



## ALEA IACTA EST: WHAT DOES THE FUTURE HOLD FOR TEACHING PROFESSIONALS IN ARTIFICIAL- INTELLIGENCE MEDIATED EDUCATION?

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### **Abstract:**

The 4th Industrial Revolution, or more widely known as Industry 4.0, is bringing about profound social, economic, and political changes due to the exponential rate of development of digital technologies and especially of Artificial Intelligence (AI). Against this backdrop, during the last decade, technological advancements have drastically transformed the nature of education, affecting both its content and the way it is delivered. These developments, in combination with the conditions that arose during the Covid-19 pandemic, enforcing an urgent shift to distance learning, have formulated a novel context within which all stakeholders in the field of education must be adjusted to. Artificial Intelligence refers to those systems that simulate human intelligence and perform complex tasks with the help of algorithms and neural networks, while making it possible for the system itself to learn and adapt its responses. Highlighting the advantages and realizing the potential of AI systems, research is increasingly drawing on the applications they can have in education and in the improvement of the learning process. Recent research data are quite intriguing, indicating improvement in learning outcomes, increase in productive learning time, enhancement of experiential learning and adaptation to the learners' individualized needs. Within this context and with an eye towards the future, the present paper attempts to highlight the role of teachers and adult educators, the skills they must develop, as well as the challenges they have to tackle, so as to be able to initially comprehend, and at a second level to integrate AI applications in their teaching practice. Alea iacta est: it is evident that all previous knowledge regarding technology is no longer sufficient, with AI-mediated education requiring novel skills and competences to manage and exploit data, to collaborate effectively with systems and learners, as well as to develop appropriate educational materials.

**Keywords:** education 4, artificial intelligence, teaching staff, skills & competences

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## 1. The Context

Since the onset of the 21st century, the 4th Industrial Revolution, widely known as Industry 4.0, associated with the exponential rate of development of digital technologies impacting all aspects of human activity, has brought about intense social, economic, and political changes (UNESCO, 2023). Against this backdrop, education, as a social subsystem, has been profoundly affected, both receiving and exerting influence in a constantly evolving role (Zawacki-Richter *et al.*, 2019)). The transition of educational systems to serve the digital era has been further accelerated by the recent COVID-19 health crisis (Ferdig & Pytash, 2021; Karalis 2020), which made it evident that all aspects of social life are subject to fluidity. Education in the 21st century is thus bound to equip learners of all ages and backgrounds with the appropriate knowledge and skills, which will facilitate successful integration into a demanding labor market and enhance readiness for an unpredictable future in fluid environments (UNESCO, 2023; Vincent-Lancrin & van der Vlies, 2020).

The integration of technology in education is not a novelty. However, it is the exponential pace of technological advancements during the last twenty years that has substantially altered not only the field of education but also the nature of learning (Ally, 2019; Kang, 2023; UNESCO, 2023). A crucial development lies in the shift of emphasis from the teaching staff to the learners, having become the epicenter of the learning process, especially on distance learning platforms and the open software they interact with (Huk, 2021). Education 4.0. has liberated learning from the confinement of classroom walls, mandating a transformation in the established norms about the way individuals' access, receive and utilize knowledge in a never-ending process, not restricted to formal education but continuing throughout life (Ally, 2019; Cantú-Ortiz *et al.*, 2020). As Toffler (1970) accurately predicted in "The Future Shock" the illiterate is not those who cannot read and write, but those who cannot learn, unlearn, and relearn.

Furthermore, the COVID-19 health crisis, an unprecedented incident in the post-war history of humanity (Ferdig & Pytash, 2021; Karalis, 2020; Miller *et al.*, 2021; Nelson *et al.*, 2021), had a critical role to play in mainstreaming distance learning and integrating digital technologies across all levels and types of education. Within a short period, new technologies and tools, already existing or newly developed, were integrated into education and learning, fostering novel learning environments which require prompt adjustment of teaching methods and implementation of innovative practices (Miller *et al.*, 2021; Nelson *et al.*, 2021; Srinivasan, 2022). At the same time, chronic issues came to the surface, such as the inequalities in access to education, the digital divide among different social groups, the lack of infrastructure and financial resources (UNESCO, 2023), and above all, the lack of the necessary digital and social skills to cope with contemporary challenges (Roy *et al.*, 2022).

