a work was done with the help of AI.

In the United States, the institution that administers the national copyright system and regulates most aspects of intellectual property is the U.S. Copyright Office (USCO). For a work to be eligible for copyright protection, the answer to each of the following questions must be yes (USCO, 2017, Art. 302, pg. 48):

- Is the work eligible for copyright protection in the United States?
- Has the work been fixed in a tangible medium of expression?
- **Was the work created by a human author?**
- Does the work constitute copyrightable subject matter?
- Is the work sufficiently original? (Was the work independently created? Does the work possess at least a minimal degree of creativity?)

If the answer to all these questions is "yes", then the work can be registered for protection. In other words, only if it meets these 5 conditions the product can be the subject of an intellectual property dispute. Article 306 stipulates the need for the author to be a human being, also referring to a text from 1879, which states that copyright law protects only "*the fruits of intellectual labor*" that "are founded in the creative powers of the mind". The Copyright Office refuses to consider any appeal if it is determined that the product is not created by a human being.

But what if, in a collaborative intellectual effort, one of the "creative minds" is artificial?

More recently, the need to revise these regulations on the protection of intellectual property has led to the initiation of broad debates, both in the United States, starting in 2019, and in Europe, to respond to the challenges brought by artificial intelligence.

The outcome of intellectual property debates is important because it regulates behaviour and how to report on it – it clearly establishes the conditions under which intellectual property is infringed and provides support for fraud prevention and countermeasures. Moreover (because it seems to be needed), this debate reinforces and updates some ethical principles, outlines and supports a moral stance, recalls and clarifies the essence of the human spirit, in parallel with a more or less intelligent computer program.

The impact of AI concerns works of different nature, from texts of various types, fiction, scientific articles, computer programs, to films, images, procedures, and solutions to problems very diverse in their nature, prototypes, and sketches of innovative products. The current debate has deeper implications. It may involve a repositioning, a different perspective on how we relate to various situations or to the (use of) simpler or more complex tools. For example, if, in order to create an iron art object, someone uses a filter and protection tool (a welding mask), should they specify this explicitly, in a visible place, next to their name labelling their position as the author of the work? Similarly, to what extent does a selection of responses to a series of well-formulated and logically structured questions, along with my interpretation, constitute my own work? And to what extent does it constitute the work of the person who answered the questions (in this case, an AI program)? In a (qualitative) research of 50 years ago, was every respondent credited as an author? Of course not. Should they be credited as the author? They probably should. But if I use the ideas from 100 articles on a certain topic to develop another article, reformulating, synthesizing, arranging in a certain logic – is this my work, original, protected by copyright law? If a computer application does this at my direction, who is the author(s)?

In the situation where we use AI to support the development of intellectual products, *crediting* the AI tool cannot give it the authorship, but rather consists of a note acknowledging its contribution, the author being the person who used the application/tool / artificial intelligence program and who is accountable for the work.

Remember!

Text, images or sounds generated by an AI tool cannot be attributed to it.

The examples in the compendium of the United States Copyright Office seem hilarious, but they are needed to understand and manage various current situations that use artificial intelligence. The following types of works cannot constitute an eligible work to be protected (USCO, pg. 63, Art. 313.2 et seq.):

- A photo taken by a monkey.
- A mural painted by an elephant.
- A piece of wood shaped by the ocean.
- A song naming the Holy Spirit as the author of the work.
- Reducing or increasing the size of a pre-existing work.
- Converting a work from analog to digital, such as transferring a motion picture from VHS to DVD.
- Transposing a song from B major to C major
- Medical imaging produced by X-rays, ultrasounds, magnetic resonance imaging or other diagnostic equipment
- A product based on a mechanical weaving process that randomly produces irregular shapes in the fabric without any discernible pattern.

We see many similarities with how we can interpret the contribution of ChatGPT or any artificial intelligence program nowadays to the development of an intellectual product. A current question is: *Is there a case where a machine could or should actually own the copyright for something that it created on its own without significant human involvement?* (Cochetti, 2023). More discussion and research are needed at the intersection of AI and intellectual property to redraw the scope and effects of copyright (UNESCO, 2022, pg. 33, Art. 99).

Many of the AI-generated texts, while appearing coherent and semantically plausible, are actually similar to the last counterexample on the U.S. Copyright Office's 2017 list, "*a product based on a mechanical weaving process that produces random irregular shapes in the fabric without any discernible pattern*", with the difference that the AI is now trained to make the generated item appear to have a pattern.

Reflect on consequences!

Artificial intelligence is not "concerned" about truth or originality, but with constructing a plausible product, generating the most likely sequel for each sequence of text, image or sound, using as a benchmark a database of similar digital products.

Image generated with Fotor/ 16:9, Photography 1, instruction: "Digital product, a communist environment 9 centuries B.C., AI art, photographic style" (Sept. 2023)

Image generated with Fotor/ 16:9, Photography 1, instruction: "Digital product, several people in a communist environment 9 centuries B.C., AI art, photographic style" (Sept. 2023)

Pending general and specific legislation on the role and contribution of AI in each case, it seems important to have this starting point – some ideas to reflect on, alongside a suite of recommendations and examples of current practice.

Does content generated with artificial intelligence applications have intellectual property restrictions?

Content generated with artificial intelligence applications does not (for now?) have intellectual property restrictions – it can be used freely, for any legal means, including commercial use. Moreover, the obtained content should be associated with the person who made the request, if they made it on their own behalf, or the company, if they have an institutional account or made the request for professional purposes. We are already talking about articles and even books co-authored with artificial intelligence. The policy of OpenAI, the company that owns ChatGPT and many other AI tools, states:

Creators who wish to publish their first-party written content (e.g., a book, compendium of short stories) created in part with the OpenAI API are permitted to do so under the following conditions:

- *The published content is attributed to your name or company.*
- *The role of AI in formulating the content is clearly disclosed in a way that no reader could possibly miss, and that a typical reader would find sufficiently easy to understand.*

- *Topics of the content do not violate OpenAI's Content Policy or Terms of Use, e.g., are not related to adult content, spam, hateful content, content that incites violence, or other uses that may cause social harm.*
- *We kindly ask that you refrain from sharing outputs that may offend others.*
  (Source: https://openai.com/policies/sharing-publication-policy, 19 Jan. 2023)

How to cite ChatGPT and Bing Chat?

There are two types of customs to indicate the addition of artificial intelligence, one is for in-text citation (just as one cites an out-of-print source) as well as addition to the bibliography, and the other is for the addition of visible informational text, usually placed at the end of the article. It is ideal to use both variants.

Example of in-text citation using the APA standard:

(ChatGPT, personal communication, April 9, 2023) or simply: *(OpenAI, 2023)*

Example of a bibliographic reference using the APA standard:

OpenAI. (2023). ChatGPT (Apr. 9 version) [Large language model]. https://chat.openai.com/chat

Example of an in-text reference/citation using MLA format:

(OpenAI. ChatGPT. Chat.openai.com/. Accessed Apr. 9, 2023)

The information text suggested by OpenAI to add to content generated with Chat GPT is: *The author generated this text in part with GPT-3 [or later versions], OpenAI's large-scale language-generation model. Upon generating draft language, the author reviewed, edited, and revised the language to their own liking and takes ultimate responsibility for the content of this publication.*

Microsoft's intelligent search assistant Bing Chat is available for free in the Edge browser, since March. It provides personalized answers to various questions, processing the relevant content obtained from various sites, developing texts in most cases original, new.

The content generated by Chat integrated into Bing is basically your property. The terms and conditions of use of Microsoft services, including Bing Chat, state (as of April 2023):

Art. 8. Ownership of content. Microsoft does not claim ownership of Captions, Prompts, Creations or any other content you provide, post, input, or submit to, or receive from, the Online Services (including feedback and suggestions).

However, we recommend you to quote and credit the source for content taken from Bing Chat.

Example of simple in-text reference/ bibliographic citation, using APA format:

(Bing Chat, personal communication, April 9, 2023)

Example of a simple in-text reference/ bibliographic citation using MLA format:

(Microsoft. Bing Chat. https://www.bing.com/chat. Accessed 9 Apr. 2023)

The informational text to be added at the end of the material can be similar, since it is anyway also about Chat GPT: *The author generated this text in part with Bing Chat/ GPT-3 [or later versions].*

Upon generating draft language, the author reviewed, edited, and revised the language to their own liking and takes ultimate responsibility for the content of this publication.