Apparently, education is not going to return to the more conventional form of the pre-pandemic period. Conversely, it will continue to rapidly integrate any technological advancement, especially Artificial Intelligence (AI), the dynamics of which are bound to profoundly transform the world we live in the years to come (Srinivasan, 2022). Within

this context, the present paper attempts to delve into the role of the teaching professionals, the skills they have to develop, as well as the challenges they must tackle so as to be able to initially comprehend, and, at a second level, integrate AI applications in their teaching practice. Alea iacta est: it is evident that all previous knowledge regarding technology is no longer sufficient, with AI-mediated education requiring novel skills and competences to manage and exploit data, to collaborate effectively with digital systems and learners, as well as to develop appropriate educational materials.

## 2. Methods

A literature review was conducted following a four-stage process, including research of preliminary sources, use of secondary sources, study of primary sources and synthesis of the literature (Gall, Borg & Gall, 1996, p. 117). Preliminary source research was conducted using bibliographic databases, such as Scopus database, Educational Resources Information Center (ERIC) and Hellenic Academic Libraries Link (HEAL LINK). The keywords used in the search were "artificial intelligence in education", "artificial intelligence applications in education", "artificial intelligence and adult education", "4th Industrial Revolution and education", "adult educator and artificial intelligence". It should be noted that our research was limited to studies published during the last decade. References within preliminary sources helped draw up a comprehensive list of primary material relevant to the topic, which once assembled and studied through a critical approach, allowed a deeper insight in the subject and a broader understanding.

## 3. Conceptual framework

The literature review highlighted that there is not a commonly accepted definition of AI, as it can come in various types and forms and describe different technologies and processes (Ali, 2023; Lindner, 2019). AI systems essentially perform cognitive tasks, analogous to human intelligence, as regards learning and problem-solving (Baker *et al.* (2019). A comprehensive definition of AI could be as follows:

*Artificial Intelligence is the software and systems that can, for a given set of human-defined objectives, act in a physical or digital environment, receive and interpret data (structured or unstructured), apply reasoning skills and process information to produce a coherent output such as content, predictions, recommendations, or decisions that affect the environments they interact with (Ali, 2023; Baker et al., 2019; Lindner, 2019).*

AI in education (AIED) is a sub-application of AI, supporting learning no matter where and when it takes place, from traditional classrooms to the workplace, from formal education to lifelong learning (Hamal *et al.*, 2022). It is a multidisciplinary field which combines data and theories from psychology, neuroscience, linguistics, sociology, and anthropology to develop state-of-the-art learning environments and tools (Kang, 2023; Kejawa & Weaver, 2004). Breines and Gallagher (2020) presume that the ultimate purpose

of AI is to transform traditional education into a more dynamic and personalized process, enabling scientists to delve into the "black box" of learning, namely the intertwined social and psychological factors, context conditions, nature and representations of knowledge. This will help determine the appropriate interactive teaching methods to optimally support individualized learning (Hamal *et al.*, 2022).

Educational institutions (schools, universities, lifelong learning and training centers) currently collect and manage large amounts of educational data, such as information about learners, the teaching staff, the organization itself, or even data generated from the use of digital tools and/or intelligent teaching systems, the so-called "digital footprints". All these data can be analyzed with the help of algorithms to outline patterns, correlations and trends (European Commission, 2022). In effect, AI systems are able to delve into the footprints of learners' digital usage and their learning activity in order to perform learning analyses, identify their learning patterns and suggest the appropriate learning pathways tailored to their individualized needs (Sadiku *et al.*, 2021).