It should be noted that, unlike ChatGPT on the OpenAI platform, searching and generating new answers through Bing Chat also provides a „bibliography" under the title „Learn more", that includes the most important sources contributing to the development of the answer provided. We recommend that you go through them and, where appropriate, cite them separately – both in the text and in the bibliography, using the APA standard specific to that type of work.

How to reference images generated with AI programs?

In the case of images, the program used can be specified at the end of the material that contains them:

The images in this material were generated with Fotor (fotor.com).

Or you can insert a note next to each image:

Image generated with Fotor AI Face Generator (https://www.fotor.com/features/ai-face-generator/, Apr 9, 2023)

Or, more specifically:

This image was generated with Fotor AI Image Generator (https://www.fotor.com/features/ai-image-generator/, on April 9, 2023, with the request: „Little elephant talking with a boy on the Moon")

Or

„Little elephant talking with a boy on the Moon" – image generated with Bing Image Creator (https://www.bing.com/create , 9 April 2023)

In scientific works, a serial number and title must be added before the image, as well as a note after the image (if necessary).

Figure 2. *A boy talking to an elephant on the moon*

4.3.3. Applications of AI in education

With the omnipresent and omniscient AI tools today, it is easier to identify education aspects that are *not* susceptible to be mixed with the new digital technologies. A variety of possibilities to account in education management and administration, many options for teachers professional development, a diversity of learning scenarios embedding AI tools, along with the pressure to change the syllabus to accommodate new ways of relating to knowledge and to learning – all these indicate the beginning of a shift in education that we will soon witness.

However, the use of AI didn't start with ChatGPT moment, some education institutions previously exploring the use of advanced technologies for various purposes such as adaptive assessment, predictions, tutoring, educational games, and assistive systems. Today, there are important steps in many directions:

- **learning** – providing fast and precise answers to questions, helping students to improve their writing skills, providing immediate feedback, supporting test preparation, assisting experiments, investigations, topics exploration, argumentative thinking etc.
- **adaptive learning**/ personalisation of learning – AI can help tailor the content, pace and feedback to each student's needs and preferences
- **lesson planning**/ learning paths design – finding relevant resources and activities, generate alternative lesson plans, providing feedback and suggestions
- **tutoring** – simulate one-on-one tutoring sessions with students and provide hints, explanations and scaffolding
- **educational games** – create engaging and immersive learning environments that can motivate and challenge students
- **assistive technologies** – increasing access, enhancing independence, boosting confidence
- **early childhood education** – adaptive games to train basic skills, engaging and effective gamified learning activities, personalised learning
- **language learning** – interactive practice, personalised feedback, adaptive learning
- **plagiarism detection** – adaptive text similarity analysis, paraphrasing detection, AI content detection
- **exam integrity** – text generation detection (identify interventions of AI writing tools), online proctoring, plagiarism detection

- **assessment and grading** – measure the student's progress and skills in real-time and provide adaptive feedback and guidance
- **automated feedback to students**
- **learning analytics** – collect and analyse data from students' interactions with learning platforms and provide insights for improving learning outcomes
- **evaluation of the course** (and QA) – provide automated reports based on the results of satisfaction evaluation (immediate feedback from students), knowledge evaluation, impact evaluation
- **classroom/ behaviour management** – attendance, attention monitoring, behaviour tracking, personalised learning, communication with parents
- **scheduling** – timetable, transportation, maintenance & administration of supplies
- **predictions** - e.g. students at risk of falling behind, dropout, etc.
- **educational institutions management and administration** – decision support based on data analysis and machine learning, administrative efficiency, professional development
- **safety/ cybersecurity** – threat detection and threat prevention, rapid complex response to threats

In particular in higher education, there are areas in which advanced universities made a custom of using assistive AI technologies to support essential activities and make them more effective:

- chatbots for enrolment and retention
- enhanced online discussion boards
- complex learning management systems
- connecting campuses
- analysing student success metrics
- transcription of faculty lectures
- inclusion and universal access (translations, automatic text reading, closed captions, remote access to synchronous activities, matching credits from other learning paths etc.)
- individualised learning
- plagiarism detection
- exam integrity
- academic research.

An interesting and pragmatic approach is proposed by UNESCO (2023) to support the decision of choosing technology in education: *From the radio right through to generative AI, when and how should we use technology in education? When does it support learning and when does it distract? Do we need to change what and how we are learning with technology to keep education relevant?* Four questions are to be answered before employing any new tool in our teaching and learning practices:

(1) Is it appropriate? "No single device will improve learning everywhere for everyone. Some technology can improve some types of learning in some contexts. But the appropriate technology must be chosen for your particular case. […]"

(2) Is it equitable? "[…] Our focus must remain on the most marginalized as we invest."

(3) Is it scalable? "[…] Deciding on whether to scale-up our choices means having a grasp of their long-term costs, but many ignore or are unaware of the full picture."

(4) Is it sustainable? "[…] (We) must map out and prioritize the digital skills they want to teach learners and teachers that will stand the test of time."

In its Ethical Guidelines (2022), the European Commission presented a structured range of relevant use cases regarding the presence of AI in the teaching, learning, and assessment process:

A. STUDENT TEACHING. Using AI to teach students

Intelligent tutoring system	The learner follows a step-by-step sequence of tasks and gets individualised instruction or feedback without requiring intervention from the teacher.
Dialogue-based tutoring systems	The learner follows a step-by-step sequence of tasks through conversation in natural language. More advanced systems can automatically adapt to the level of engagement to keep the learner motivated and on task.
Language learning applications	AI-based learning apps are used in formal and non-formal education contexts. They support learning by providing access to language courses, dictionaries and provide real-time automated feedback on pronunciation, comprehension and fluency.

B. STUDENT SUPPORTING. Using AI to support student learning

Exploratory learning environments	Learners are offered multiple representations that help them identify their own routes to achieving the learning goals.
Formative writing assessment	Learners are provided with regular automatic feedback on their writing/ assignments.
AI-supported collaborative learning	Data on each learner's work style and past performance is used to divide them into groups with the same ability levels or suitable mix of abilities and talents. AI systems provide inputs/suggestions on how a group is working together by monitoring the level of interaction between group members.

C. TEACHER SUPPORTING. Using AI to support the teacher

Summative writing assessment, essay scoring	AI is used to evaluate and grade learners' written work automatically. AI and machine learning techniques identify features such as word usage, grammar and sentence structure to grade and provide feedback.
Student forum monitoring	Key words in student forum posts trigger automatic feedback. Discussion analytics provide insights to students' forum activity and can highlight students who may need help or are not participating as expected.

AI teaching assistants	AI agents or chatbots provide answers to commonly asked questions by learners with simple instruction and directions. Over time, the AI system is able to broaden the range of answers and options provided.
Pedagogical resource recommendation	AI recommendation engines are used to recommend specific learning activities or resources based on each student's preferences, progress and needs.

D. SYSTEM SUPPORTING. AI to support diagnostic or system-wide planning

Educational data mining for resource allocation	Universities/ schools gather student data which are analysed and used to plan how available resources can be best allocated for tasks like creating class groupings, assigning teachers, timetabling, and highlighting students who may require additional learning support.
Diagnosing learning difficulties	Using learning analytics, cognitive skills such as vocabulary, listening, spatial reasoning, problem-solving, and memory are measured and used to diagnose learning difficulties, including underlying issues that are hard for a teacher to pick up but might be detected early using AI systems.
Guidance services	AI based guidance services provide ongoing prompts or choice to create pathways for future education. Users can form a competence profile including previous education and include their own interests. From this data, combined with up-to-date course catalogue or study opportunity information, relevant study recommendations can be created using natural language processing.

Examples of frequently used AI tools for learning and researching

From many AI tools that can be explored in 2023, we have made a selection and we invite you to try them in order to get a good grasp of what students are doing or could be doing. Most of them are useful and should be recommended to students as learning companions, to improve their productivity, to motivate them to be smarter and more creative, to support their preparation for tomorrow's professions:

- book search using natural language prompts: **Talk to Books** (Google)
- literature research, personalized alerts, etc.: **ResearchRabbit** (Human Intelligence Technologies Inc.)
- evaluation of scientific works – analysis of the topics covered by comparison with other relevant works: **scite** (Scite Inc.)
- finding relevant papers on a topic or starting from a research hypothesis: **Elicit** (Ough Inc.)
- pdf document analysis and synthesis; answer questions based on the material/ book: **ChatPDF** (Mathis Lichtenberger und Moritz Lage GbR)
- development of a scientific/ research article: **Smodin** (Smodin LLC) – paid. Instrument: Smodin Author (AI Writer).

- analysing a (course) video and creating the summary, reading notes, quiz/ flashcards based on the content: **YouLearn** (Achyut Byanjankar, Advait Paliwal, David Yu)

Planning for effective use of IA and data in educational institutions

The Ethical Guidelines prepared by the European Commission (2022) put basis for a proper implementation of AI, as part of the institutional digitalisation process and transformation towards more efficient administrative and teaching processes.

The first preparatory actions should be related to raising awareness and community engagement – as the most important aspect is preparedness of human resources: staff, collaborators, beneficiaries:

Discuss with colleagues. Collaboration between educators contributes to school/ university improvement and student success. Educators often draw support from each other and can delegate tasks in ways that help them collectively to be more effective. Working collaboratively can help to make more informed decisions and helps ensure a more consistent approach to using AI and data systems across the educational institution.

Collaborate with other educational institutions. Collaboration between schools/ universities is an effective way to share experiences and best practices and learn how other educational institutions have implemented AI systems. This can also be useful in identifying and dealing with reliable providers of AI and data systems that adhere to the key requirements for trustworthy AI. It is important that educational institutions participate in supervised projects and experiments organised at regional, national, or European level through initiatives such as Erasmus+. These provide opportunities for educators and decision makers to participate collaboratively in a process of applied research and inform future use and development of AI and data use in educational institutions.

Communicate with stakeholders. Involving all stakeholders and especially learners in discussions and decision making will lead to better understanding and trust in what the institution is aiming to achieve through the use of AI systems. Careful consideration needs to be given to explain what data is being collected, what is being done with the data, how and why it is being collected, and how this is protected. It will be important to share these explanations with learners (and parents) and to provide opportunities for them to provide their feedback and voice possible concerns. Learners might require different approaches in order to engage them so that they can participate in informed decision making.

Keep up to date. As AI systems continue to evolve and data usage increases, it is very important to develop a better understanding of their impact on the world around us, including in education and training. Educators will need to continue to keep informed of new innovations and development through participation in continuing professional learning and involvement in communities of practice. Decision makers will need to provide opportunities for staff to upskill and continue to develop competences for ethical use of AI and data. – (European Commission, 2022)

The same Ethical Guidelines suggest the main steps to be approached when planning for effective use of AI in educational institutions (EC, 2022):

Review current AI systems and data use	Research about the AI systems that are already in place. When carrying out a review, it is useful to list what data is being gathered by the educational institution and clarify what purpose this serves. Consider

	how long the data will be needed for and how the school/ university might be able to retain it for as little time as possible. The European Union General Data Protection Regulation (GDPR) requires this kind of analysis.
Initiate policies and procedures	Prior to implementing an AI system, institutional wide policies and procedures need to be put in place to establish expectations and to provide guidance on how to consistently deal with issues when they arise. These could include measures for: • ensuring public procurement of trustworthy and human-centric AI; • implementing human oversight; • ensuring that input data is relevant to the intended purpose of the AI system; • the provision of appropriate staff training; • monitoring the operation of the AI system and taking corrective actions; and, • complying with relevant GDPR obligations, including carrying out a data protection impact assessment.
Carry out a pilot of the AI system	It can be useful to trial the system with a particular learner cohort. It is important to have a clear vision of what is to be achieved with the new technology so that an informed decision can be made involving students and other stakeholders. Specific evaluation criteria are required so that an informed judgement can be made on the effectiveness of the AI system in terms of improvement of learning outcomes, value for money and ethical use. This will also highlight some of the key questions that may need to be asked of the supplier before purchasing the system.
Collaborate with the AI system provider	It is important to maintain contact with the AI system provider prior to deployment and throughout the lifecycle of the AI system. Look for clear technical documentation and seek clarification on any aspects that are unclear. Assurances should be sought from the provider in terms of their adherence to applicable legal obligations. The university/ school should also consider future dependence on the provider if, for example, it seeks to change provider in the future, or move to a different AI system altogether. It is also important that any human oversight measures identified by the provider are implemented by the educational institution while the AI system is being used.
Monitor the operation of the AI system and evaluate the risk	The use of the AI system should be monitored on an ongoing basis to evaluate the impact on learning, teaching, and assessment practices. At school/ university level, it will be important to decide how monitoring will be organised and carried out, who will be responsible for monitoring and how progress will be determined and reported. The

evidence gathered, as a result of ongoing monitoring, should inform and influence the future use of AI systems or the decision not to use them in particular circumstances.

4.3.4. AI-related competences

New competences for the teaching staff

In an era in which digital technologies are all-present, the skills to use them in professional, social, personal, cultural areas are more and more complex. The knowledge, abilities and attitudes necessary to cope with everyday tasks that involves digital technologies are structured in **DigComp** document (Vuorikari at al., 2022), promoted by the European Commission.

A little more than that, education professionals are called to master them and to guide their students towards digital skills development. The new set of competences are listed in **DigCompEdu** framework (Punie et al, 2017).

DigComp is the European Digital Competence Framework for Citizens. It is a tool to improve the digital competence of European people by providing a common language and understanding of what digital competence is.

DigComp defines digital competence as "the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society". It identifies the key components of digital competence in five areas and 21 specific competences. The five areas are:

- Information and data literacy: To articulate information needs, to locate and retrieve digital data, information and content. To judge the relevance of the source and its content.
- Communication and collaboration: To interact, communicate and collaborate through digital technologies while being aware of cultural and generational diversity. To participate in society through public and private digital services and participatory citizenship. To manage one's digital identity and reputation.
- Digital content creation: To create and edit digital content in different formats, to express oneself through digital means. To copyright and license one's own and use others' digital content with respect to intellectual property rights. To integrate and re-elaborate digital content and data according to one's needs. To know how to apply digital tools for innovative problem-solving.
- Safety: To protect devices, content, personal data and privacy in digital environments. To protect physical and psychological health, and to be aware of digital technologies for social well-being and social inclusion. To be aware of the environmental impact of digital technologies and their use.
- Problem solving: To identify needs and problems, and to resolve conceptual problems and problem situations in digital environments. To use digital tools to innovate processes and products. To keep up-to-date with the digital evolution.

DigComp also describes eight proficiency levels, examples of knowledge, skills and attitudes, and use cases in education and employment contexts.

DigCompEdu is the European Framework for the Digital Competence of Educators. It is a tool to support educators in developing and assessing their digital competence by providing a common reference frame and a common language.

DigCompEdu is based on DigComp, but it adapts and extends it to the specific needs of educators. It defines digital competence as "the confident, critical and creative use of ICT to achieve goals related to work, employability, learning, leisure, inclusion and/or participation in society". It identifies the key components of digital competence for educators in six areas and 22 specific competences. The six areas are:

- Professional engagement: Using digital technologies for communication, collaboration and professional development.
- Digital resources: Sourcing, creating and sharing digital resources.
- Teaching and learning: Using digital technologies and strategies to enhance teaching and learning.
- Assessment: Using digital technologies and strategies to enhance assessment.
- Empowering learners: Using digital technologies and strategies to empower learners as digital citizens and creative thinkers.
- Facilitating learners' digital competence: Using digital technologies and strategies to facilitate learners' development of digital competence.

DigCompEdu also describes six stages or levels along which educators' digital competence typically develops, from newcomer to leader.

DigComp and AI

The 2022 release of DigComp (version 2.2) includes references to new and emerging systems such as the ones driven by artificial intelligence, virtual and augmented reality, robotisation, the Internet of things.