#### 4. AI applications in education

Delving into relevant literature indicated that the classification of AI systems and applications is diversified depending on an array of distinct criteria (Srinivasan, 2022; Vincent-Lancrin & van der Vlies, 2020). The main classifications identified are based on interaction (who and how interacts with the system) (Chounta *et al.*, 2021; Luckin *et al.*, 2022), the context (within the system is used) (UNESCO, 2023), the task the system performs (general AI, or performing a specific task) (Atwell *et al.*, 2020; Kejawa & Weaver, 2014), the mode of operation (symbolic or non-symbolic AI), or the architecture of the model (neural networks or rule-based systems) (European Commission, 2022; Pedro *et al.*, 2019). The main applications of AI in education could be, therefore, grouped as follows:

- Intelligent Instructional Systems (ITS): ITSs are the most popular applications of AEID, as they offer a range of functions and can prove highly beneficial for both learners and teaching staff. They use advanced technologies which provide adaptive, personalized and effective learning, structured on knowledge representation models (Hamal *et al.*, 2022): a) The Learner Model collects information about learners' cognitive level and special traits, and takes into account possible misconceptions about the subject or even their emotional state; b) The Pedagogy Model addresses learners with custom developed educational materials, exploiting the accumulated scientific knowledge having emerged from theory and research; c) The Domain Model relies on aggregated educational materials; and d) The Interface Model focuses on the interaction with the users/learners. ITSs take advantage of self-learning, i.e. the ability of the system to learn, extract patterns and modify its response to new data, without human intervention (European Commission, 2022). They can identify learners' strengths and weaknesses and prescribe suitable educational materials, offering alternative ways of approaching, processing and interacting with them. They can thus

construct a personalized learning pathway for each learner with all parameters adapted to his/her own needs, particularities and pace (Vincent-Lancrin & van der Vlies, 2020). We could assume that ITSs act as "Facilitators" which guide, support and encourage each learner to make informed decisions about his/her own learning.

- **Early Warning and Prediction Systems (EWPS):** These systems fall under the broader category of Educational Data Mining (EDM) (European Commission, 2022), using machine learning and statistics to make predictions so that teaching professionals can intervene in time (Zawacki-Richter *et al.*, 2019). Combining and analyzing data makes it possible, for example, to predict learners' chances of failing or dropping out of a course, an issue of paramount importance in education. They apply specific indicators, such as a number of absences, success rates per subject, average grades, and disciplinary sanctions, indicated by relevant research to be important predictors of academic failure or attrition (Vincent-Lancrin & van der Vlies, 2020). This is why EWPSs are primarily used at organizational and administrative levels to help make informed decisions.
- **Automated Assessment Systems (AAS):** AASs enable the automation of the assessment of written assignments. They provide learners with immediate feedback and can assess the level of understanding of the subject matter, the involvement of the learners and the quality of their writing (Vincent-Lancrin & van der Vlies, 2020). At the same time, they are able to detect cases of plagiarism, even in long texts. The specific applications were developed to meet the needs of assessing large volumes of written assignments, especially in Universities with large numbers of students, in order to reduce the workload of the teaching staff and increase their productive teaching time (Pedro *et al.*, 2019), contributing significantly to improving the quality of the education provided.
- **Natural Language Processing (NLP) & Virtual Personal Assistants (VPA):** These AI systems can comprehend and process natural language, supporting the user at every stage of the educational process. A VPA understands voice commands in natural language and can perform tasks for the user, such as read out texts, question and answer, or discuss a specific topic (European Commission, 2022). Also known as "dual teachers" (Kang, 2023; Zawacki-Richter *et al.*, 2019), such systems enable group teaching whereby the instructor is supported by one or more VPAs. Though voice, they facilitate interaction with technology, enable communication among learners, as well as between learners and the instructor. Recently, ChatGPT, an advanced written natural language processing system, was released. ChatGPT can conduct conversations, produce high-quality texts in various fields, recall previous searches and provide results based on them (Malinka *et al.*, 2023; Sazalieva & Valentini, 2023). It is a tool, which, although it was not designed for educational purposes, brought about a revolution in the education field, while it also induced conflicting reactions (Tili *et al.*, 2023). It can operate at both teaching and learning, as well as at research and educational

administration levels, assuming a variety of roles. It is a tool that is swiftly gaining ground in education, as it fosters personalized learning experiences.