For example, area 5 [Problem solving], competence 5.3 [Creatively using digital technology], on the highly specialised proficiency level (7/8), an example of attitudinal trait is: *Open to engage in collaborative processes to co-design and co-create new products and services based on AI systems to support and enhance citizens' participation in society*. Competence 5.4 [Identifying digital competence gaps] is also addressing important elements of nowadays world: *Has a disposition to keep learning, to educate oneself and stay informed about AI (e.g. to understand how AI algorithms work; to understand how automatic decision-making can be biased; to distinguish between realistic and unrealistic AI; and to understand the difference between Artificial Narrow Intelligence, i.e. today's AI capable of narrow tasks such as game playing, and Artificial General Intelligence, i.e. AI that surpasses human intelligence, which still remains science fiction)*.

As most of these digital competences are developed and practiced in educational institution, in various domains, the main role and responsibility in designing appropriate education situations remains with the teacher. The higher the level of education, the more diverse and advanced AI skills are required from both apprentice and mentor.

Rather than limiting to the *knowledge* of AI, DigComp is focusing on the *interaction of citizens with AI systems*, grouped in 5 areas (see DigComp 2.2., pg. 77: publications.jrc.ec.europa.eu/repository/handle/JRC128415). We are providing below some DigComp examples of the knowledge, skills, and attitudes that we found more relevant in this early stage of introducing AI in education process:

A. What do AI systems do and what do they not do?

- Able to identify some examples of AI systems: product recommenders (e.g. on online shopping sites), voice recognition (e.g. by virtual assistants), image recognition (e.g. for detecting tumours in x-rays) and facial recognition (e.g. in surveillance systems). [5.2. - knowledge]
- Aware that AI systems collect and process multiple types of user data (e.g. personal data, behavioural data and contextual data) to create user profiles which are then used, for example, to predict what the user might want to see or do next (e.g. offer advertisements, recommendations, services). [2.6. - knowledge]
- Aware that AI systems can be used to automatically create digital content (e.g. texts, news, essays, tweets, music, images) using existing digital content as its source. Such content may be difficult to distinguish from human creations. [3.1. - knowledge]
- Aware that AI systems can help the user to edit and process digital content (e.g. some photo editing software uses AI to automatically age a face, while some text applications use AI to suggest words, sentences and paragraphs). [3.2. - knowledge]
- Aware that some AI systems can detect users' moods, sentiments and emotions automatically from one's online content and context (e.g. content posted on social media), but this application is not always accurate and can be controversial. [2.5. - knowledge]
- Aware that some AI systems have been designed to support teaching and training humans (e.g. to carry out tasks and assignments in education, at work or doing sports). [5.4. - knowledge]

B. How do AI systems work?

- Aware that AI systems use statistics and algorithms to process (analyse) data and generate outcomes (e.g. predict what video the user might like to watch). [1.3. - knowledge]
- Aware that sensors used in many digital technologies and applications (e.g. facial tracking cameras, virtual assistants, wearable technologies, mobile phones, smart devices) automatically generate large amounts of data, includ-ing personal data, that can be used to train an AI system. [1.3. - knowledge]
- Knows that AI *per se* is neither good nor bad. What determines whether the outcomes of an AI system are positive or negative for society are how the AI system is designed and used, by whom and for what purposes. [2.3. - knowledge]
- Aware that what AI systems can do easily (e.g. identify patterns in huge amounts of data), humans are not able to do; while many things that humans can do easily (e.g. understand, decide what to do, and apply human values), AI systems are not able to do. [5.2. - knowledge]

C. When interacting with AI systems

- Knows how to formulate search queries to achieve the desired output when interacting with conversational agents or smart speakers, e.g. recognising that, for the system to be able to respond as required, the query must be unambiguous and spoken clearly so that the system can respond. [1.1. - knowledge]
- Open to AI systems supporting humans to make informed decisions in accordance with their goals (e.g. users actively deciding whether to act upon a recommendation or not). [2.1. – attitude]
- Able to interact and give feedback to the AI system (e.g. by giving user ratings, likes, tags to online content) to influence what it next recommends (e.g. to get more recommendations on similar movies that the user previously liked. [2.1. - skill]
- Knows how to modify user configurations (e.g. in apps, software, digital plat-forms) to enable, prevent or moderate the AI system tracking, collecting or analysing data (e.g. not allowing the mobile phone to track the user's location). [2.6. - knowledge]
- Knows how to incorporate AI edited/manipulated digital content in one's own work (e.g. incorporate AI generated melodies in one's own musical composition). This use of AI can be controversial as it raises questions about the role of AI in artworks, and for example, who should be credited. [3.2. - knowledge]
- Open to AI systems supporting humans to make informed decisions in accordance with their goals (e.g. users actively deciding whether to act upon a recommendation or not). [2.1. – attitude]

D. The challenges and ethics of AI

- Aware that the data, on which AI depends, may include biases. If so, these biases can become automated and worsened by the use of AI. For example, search results about occupation may include stereotypes about male or fe-male jobs (e.g. male bus drivers, female sales persons). [1.2. - knowledge]
- Knows that the term "deep-fakes" refers to AI-generated images, videos or audio recordings of events or persons that did not really happen (e.g. speeches by politicians, celebrity faces on pornographic imagery). They may be impossible to distinguish from the real thing. [1.2. - knowledge]

E. Attitudes regarding human agency and control

- Open to AI systems supporting humans to make informed decisions in accordance with their goals (e.g. users actively deciding whether to act upon a recommendation or not). [2.1. – attitude]
- Recognises that while the application of AI systems in many domains is usually uncontroversial (e.g. AI that helps avert climate change), AI that directly interacts with humans and takes decisions about their life can often be controversial (e.g. CV-sorting software for recruitment procedures, scoring of exams that may determine access to education). [2.3. – skill]
- Willing to collaborate with AI projects for social good in order to create value for others (e.g. by sharing data so long as appropriate and robust controls are in place). [2.2. – attitude]
- Open to engage in collaborative processes to co-design and co-create new products and services based on AI systems to support and enhance citizens' participation in society. [5.3. – attitude]

- Has a disposition to keep learning, to educate oneself and stay informed about AI (e.g to understand how AI algorithms work; to understand how automatic decision-making can be biased; to distinguish between realistic and unrealistic AI; and to understand the difference between Artificial Narrow Intelligence (i.e. today's AI capable of narrow tasks such as game playing) and Artificial General Intelligence (i.e. AI that surpasses human intelligence, which still remains science fiction). [5.4. – attitude]

DigCompEdu and AI

Several competence elements included in the European Framework of Digital Competence of Educators (DigCompEdu) are useful landmarks regarding the necessary knowledge and skills for a proper employ of digital technologies in the educational professional field. In its "*Ethical guidelines on the use of artificial intelligence (AI) and data in teaching and learning for educators*", the European Commission presented some potential indicators to be included in the future versions of DigCompEdu, encompassing the ethical use of AI in the six areas:

1. Professional Engagement

Is able to critically describe positive and negative impacts of AI and data use in education

- Takes an active part in continuous professional learning on AI and learning analytics and their ethical use.
- Able to give examples of AI systems and describe their relevance.
- Knows how the ethical impact of AI systems is assessed in the school.
- Knows how to initiate and promote strategies across the school and its wider community that promote ethical and responsible use of AI and data

Understand the basics of AI and learning analytics

- Aware that AI algorithms work in ways that are usually not visible or easily understood by users.
- Able to interact and give feedback to the AI system to influence what it recommends next.
- Aware that sensors used in many digital technologies and applications generate large amounts of data, including personal data, that can be used to train an AI system.
- Aware of EU AI ethics guidelines and self-assessment instruments

2. Digital resources

Data governance

- Aware of the various forms of personal data used in education and training.
- Aware of responsibilities in maintaining data security and privacy.
- Knows that the processing of personal data is subject to national and EU regulation including GDPR.
- Knows that processing of personal data usually cannot be based on user consent in compulsory education.
- Knows who has access to student data, how access is monitored, and how long data are retained.

- Knows that all EU citizens have the right to not be subject to fully automated decision making.
- Able to give examples of sensitive data, including biometric data.
- Able to weigh the benefits and risks before allowing third parties to process personal data especially when using AI systems.

AI governance

- Knows that AI systems are subject to national and EU regulation (notably AI Act to be adopted).
- Able to explain the risk-based approach of the AI Act (to be adopted).
- Knows the high-risk AI use cases in education and the associated requirements under the AI Act (when adopted).
- Knows how to incorporate AI edited/manipulated digital content in one's own work and how that work should be credited.
- Able to explain key principles of data quality in AI systems

3. Teaching and Learning

Models of learning

- Knows that AI systems implement designer's understanding of what learning is and how learning can be measured; can explain key pedagogic assumptions that underpin a given digital learning system.

Objectives of education

- Knows how a given digital system addresses the different social objectives of education (qualification, socialisation, subjectification).

Human agency

- Able to consider the AI system impact on teacher autonomy, professional development, and educational innovation.
- Considers the sources of unacceptable bias in data-driven AI.

Fairness

- Considers risks related to emotional dependency and student self-image when using interactive AI systems and learning analytics.

Humanity

- Able to consider the impact of AI and data use on the student community.
- Confident in discussing the ethical aspects of AI, and how they influence the way technology is used.

Participates in the development of learning practices that use AI and data

- Can explain how ethical principles and values are considered and negotiated in co-design and co-creation of learning practices that use AI and data (linked to learning design).

4. Assessment

Personal differences

- Aware that students react in different ways to automated feedback.

Algorithmic bias

- Considers the sources of unacceptable bias in AI systems and how it can be mitigated.

Cognitive focus

- Aware that AI systems assess student progress based on pre-defined domain specific models of knowledge.
- Aware that most AI systems do not assess collaboration, social competences, or creativity.

New ways to misuse technology

- Aware of common ways to manipulate AI-based assessment.

5. Empowering learners

AI addressing learners' diverse learning needs

- Knows the different ways personalised learning systems can adapt their behaviour (content, learning path, pedagogical approach).
- Able to explain how a given system can benefit all students, independent of their cognitive, cultural, economic, or physical differences.
- Aware that digital learning systems treat different student groups differently.
- Able to consider impact on the development of student self-efficiency, selfimage, mindset, and cognitive and affective self-regulation skills.

Justified choice

- Knows that AI and data use may benefit some learners more than others.
- Able to explain what evidence has been used to justify the deployment of a given AI system in the classroom.
- Recognises the need for constant monitoring of the outcomes of AI use and to learn from unexpected outcomes.

6. Facilitating learners' digital competence

AI and Learning Analytics ethics

- Able to use AI projects and deployments to help students learn about ethics of AI and data use in education and training.

4.3.5. Pedagogical innovation with AI

Pedagogy is still a field in continuous innovation, as long as the current pedagogical knowledge constitutes a foundation for new hypotheses and theories, but mostly a tool to understand and

appraise new educational practices. In principle, AI comes to empower teachers, to innovate curriculum, to enhance and personalise learning. But how and when are these actually happening? How exactly is this innovation penetrating education theory and practice?

How might we reimagine analog teaching in terms of the digital? (Fyfe, 2011). This is the starting point, with various interpretive openings, from the transposition of education as such in the new environment, to the complete reformulation of learning paths.

In fact, digital pedagogy brings a fresh vision of how to teach and learn, but also of what is taught. The new forms of organization of the learning path sometimes shed a different light on the learning contents, forced to adapt to other dimensions, benefiting from more efficient ways of traversing, interpreting and re-signifying, processing, practicing, internalizing, re-creating, co-creating. Digital technologies facilitate documentation, identification of problems and possible solutions, approach to real life, communication between those involved, structuring of the deconstruction and reconstruction process, contact with experts, finding resources, exposure of results and (public) validation of the approach. But the abundance of possibilities is both an opportunity to use multiple and enhanced elements in the didactic process, as well as a potential obstacle in focusing on relevant learning results and the efficient use of time – conventional pedagogical strategies and established algorithms must incorporate new aspects regarding the selection of relevant and scientifically validated contents, the reinterpretation of the expected learning outcomes, the transposition of work tasks in collaborative (remote) work contexts, ensuring access, techniques to motivate and involve all team members in learning activities, strategies to encourage independent learning, elements of digital security and student safety in the online environment. The vast and unstructured content publicly available in digital format reinforces the educators' role as facilitator, who has the task, on the one hand, of guiding students to valid sources of knowledge, relevant for the intended learning objectives, and on the other hand part of familiarizing them with ways to identify, evaluate, discern between authentic knowledge/ valuable ideas and alternative sources, unrelated to the corpus of information and values in the widely accepted sphere (Istrate, 2022).

It is important to adopt some best practices when integrating new disruptive technologies such as AI into education:

- Start small: Rather than trying to implement AI across the entire curriculum, it is recommended to start with small steps and work the way up. Identify specific learning objectives or challenges that could be addressed with AI; select appropriate tools or strategies that match your own pedagogical approach; pilot test your ideas with a small group of students before scaling up to larger groups or contexts.
- Collaborate with colleagues: Peers in your university or from other institutions can have similar experiences, and regular collegial discussions can clarify, potentiate, or prevent several issues that might occur.
- Seek feedback and evaluation: Students can be reliable partners in this matter helping you to improve the activity as it unfolds, and providing valuable feedback at the end, so you can adjust learning objectives, content, duration or pace.
- Partner with a reliable AI provider/ Use trustworthy AI tools: Finding reliable AI partners/ systems is crucial for the successful integration of AI. The partner should have expertise in both education and technology domains, as well as a clear vision and mission for using AI for social good. The partner should also provide adequate training, support, and feedback for the educators and learners who use their AI products or services.

The most important benefit of the effort to articulate a digital pedagogy consists in developing the capacity of the teachers to design, carry out and evaluate effective, useful educational situations adapted to the times and to the learners.

"Teaching without digital technology is an irresponsible pedagogy", said someone at the dawn of digital education (David Parry, 2009, apud Fyfe, 2011), and the meaning of this challenge launched at an early, enthusiastic stage, where technologies showed a lot of potential, is rather an invitation for educators to understand the advantages of new media in order to know when, how, if and why to integrate them into teaching practice. Equally, it can be a warning against unreasonable, limiting conservatism. The subsequent reformulation adequately reflects the concerns of contemporary educational theorists and practitioners: "*It is irresponsible to teach with technology without a digital pedagogy*" (Fyfe, 2011).

With or without the "digital" addition, pedagogy today incorporates the achievements and promises of technology, in hypothetical scientific extensions in the process of crystallization, sometimes implausible, often valuable, sometimes sterile. It is likely that, after a period of intense searches and rediscoveries, digital technologies will find a place, prominent of course, in an enriched pedagogy and based on new frameworks, in chapters dedicated to teaching methods, external conditions of learning, learning climate, classroom management and others, and in certain situations the education will be digital in a natural way, in a *sine qua non* cohabitation.

Attempts to limit education to "conventional" spaces and frameworks, in what is called "traditional" education, are a refuge for an anachronistic, reductionist, reality-impassive pedagogy.

Instructional design. Educational activities including AI

In most cases, teachers are turning to new digital tools and resources to organize conventional teaching experiences. The innovation specific to digital pedagogy is where digital educational situations can no longer be transposed (back) into the analogue environment (Istrate, 2022).

Let's find together some innovative pedagogical elements in AI-assisted educational situations we can design, starting from the following examples.

Example 1. Using IA for Physics

The external photoelectric effect – essay

Learning task for students:

Verify experimentally the laws of the external photoelectric effect, using PhET Colorado simulation:

https://phet.colorado.edu/ro/simulations/photoelectric

Then,

(1) Explore the topic on the Internet and build a short history of research on the external photoelectric effect, in one of the following ways: essay, poster, drawing, demonstration, etc.). Include only the relevant moments of this discovery process.

(2) Use an AI tool to draft a similar essay/ poster/ drawing/ demonstration.

(3) Compare the two outputs and present your conclusions in class.

Intended learning objectives:

To state the laws of the external photoelectric effect

To describe the experimental setup used in the study of the external photoelectric effect

To describe the current-voltage characteristic

To state the laws of the external photoelectric effect

To experimentally highlight the laws of the external photoelectric effect

To verify experimentally (with the help of simulation) the laws of the external photoelectric effect

Expected/ most probable learning path:

Students will access the external photoelectric effect simulation from PhET Colorado. Using the simulation, students will verify each law separately by varying: the flux of incident electromagnetic radiation keeping the frequency constant, then varying the frequency of the radiation, changing the material of the cathodes – all situations mentioned in class.