- Virtual Reality (VR) & Augmented Reality (AR): Two distinct technologies that aim to maximize the learning experience, enhance interaction, and encourage learner engagement (Ali, 2023). Virtual reality refers to the creation of a virtual environment with which users interact through special devices (helmets, gloves equipped with sensors). It significantly contributes to a better and deeper understanding of abstract concepts and has already found applications in medicine and aviation, which require specialized professional skills (Ally, 2019). It enables learners to experience realistic scenarios, explore natural environments and simulate scientific phenomena, gaining a whole new experience of the real world (European Commission, 2022).

Augmented reality, on the other hand, can enhance the real world with additional elements, such as graphics, sounds, images, which the user can perceive through portable devices (i.e. smartphones, glasses). It is an immersive experience whereby real environments are supplemented with computer-generated animation sequences. Through interaction and experimentation, learners take theoretical concepts into practice, expanding and strengthening their skills.

Both applications are currently used to build educational games and create rich learning environments (European Commission, 2022).

## 5. Teaching Professionals' Role in AI-mediated Education

The exponential development of educational technologies that took place during the last decades formulated a whole new context wherein teaching professionals have to assume new roles, redefining important aspects of teaching, such as philosophy, pedagogical approaches, teaching methodology and practices (Skhephe *et al.*, 2020), as well as interaction with learners (Cantú-Ortiz *et al.*, 2020; Keramati *et al.*, 2011). Leading in the digital era, teaching professionals are expected to equip individuals with knowledge, skills and competences both for the present and the future; to pave the way for learners to get fully familiarized with technology - and this does not only apply to younger learners who already have an advantage with digital technologies, but also to adult learners who may encounter significant difficulties.

These new mandates have triggered the formulation of relevant frameworks (Pedro *et al.*, 2019), which include a set of generic skills that the teaching staff should develop (U.S. Department of Education, 2023), as well as more specialized ones related to digital competence and skills to keep pace with the challenges of the digital era. Apparently, all teaching professionals must be technologically and digitally literate, that is, to be able to use digital technologies to communicate and collaborate, to build digital educational materials taking into account copyright issues, to ensure the security of their personal data, and to make rational use of digital learning resources (Pedro *et al.*, 2019; Skhephe *et al.*, 2020).

Introducing AI into education and the consequent changes brought about, will clearly further redefine the role of teaching professionals, which will hereon require the development of more elaborate skills (Markauskaite *et al.*, 2022). The currently available AI systems and applications and systems can improve the pedagogical approaches and allow learners to self-direct their learning and enhance their autonomy (Srinivasan, 2022). Teaching professionals are no longer the sole source of knowledge; however, with the synergy of AI, they have an array of effective tools to guide, support, and encourage learning (Ally, 2019). They essentially need to collaborate with the advanced systems available and act as facilitators of learning, (Kang, 2023), with the learners at the epicenter (Ally, 2019), while utilizing tools and applications that enrich and maximize the learning experience (Ally, 2019; Ali, 2023).

Against this backdrop, teaching professionals' preexisting skills and knowledge regarding digital technologies may no longer be sufficient to cope with AI systems, the structure and operation of which differ significantly. For instance, Intelligent Teaching Systems personalize the educational process tailoring it to learners' needs and characteristics. With their operation based on algorithms, they collect and analyze data drawn from responses and interactions with the users. They monitor learners' progress and performance, taking into account their responses, the time required to complete a task, and predetermined constraints (Kavitha *et al.*, 2023). Through self-learning, ITSs identify patterns in the learners' data and adjust contents to suit their personalized learning needs. Integrating ITSs in the educational process does not actually demand knowledge of the deeper structure of their operation, but merely of their capabilities and limitations (European Commission, 2022; Luckin *et al.*, 2022). This is sufficient for their effective use by the teaching staff, which comprises the adjusting of contents and basic parameters, such as the difficulty level of questions or the way materials are presented, and certainly the analyzing of the data collected about learners' progress in order to adapt their teaching approaches (Kang, 2023; U.S. Department of Education, 2023).