Then, they will search the Internet for the history of the explanation of the external photoelectric effect and write a short (multimodal) essay on this topic, also reaching Albert Einstein's Photon Hypothesis.

The added value of the workload consists in stimulating conscious learning and reflection on the possibilities offered by advanced technological tools to support the development of scientific fields.

Example 2. Using IA for Career management

Occupations and fields of activity

Learning task for students:

In pairs/ teams: after the class discussion where the most desirable and interesting professional specialisations were determined, one of them will be assigned for each team. The number of members will be approximately equal in all teams formed.

Students will have to trace the professional path of their chosen specialisation. The elements to consider:

1) What exactly does the chosen professional do? (roles, responsibilities, daily tasks);

2) What subjects from your curriculum are useful for following this professional path/ specialisation and to what degree?

3) What competences are the most important?

4) What could be the impact of digital technologies on this profession/ specialisation, in 5/10 years?

5) What career alternatives can be similar to the chosen one? (optional)

Using any digital or physical means (Canva, PowerPoint, physical format - on A3 paper, role play, etc.) students must be able to represent the information found about the proposed topic. For some parts of the task, students can use ChatGPT, Bing Chat or any other AI tool. Students must earmark the ideas provided by AI.

Intended learning objectives:

Students should be able to compare the different fields of activity in order to make informed career decision.

Students should be able to plan their chosen professional path.

Given a model for analysing a professional career/ professional development, the students should be able to distinguish from it the structure of the professional career specific to the job in which they are particularly interested.

Students should be able to apply the tracking scheme of the main activities/ training needed in the evaluation of a professional path (and to predict the professional success).

Expected/ most probable learning path:

Students could solve this task using their creativity and the many digital tools they use even in everyday activities (including AI tools). It should be an interesting activity to students, as it gives more clarity to what their career dreams entail. This can serve both to motivate them and to direct them to activities of interest, but also help them to know alternatives, thus strengthening self-awareness, self-confidence and the idea of safety. In solving the task, students should illustrate/ develop the following abilities: To know some essential criteria for the professional pathway of a job; To plan the chosen professional path; To use online tools and applications to perform various professional tasks; To be able to learn in other ways than the traditional ones, developing their creativity.

Example 3. Using IA for Psychology/ Social sciences

Affectivity – emotions

Learning task for students:

Elaborate a 2 pages paper describing how you imagine a day in your life would go if you felt no emotions at all.

The project will be composed of three parts.

In the first part, answer the requirement using your imagination.

In the second part, use an AI application (eg ChatGPT or another AI application) as a homework helper.

The third part of the project will consist of the opinion/ conclusion you reach by comparing the two versions made in the first two parts.

Intended learning objectives:

To give at least three examples of types of affective processes (affective moods, emotions, feelings, passions) that they can imagine as part of their life experience.

To give examples of physiological changes and behavioural reactions for affective processes such as affective moods or emotions, starting from examples they imagine related to their personal lives.

To identify at least one property of affective processes (expressiveness, conversion, persistence) based on imaginary examples related to their personal life.

To highlight at least one role of affectivity in interpersonal relationships starting from real or imagined life scenarios.

Expected/ most probable learning path:

The requirement is an invitation to students to reflect on the importance of affective processes in their lives. The way the requirement is formulated will allow students to differentiate more easily between a robot (with a large amount of information, but without emotions, consciousness and personal life) and a human who, in addition to having/ understanding some information, is also capable to feel a varied range of emotions that leave their mark on behaviours, decisions and even the way in which information is perceived. Also, the topic allows students to become familiar with AI technology. The specific of the theme focuses on the role of AI in the educational process in order to train students to perceive AI software as potential assistants in the achievement of academic tasks, but that they have the freedom, power and opportunity to complement the help coming from AI with personal input of creativity, analytical power and thus enhance its products obtained with the help of AI.

4.3.6. The ethical issues of using AI in education

Plagiarism. Can content generated by AI applications be detected?

Obviously, the presentation of texts, images or films made with specialized content creation software without specifying the contribution of AI constitutes a moral problem. Cases where pupils and students complete essays, practical projects and scientific articles with the help of AI are common and almost impossible to detect. Paraphrasing software, built ”to avoid plagiarism” (sic!) are old tools, but, with the new technology, fraud techniques are evolving rapidly, even changing the meaning of the term *fraud*; now, apps like gocopy.ai, copyshark.ai, instatext.io or quillbot.com are created as ”writing assistants”.

For the evaluation of academic papers for fraud detection, AI-based tools have emerged (eg. Plag.ai or Oxsico), as well as software specialized in AI plagiarism detection.

All over the world, schools and universities have begun to take measures, some outright banning the use of AI or others inviting teachers to explore with students and pupils the potential of this new tool for intellectual work activities, productivity, human creativity.

It seems certain that we need to rethink what we do, how we build knowledge and how we develop (our) skills.

In short, the answer is that, for the moment, the partial or exclusive contribution or intervention of artificial intelligence in the development of a text or any other product in digital format cannot be detected.

No one can say with certainty whether a text was constructed by an AI program, except particular cases where the generated product has specific flaws (eg, invented bibliography or incorrect factual data). But a brief review of the text can remove any error. AI plagiarism detection apps provide a likelihood score – their output cannot be used to accuse someone of fraud. And the truth is that many of the texts constructed with artificial intelligence software resemble many of the texts produced by human beings (or vice versa):

- Sample of 27 texts developed by artificial intelligence on the topic of education (in December 2022): https://digital-pedagogy.eu/ariadna-experiment-the-role-of-artificial-intelligence-in-education-sciences/#signal

Texts generated with AI have some characteristics. With some exercise, one can determine if an essay sent by a student could be ”fake” or not, without help from AI-specialised anti-plagiarism software, with the same degree of accuracy. The signs to look for are:

- Repetitive text. A sign of AI-generated textual content is the presence of repeated content in the document or report, repetition of words or phrases that are not common or natural in human language.
- Many paragraphs beginning with a mark of generative texts: in addition, furthermore, another…, also. Most of the times, this is a clear sign of AI-generated text.
- Inconsistency in style, tone, vocabulary, or topic across the text or within the same paragraph. Unnatural transitions between sentences or paragraphs that do not follow a logical or coherent flow. The use of unnatural language that does not have coherence or smoothness; sometimes denoted by small, precise sentences instead of long argumentative sentences.
- Small errors in grammar, spelling, punctuation that are not typical of human writers.
- Errors in factual information.
- Lack of bibliography or erroneous/ fabricated bibliographical references.
- Lack of details. LLMs use large datasets of online content to generate text, but it may lack context in its paragraphs. This makes it less believable and authentic, unlike human-written content.
- Absence of emotions or personal opinions that reflect the author’s personality or perspective. (Lack of ”I think that…”, ”In our opinion…”, ”It seems obvious that”, ”We were intrigued by…”, etc.)

These signs are not definitive, and some AI-generated text can be very realistic and convincing. However, they can help you to be more critical and cautious when reading online content and when assessing students’ work. They can definitely help you have a valid second opinion regarding the results of automatic AI plagiarism detectors.

Automatic tools to identify AI-generated textual content with a reasonable degree of accuracy:

- **Writer** (Writer, Inc.) – free
- **Hugging Face** (Hugging Face, Inc.) – free
- **Crossplag** (Crossplag) – free – *cross-lingual tool!*
- **Copyleaks AI Content Detector** (Copyleaks) – 10 pages trial
- **Content at Scale** (Workado LLC) – free
- **Sapling** (Sapling Intelligence, Inc.) – free
- **GPT-2 Output Detector** (OpenAI) – demo
- **GPTZero** (Edward Tian) – free
- **ZeroGPT** (Zero GPT) – free

Other instruments to detect AI-based plagiarism:

- **Originality.ai** (Originality.AI) – paid
- **Turnitin** – paid

These tools are not perfect and may have some limitations or errors. Therefore, it is advisable to use them with caution and cross-check their results with your intuition and other plagiarism checkers. It is important to develop our own critical thinking and your specific digital literacy skills to evaluate the credibility and quality of the textual content that you encounter online or in your activities with students.

About the ethics of AI

Being a disruptive and rapidly growing technology, AI also raises important ethical questions that must be addressed, not only in fields as healthcare, transportation systems, and scientific research. Some say it also poses significant risks and even existential threats to humanity.

The ethics of AI is concerned with identifying and addressing these risks and ensuring that the development and deployment of AI is done in a responsible and ethical manner. This involves considering a wide range of issues, such as algorithmic bias, transparency and accountability, data privacy and security, and the impact of AI on society as a whole.

In recent years, there has been growing interest in the ethics of AI from both academia and industry. Many organizations have developed ethical guidelines for the development and deployment of AI systems, and there is an increasing recognition of the need for interdisciplinary collaboration to address these complex issues.

This chapter aims to provide an introduction to the ethics of AI in education field. It will explore the key ethical issues raised by AI, examine existing ethical frameworks for addressing these issues, and propose practical approaches for ensuring that the development and deployment of AI is done in a responsible and ethical manner. The content is based on the European Commission's ethical guidelines on AI and data usage in teaching and learning (issued in oct. 2022), designed to help educators understand the potential that the applications of AI and data usage can have in education and to raise awareness of the possible risks so that they are able to engage positively, critically and ethically with AI systems and exploit their full potential.

Risks and misconceptions in using AI in education

The fast pace of technological innovation creates many dangers and difficulties that have not been adequately addressed by policy discussions and regulations. The main AI risks in education consist of:

- Algorithmic bias: AI systems can perpetuate and amplify existing biases in society, leading to unfair treatment of certain groups of students
- Data privacy and security: The use of AI in education requires the collection and analysis of large amounts of data, which can be vulnerable to cyberattacks and data breaches
- Job displacement: The automation of certain tasks through AI can lead to job displacement for teachers and other education professionals
- Inappropriate content: AI systems can produce output that is inappropriate or wrong, leading to the dissemination of false or harmful information

These examples of the risks associated with AI in education reminds us how important it is to ensure that the development and deployment of AI in education is done in a responsible and ethical manner. On the other hand, there are as well several "fake risks", generated by a series of misconceptions about AI (extracted from: European Commission, 2022):

AI is too difficult to understand

Many people who don't have a computer science background are put off by jargon associated with AI and data systems. Even those who do have the relevant background can struggle to fully understand how AI works, as it is a broad and complex domain. This is sometimes referred to as the 'black box' problem as it is difficult to understand the AI system's inner workings. Artificial Intelligence is not a specific thing but a collection of methods and techniques to build an AI system. Rather than trying to understand the full functionality of AI systems, it is more important that educators are aware of the basic mechanisms and limitations of AI systems and how AI systems can be used to support teaching and learning in a safe and ethical way. These guidelines are designed to provide some basic questions one should ask when considering the use of an AI system and provide easy to understand use scenarios from education as well as a glossary to help with the terminology that is used to describe these systems and what they do.

AI has no role in education

AI is already changing how we learn, work and live and education is being impacted by this development. Everyone should be able to contribute to the development of AI and also benefit from it. By making ethical principles a key focus of the conversation about the role of AI in education, we can open the way for AI systems and solutions to be developed and used in an ethical, trustworthy, fair and inclusive way.

AI is not inclusive

AI can result in new forms of inequalities or discrimination and exacerbate existing ones. However, if properly designed and used, it can also offer opportunities to improve access and inclusion - in everyday life, in work, and in education. There is also significant potential for AI to provide educational resources for young people with disabilities and special needs. For example, AI-based solutions such as real-time live captioning can assist those with impaired hearing, while audio description can make access easier and more effective for people with low levels of vision.

AI systems can't be trusted

As AI systems become more powerful, they will increasingly supplement or replace specific tasks performed by people. This could raise ethical and trust issues regarding the ability to make fair decisions using AI, as well as protecting the data collected and used to support those decisions. The complexity of the legal area can be a real challenge for educators. However, the proposed EU AI Act will help to ensure that certain AI systems classified as "high-risk" (in view of the risks that they may pose to the health, safety and fundamental rights of individuals) are developed by providers according to mandatory requirements to mitigate such risks and ensure their reliability.

Education authorities and schools should therefore be able to verify that AI systems comply with the AI regulatory framework and focus on the ethical use of AI and data to support educators and learners in teaching, learning and assessment, while also adhering to the applicable data protection regulations.

AI will undermine the role of the teacher

Many teachers fear that as the use and impact of Artificial Intelligence in education broadens in the future, these systems will diminish their role or even replace them. Rather than replacing teachers, AI can support their work, enabling them to design learning experiences that empower learners to be creative, to think, to solve real-world problems, to collaborate effectively, and provide learning experiences that AI systems on their own cannot do. Moreover, AI can automate repetitive administrative tasks allowing more time to be dedicated to the learning environment. In this way the role of the teacher is likely to be augmented and evolve with the capabilities that new innovations for AI in education will bring. However, this requires diligent governance of the development and use of AI applications and focus on sustaining teacher agency.

Ethical considerations and requirements

Nowadays, educational institutions and teaching professionals should carefully reflect about the implications of employing any new digital technology in their activities. Some guiding elements can help us understand if and to what extent the AI system is trustworthy. The questions below are proposed by the European Commission (2022, pp. 19-21) based on the main ethical standards for AI systems regarding practical aspects and/or ethics, structured on four values: human agency, fairness, humanity, and justified choice.

Human agency relates to an individual's capability to become a competent member of society. A person with agency can determine their life choices and be responsible for their actions. Agency underpins widely used concepts such as autonomy, self-determination, and responsibility.

Fairness relates to everyone being treated fairly in the social organisation. Clear processes are required so that all users have equal access to opportunity. These include equity, inclusion, non-discrimination, and fair distribution of rights and responsibilities.

Humanity addresses consideration for the people, their identity, integrity, and dignity. We need to consider the well-being, safety, social cohesion, meaningful contact, and respect that is necessary for a meaningful human connection. That connection implies, for example, that we approach people with respect of their intrinsic value and not as a data object or a means-to-an-end. It is at the essence of the human-centric approach to AI.

Justified choice relates to the use of knowledge, facts, and data to justify necessary or appropriate collective choices by multiple stakeholders in the school environment. It requires transparency and is based on participatory and collaborative models of decision-making as well as explainability.

The guiding questions for educators relies on these four key considerations.

(1) Human Agency and Oversight

- Is the teacher role clearly defined so as to ensure that there is a teacher in the loop while the AI system is being used? How does the AI system affect the didactical role of the teacher?
- Are the decisions that impact students conducted with teacher agency and is the teacher able to notice anomalies or possible discrimination?
- Are procedures in place for teachers to monitor and intervene, for example in situations where empathy is required when dealing with learners or parents?
- Is there a mechanism for learners to opt-out if concerns have not been adequately addressed?
- Are there monitoring systems in place to prevent overconfidence in or overreliance on the AI system?
- Do teachers and school leaders have all the training and information needed to effectively use the system and ensure it is safe and does not cause harms or violate rights of students?

(2) Transparency

- Are teachers and school leaders aware of the AI methods and features being utilised by the system?
- Is it clear what aspects AI can take over and what not within the system?
- Do teachers and school leaders understand how specific assessment or personalisation algorithms work within the AI system?
- Are the system processes and outcomes focussed on the expected learning outcomes for the learners? How reliable are the predictions, assessments and classifications of the AI system in explaining and evaluating the relevance of its use?
- Are the instructions and information accessible and presented in a way that is clear both for teachers and learners?

(3) Diversity, non-Discrimination and Fairness

- Is the system accessible by everyone in the same way without any barriers?
- Does the system provide appropriate interaction modes for learners with disabilities or special education needs? Is the AI system designed to treat learners respectfully adapting to their individual needs?
- Is the user interface appropriate and accessible for the age level of the learners? Has the usability and user-experience been tested for the target age group?

- Are there procedures in place to ensure that AI use will not lead to discrimination or unfair behaviour for all users?
- Does the AI system documentation or its training process provide insight into potential bias in the data?
- Are procedures in place to detect and deal with bias or perceived inequalities that may arise?