It is a prerequisite, therefore, that teaching professionals acquire data management skills, as their novel role involves the uploading of critical educational data that result from needs assessment and learners' special characteristics to help AI systems generate the correlations and models they are programmed for (Pedro *et al.*, 2019). Relevant research has indicated that AI systems per se cannot improve learning outcomes (UNESCO, 2023; Vincent-Lacrin & van der Vlies, 2020). It is a sine qua non that they operate under human supervision, whereby the teaching staff closely collaborate with AI systems and decide when and whether their mediation is necessary for the learning process (Atwell *et al.*, 2020; Luckin *et al.*, 2022).

It is evident that with the introduction of AI in education and the consequent automation of many tasks previously carried on by the teaching staff, new balances must be reached concerning effectiveness and efficiency, time management, mental energy, and the development of appropriate and up-to-date digital educational materials (Kang, 2023; Skhephe *et al.*, 2020). Teaching professionals must be constantly in search of varied and valid learning resources (Ally, 2019), know how to apply AI tools in the design of

educational programs and activities (Vincent-Lacrin & van der Vlies, 2020), as well as invest in their own professional development (Skhephe *et al.*, 2020; UNESCO, 2023).

In this context, previous knowledge regarding technology is no longer sufficient for teaching professionals to be digitally literate. AI-mediated education requires novel skills and competences to integrate in a critical and forward-looking manner AI into their daily teaching practice, by managing and exploiting data, by collaborating effectively with systems and learners, as well as by developing appropriate educational materials.

## 6. Conclusions

The 4th Industrial Revolution and the consequent changes and technological developments it has brought about, have shaped a new socioeconomic context wherein education is bound to adapt. The integration of AI systems in education calls for the swift adjustment of all stakeholders, and especially of the teaching staff.

AI applications in education offer multiple advantages, such as personalized support, learning tailored to learners' needs and special characteristics, enriched learning experiences and a deeper understanding of teaching materials. Furthermore, predictive AI systems can be a powerful tool for educational organizations to make informed decisions, while automated AI systems can free educational and administrative staff from the burden of standardized and repetitive processes. Not to mention, virtual assistants can significantly support the role of instructors and enhance learning, by making access to knowledge easier and the educational process more interesting.

Against this backdrop, AI-mediated education calls for teaching professionals ready to pave the way for learners of all ages to get fully familiarized with technology and equip them with knowledge, skills and competences both for the present and the future. To this end, teaching professionals need to be able to understand new concepts (i.e. algorithms, neural networks, machine learning), to manage and leverage large amounts of data, to collaborate effectively with advanced systems and to develop appropriate educational materials (Pedro *et al.*, 2019).

In effect, teaching professionals in the digital era must be ready to understand, use, evaluate and ultimately, critically integrate AI into their daily teaching practice. On a second level, however, they must develop a dialectical relationship with the new reality (Bearman *et al.*, 2023) to engage in a fruitful dialogue with the advancements taking place and to transform themselves into digitally literate professionals with critical consciousness.

*Alea iacta est!* Are teaching professionals ready for AI-mediated education?

### Conflict of Interest Statement

The authors declare no conflicts of interest.

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## References

- Ali A, 2023. Assessing Artificial Intelligence Readiness of Faculty in Higher Education: Comparative Case Study of Egypt. Master's Thesis, the American University in Cairo. AUC Knowledge Fountain. <https://fount.aucegypt.edu/etds/2096>
- Ally M, 2019. Competency Profile of the Digital and Online Teacher in Future Education. *International Review of Research in Open and Distributed Learning* 20,2. <https://doi.org/10.19173/irrodl.v20i2.4206>
- Attwell G, Deitmer L, Tütlys T, Roppertz S, & Perini M, 2020. Digitalisation, artificial intelligence and vocational occupations and skills: What are the needs for training teachers and trainers? In Nägele C, Stalder BE, & Kersh N (Eds.). Trends in vocational education and training research, Vol. III. Proceedings of the European Conference on Educational Research (ECER), Vocational Education and Training Network (VETNET), pp. 30–42, <https://doi.org/10.5281/zenodo.4005713>
- Baker T, Smith L, & Anissa N, 2019. Educ-AI-tion rebooted? Exploring the future of artificial intelligence in schools and colleges. <https://www.nesta.org.uk/report/education-rebooted/>. Accessed October 12 2023
- Bearman M, Ryan J, & Ajjawi R, 2023. Discourses of artificial intelligence in higher education: a critical literature review. *Higher Education* 86:369-385, <https://doi.org/10.1007/s10734-022-00937-2>
- Breines MR, & Gallagher M, 2020. A return to Teacherbot: Rethinking the development of educational technology at the University of Edinburgh. *Teaching in Higher Education*, 1–15. <https://doi.org/10.1080/13562517.2020.182537>
- Cantú-Ortiz F, Galeano-Sánchez N, Garrido L, Terashima-Marin H, & Brena R, 2020. An artificial intelligence educational strategy for the digital transformation. *International Journal on Interactive Design and Manufacturing*, <https://doi.org/10.1007/s12008-020-00702-8>

- Chounta I, Bardone E, Raudsep A, & Pedaste M, 2021. Exploring teachers' perceptions of Artificial Intelligence as a tool to support their practice in Estonian K-12 education. *International Journal of Artificial Intelligence in Education*, <https://www.researchgate.net/publication/352066912>
- European Commission, 2022. Ethical guidelines on the use of artificial intelligence (AI) and data in teaching and learning for educators. Publications Office of the European Union, <https://data.europa.eu/doi/10.2766/153756>
- Ferdig RE, & Pytash KE, 2021. What Teacher Educators Should Have Learned from 2020. Association for the Advancement of Computing in Education (AACE). <https://www.learntechlib.org/p/219088/>. Accessed March 17 2021
- Gall MD, Borg WR, & Gall, JP, 1996. Educational research: An introduction. White Plains NY: Longman.
- Hamal O, Faddouli N, Harouni MHA, & Lu J, 2022. Artificial Intelligent in Education. *Sustainability* 14, 2862. <https://doi.org/10.3390/su14052862>
- Huk T, 2021. From Education 1.0 to Education 4.0 - Challenges for the Contemporary School. The New Educational Review. <https://czasopisma.marszalek.com.pl/images/pliki/tner/202104/tner6603.pdf>
- Kang H, 2023. Artificial intelligence and its influence in adult learning in China, *Higher Education, Skills and Work-Based Learning* 13,3: 450-464. <https://doi.org/10.1108/HESWBL-01-2023-0017>
- Karalis Th, 2020. Planning and Evaluation During Educational Disruption: Lessons Learned from COVID-19 Pandemic for Treatment of Emergencies in Education. *European Journal of Education Studies* 7,4: 125-142.
- Kavitha KB, Pradeep K, Nithiya S, & Suguna A, 2023. Implementation of Artificial Intelligence in Education. *International research journal of computer science* 10,05: 104-108. doi: 10.26562/irjcs.2023.v1005.01
- Keramati A, Afshari-Mofrad M, & Kamrani A, 2011. The role of readiness factors in E-learning outcomes: An empirical study. *Computers & Education* 57: 1919-1929, doi:[10.1016/j.compedu.2011.04.005](https://doi.org/10.1016/j.compedu.2011.04.005)
- Kejawa I, & Weaver C, 2004. The development of Artificial Intelligence Curriculum for adult learners at the Adult Education Center of the Palm Beach Country School District. Theses, Student Research, and Creative Activity: Department of Teaching, Learning and Teacher Education 85. <https://digitalcommons.unl.edu/teachlearnstudent/85>
- Lindner A, 2019. Teachers' Perspectives on Artificial Intelligence. <https://www.researchgate.net/publication/337716601>
- Luckin R, Cukurova M, Kent C, & Du-Boulay B, 2022. Empowering educators to be AI-ready. *Computers and Education* 3. <https://doi.org/10.1016/j.caeai.2022.100076>
- Malinka K, Perešini M, Firc A, Hujňák O, & Januš F, 2023. On the Educational Impact of ChatGPT: Is Artificial Intelligence Ready to Obtain a University Degree? In Proceedings of the 2023 Conference on Innovation and Technology in Computer Science Education V.1 (ITiCSE 2023), July 8–12, Turku, Finland. ACM, New York NY, USA. <https://doi.org/10.1145/3587102.3588827>