(4) Societal and Environmental Wellbeing

- How does the AI system affect the social and emotional wellbeing of learners and teachers?
- Does the AI system clearly signal that its social interaction is simulated and that it has no capacities of feeling or empathy?
- Are students or their parents involved in the decision to use the AI system and support it?
- Is data used to support teachers and school leaders to evaluate student wellbeing and if so, how is this being monitored?
- Does use of the system create any harm or fear for individuals or for society?

(5) Privacy and Data Governance

- Are there mechanisms to ensure that sensitive data is kept anonymous? Are there procedures in place to limit access to the data only to those who need it?
- Is access to learner data protected and stored in a secure location and used only for the purposes for which the data was collected?
- Is there a mechanism to allow teachers and school leaders to flag issues related to privacy or data protection?
- Are learners and teachers informed about what happens with their data, how it is used and for what purposes?
- Is it possible to customise the privacy and data settings?
- Does the AI system comply with General Data Protection Regulation?

(6) Technical Robustness and Safety

- Is there sufficient security in place to protect against data breaches?
- Is there a strategy to monitor and test if the AI system is meeting the goals, purposes and intended applications?
- Are the appropriate oversight mechanisms in place for data collection, storage, processing, minimisation and use?
- Is information available to assure learners and parents of the system's technical robustness and safety?

(7) Accountability

- Who is responsible for the ongoing monitoring of results produced by the AI system and how the results are being used to enhance teaching, learning and assessment?

- How is the effectiveness and impact of the AI system being evaluated and how does this evaluation consider key values of education?
- Who is responsible and accountable for final decisions made regarding the procurement and implementation of the AI system?
- Is there a Service Level Agreement in place, clearly outlining the support and maintenance services and steps to be taken to address reported problems?

Guidance for teaching staff and for governing board

The following use cases were adapted from the European Commission's Guidelines, in order to help setting the basis for a thorough examination towards the implementation of artificial intelligence in the educational institution.

1. Using adaptive learning technologies to adapt to each learner's ability

A faculty is using an Intelligent Tutoring System to automatically direct learners to resources specific to their learning needs. The AI based system uses learner data to adapt problems to the learner's predicted knowledge level. As well as providing constant feedback to the learner, the system provides real-time information on their progress on a teacher dashboard.

The following guiding questions highlight areas that require attention:

- Are the system processes and outcomes focussed on the expected learning outcomes for the learners? How reliable are the predictions, assessments and classifications of the AI system in explaining and evaluating the relevance of its use? **Transparency**
- Does the system provide appropriate interaction modes for learners with disabilities or special education needs? Is the AI system designed to treat learners respectfully adapting to their individual needs? **Diversity, non-Discrimination and Fairness**
- Are there monitoring systems in place to prevent overconfidence in or overreliance on the AI system? **Human agency and oversight**

2. Using student dashboards to guide learners through their learning

A faculty is considering the use of a personalised online student dashboard which will provide feedback to learners and support the development of their self-regulation skills. Instead of focusing on what the learner has learned, the visualisations provide the student with a view of how they are learning.

The following guiding questions highlight areas that require attention:

- Does the AI system clearly signal that its social interaction is simulated and that it has no capacities of feeling or empathy? **Societal and environmental wellbeing**
- Is access to learner data protected and stored in a secure location and used only for the purposes for which the data was collected? **Privacy and data governance**

- Is there a Service Level Agreement in place, clearly outlining the Support and Maintenance Services and steps to be taken to address reported problems? **Accountability**

3. Providing individualised interventions for special needs

A faculty is considering how AI systems can help reduce barriers for students with special educational needs. The faculty is currently trialling an AI system to detect student support demands early on and provide tailored instructional support. By detecting patterns of corresponding characteristics from measures such as learning performance, standardised tests attention span or reading speed, the system suggests probabilities of specific diagnoses and related recommendations for interventions.

The following guiding questions highlight areas that require attention:

- Are procedures in place for teachers to monitor and intervene, for example in situations where empathy is required when dealing with learners or parents? **Human agency and oversight**
- Is information available to assure learners and parents of the system's technical robustness and safety? **Technical robustness and safety**
- Is the teacher role clearly defined so as to ensure that there is a teacher in the loop while the AI system is being used? How does the AI system affect the didactical role of the teacher? **Human agency and oversight**

4. Scoring essays using automated tools

A faculty is looking at how AI systems can support the assessment of student written assignments. A provider has recommended an automated essay scoring system which uses large natural language models to assess various aspects of text with high accuracy. The system can be used to check student assignments, automatically identify errors, and assign grades. The system can also be used to generate sample essays. Over time, the system can train large artificial neural networks with historical cases that contain various types of student mistakes to provide even more accurate grading. The system has a plagiarism detection option which can be used to automatically detect instances of plagiarism or copyright infringement in written work submitted by students.

The following guiding questions highlight areas that require attention:

- Are there procedures in place to ensure that AI use will not lead to discrimination or unfair behaviour for all users? **Diversity, non-discrimination and fairness**
- Who is responsible for the ongoing monitoring of results produced by the AI system and how the results are being used to enhance teaching, learning and assessment? **Accountability**
- Do teaching staff and faculty board understand how specific assessment or personalisation algorithms work within the AI system? **Transparency**

5. Managing student enrolment and resource planning

A faculty uses the data collected when students enrol to predict and better organise the number of students who will attend in the coming year. The AI system is also used to assist with forward

planning, resource allocation, class allocations and budgeting. This has enabled the faculty to consider more student attributes than before, for example, to increase gender parity and student diversity. The faculty is now considering using prior grades and other metrics like standardised tests to develop targets for their students to achieve and to support professors to predict student success on a per subject basis.

The following guiding questions highlight areas that require attention:

- Who is responsible for the ongoing monitoring of results produced by the AI system and how the results are being used to enhance teaching, learning and assessment? **Accountability**
- Are there mechanisms to ensure that sensitive data is kept anonymous? Are there procedures in place to limit access to the data only to those who need it? **Privacy and data governance**
- How is the effectiveness and impact of the AI system being evaluated and how does this evaluation consider key values of education? **Accountability**

6. Using chatbots to guide learners and parents through administrative tasks

A faculty uses a chatbot virtual assistant on its website to guide learners through administrative tasks such as enrolment for courses, paying course fees or logging technical support issues. The system is also used to help students to find learning opportunities, provide feedback on pronunciation or comprehension. The virtual assistant is also used to support students with special educational needs through administrative tasks.

The following guiding questions highlight areas that require attention:

- Does the AI system clearly signal that its social interaction is simulated and that it has no capacities of feeling or empathy? **Societal and environmental wellbeing**
- Is there a strategy to monitor and test if the AI system is meeting the goals, purposes and intended applications? **Technical robustness and safety**
- Is there a mechanism to allow teaching staff and faculty board to flag issues related to privacy or data protection? **Privacy and data governance**

Two benchmarks are commonly used to assess the quality of an educator's work, **students' performance** and **participation** in the proposed learning activities. Performance (or improvement) is interdependent with participation to a great extent: it is more likely that a good performer is actively involved in activities and it is expected that a student who is attentive and active to learn better. Students' participation in learning activities is not achieved by forcing them to be careful or waiting for us to understand the ultimate goal of learning and the potential value of the information we present (although they also have their role at higher school levels in other). Exclusive use of this tactic in education is counterproductive, leading to the association of school learning with monotony, boredom, frustration, anxiety (Macklem, 2015).

Using AI tools (and in general digital technologies), the challenge for teachers is to prepare *exciting activities* in order to attract students into learning. The AI tools are coming to complete and intensify educational situations, placing themselves in the zone of external conditions for learning. In digital environment, class-group dynamics may be different from how students respond and interact in

conventional contexts. Group structure and classroom relationships are partially changed on the basis of the digital competence of each student – often, shy students or students who are not "rated" as being the best can find new learning activities using new technologies, new benchmarks and new ways of expression, more familiar and facilitating their academic progress. Therefore, teachers can view **AI-enabled teaching activities as opportunities** to stimulate the progress of certain learners, to bring (some of) them closer to the knowledge domain, and to strengthen class cohesion and adherence to the proposed learning paths. A better design of education situations, by using a variety of instructional methods and strategies, by including the tools and resources available at the moment, constitutes the premise for better development of didactic activities, resulting in a better participation of students in activities and higher academic achievement.

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