- Markauskaite L, Marrone R, Poquet O, Knight S, Martinez- Maldonado R, Howard S, Tondeur J, De-Laat M, Shum S, Gašević D, & Siemens G, 2022. Rethinking the entwinement between artificial intelligence and human learning: What capabilities do learners need for a world with AI?. *Computers and Education: Artificial Intelligence* 3, <https://doi.org/10.1016/j.caeai.2022.100056>
- Miller KE, Riley J, & Laura S, 2021. School Belonging Matters Now More Than Ever: Preparing Teachers to Foster A Technology-Mediated Culture of Care. In Ferdig RE, & Pytash KE (Eds). *What Teacher Educators Should Have Learned from 2020*, Association for the Advancement of Computing in Education (AACE). <https://www.learntechlib.org/p/219088/>. Accessed March 17 2023
- Nelson R, Mollenkopf D, & Gaskill M, 2021. The Four Pillars of Digitally Infused Education: Transcending Modalities in a Post-COVID Learning Environment. In Ferdig RE, & Pytash KE (Eds). *What Teacher Educators Should Have Learned from 2020*. Association for the Advancement of Computing in Education (AACE). <https://www.learntechlib.org/p/219088/>. Accessed March 17 2023
- Pedro Fr, Subosa M, Rivas A, & Valverde P, 2019. *Artificial Intelligence in Education: Challenges and Opportunities for Sustainable Development*. France, UNESCO.
- Roy R, Babakerkhell M, Mukherjee S, Pal D, & Funilkul S, 2022. Evaluating the Intention for the Adoption of Artificial Intelligence-Based Robots in the University to Educate the Students. *IEEE Access*, 10.1109/ACCESS. 2022.3225555
- Sadiku M, Ashaolu T, Ajayi-Majebi A, & Musa S, 2021. Artificial Intelligence in Social Media. *International Journal Of Scientific Advances* 2, 10.51542/ijscia.v2i1.4.
- Sazalieva E, & Valentini A, 2023. ChatGPT and artificial intelligence in higher education: quick start guide. UNESCO, <https://unesdoc.unesco.org/ark:/48223/pf0000385146>. Accessed November 30 2023
- Skhephe M, Caga NP, & Boadzo R, 2020. Accounting teachers' readiness for e-learning in the Fourth Industrial Revolution: A case of selected high schools in the Eastern Cape, South Africa. *Perspectives in Education* 38: 43-57. 10.18820/2519593X/pie.v38i1.4.
- Srinivasan, V. (2022). AI & learning: A preferred future. *Computers and Education: Artificial Intelligence*, 3, <https://doi.org/10.1016/j.caeai.2022.100062>
- Tlili A, Shehata B, Adarkwah M, Bozkurt A, Hickey D, Huang R, & Agyemang B, 2023. What if the devil is my guardian angel: ChatGPT as a case study of using chatbots in education. *Smart Learning Environments*. <https://doi.org/10.1186/s40561-023-00237-x>
- Toffler A, 1971. *Future Shock*. Bantam
- UNESCO, 2023. *Global Education Monitoring Report Summary 2023: Technology in education: A tool on whose terms?* Paris, UNESCO.
- U.S. Department of Education, 2023. *Artificial Intelligence and Future of Teaching and Learning: Insights and Recommendations*. Office of Educational Technology, Washington, DC.
- Vincent- Lancrin S, & van der Vlies R, 2020. Trustworthy artificial intelligence (AI) in education: promises and challenges. *OECD Education Working Paper No. 218*

Zawacki- Richter O, Marin V, Bond M, & Gouverner F, 2019. Systematic review of research on artificial intelligence applications in higher education – where are the educators? *International Journal of Educational Technology in Higher Education* 16:39, <https://doi.org/10.1186/s41239-019-0171-0>

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