STUDY ON AI IN EDUCATION POLICIES

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Abstract

Artificial intelligence (AI) is undoubtedly inevitable in the future of many industries, and it will also be an indispensable technology in schools, universities, and training centers. Presently, the developmental stage of AI in education (AIinED) is still in its infancy. AIinED will not only change the nature of teaching and learning in the classrooms, but also have a profound impact on the organization and operation of educational institutions and policymaking in educational systems.

Due to the emerging nature of the research on AIinED and the diverse presentation formats of literature and government documents, a meta-analytical systematic review is not yet feasible. Instead, a systematic qualitative/thematic analysis and synthesis approach is adopted in this paper.

This study is, therefore, focused on the major stakeholders and policymakers around the world including UNESCO, European Parliament, European Commission, National Security Commission on Artificial Intelligence of the USA, etc. Their policy documents published in the last 3 years on strategic plans and proactive regulations, as well as research papers published by experts in the area such as faculty, scientists, and consultants, will be studied in this paper. These documents will be the most significant and most relevant to this study.

This study focuses on the EU and USA, and there are several discoveries from this study. Firstly, the demand of AI related college courses has increased, which is an encouraging trend, but there may be a lack of faculty with relevant expertise, while the graduates mostly go for industry jobs instead of staying in academia. Secondly, the geographic distribution of such AI related programs is unbalanced in the EU, with three out of twenty-seven countries offering half of the undergraduate and graduate AI related programs in the EU. Thirdly, in the EU, the number of undergraduate AI-related programs is 3 to 4 times less than the AI-related graduate programs, so that the undergraduate programs in EU need to be strengthened in the AI-related field, while the USA offers about the same number of undergraduate and graduate AI-related programs.

This study also identifies the risks related to AIinED, such as unrealistic expectations from the general population, lack of expertise, challenges in data handling, and unpreparedness of the educational system in some countries. AIinED risk management policy with clear and executable procedures must be in place to lead to a higher consistency and less uncertainty in implementation.

The purpose of education is student learning, and hence the students are considered to be the center of AIinED. This study proposes a model, with students in the center, to describe how AIinED can be implemented with relevant stakeholders and needed resources at the school level, which could serve as a guideline to scale up such implementations at more schools.

Keywords: Artificial intelligence, education, policies, AI risks, AIinED model.

1 INTRODUCTION

Artificial intelligence (AI) technologies are considered to bring more than a trillion euros to the global economy by 2030 [1]. If the world is ready for it is a fundamental question. In 2019 UNESCO published “Final Report Planning Education in the AI era: lead the leap” [2]. The European member countries were fostered by the European Commission to prepare strategic documents for AI in Education and Education for AI. These documents did not seem to play a significant role in the policy shaping of the educational system, though. Meanwhile, a critical problem was noticed: there were not enough specialists to assure the proper implementation of AI in education. In 2020, the Oxford University published an interesting set of data showing “the readiness” of the governments across the world for AI [3] that demonstrated that not much had changed since 2017. By 2021, however, in comparison with the results from a 2020 study, the global pandemic of COVID-19 had a positive effect on the adoption of AIinED and the United States of America is leading in developing and implementing new technologies [4]. It is not unexpected that

during the pandemic the 'Silicon Valley' increased its influence, which was reflected in the ranking, putting USA as a leader with remarkable achievements.

The pandemic brought out another concern that the gap between the Global South and Global North has increased, when regions like Africa and South Asia are lagging with their readiness, widening global inequalities.

1.1 Artificial Intelligence in Education

The adoption of technology in education was progressing slowly before 2020 due to the mismatch between supply and demand. The COVID-19 pandemic promoted online education and fostered the implementation of technology [5]. Now, the usage of technology affects all levels of education, from elementary school to college [6]. To learn effectively with technology, we need to build an evidence base. This goes hand in hand with tools and processes for collecting, storing, researching, and evaluating large amounts of educational data. This "big data" comes from students' technology-enhanced learning activities, transforming data into information to create and recommend actions to improve learning outcomes. Artificial intelligence in education will not only change the nature of teaching and learning, but also have a profound impact on the organization of educational institutions and systems [7]. Artificial intelligence in education (AIinED) is a component of technology enhanced learning [8], [9]. In that sense it cannot be considered as a singularity but more than part of implementing technologies in education. In addition, AIinED is based on the research results and applications of fields such as Machine Learning, Automation, Deep Learning, Big-Data, Data-Mining, Learning Analytics, Text-Mining, Web-Mining, Multimedia Mining, Semantic Technologies, Social Network Analysis, Language Technologies, Natural Language Processing, Multi-lingual, Cross-lingual Technologies, Real-time Data Analysis, Data Visualization, Knowledge Management, Knowledge Reasoning, Cognitive Systems.

On the other hand, AI technology enhanced learning has three key components - Educational Data Mining (EDM), Learning Analytics (LA), and AIinED. While LA and EDM are focused on data, AIinED aims to provide intelligent agents through AI facilitated platforms for learners and tutors with automated grading and modelling and understanding of learning pathways. In other words, AIinED leads to learning, ensuring support, tutoring and assessment. Learning analytics visualize the data to give better insights into student's learning experience and results in an optimized learning environment. AIinED is the measurement and acquisition of digital teaching and learning behavior based on LA. In conclusion, LA is the data provider of AIinED used for personalization of education and personalized learning, optimization of e-learning, students, behavior modelling, predicting students' performance and realization, students' assessment content generation, competencies assessment, and student advising.

2 METHODOLOGY

When studying AIinED, due to the developing nature of this research field and the diverse representations of various evidence, a meta-analysis, such as in [10], has not been feasible. Instead, an efficient qualitative/thematic analysis, similar to the approach utilized in [11] has been conducted. This analysis includes empirical studies (qualitative, quantitative, and mixed-methods research), literature reviews (comprehensive reviews and shorter, topic-specific summaries), policy analyses (examinations of a policy's origins or impacts, policy briefs, and legal analyses), and theoretical analyses (analyses foregrounding or developing a particular theory or framework) focused on state of the art of the AIinED in the USA and EU. The empirical studies and the research papers reviews were used to analyze the trends offering education on AI, which is a key factor in developing and assuring expertise in the implementation of AIinED as well as to identify the key risks. The study includes analyses of the most relevant and sufficient policy documents issued by the main world stakeholders (UNESCO, EU Commission, EU Parliament, US National Security Commission on AI) to identify and describe the role of three major groups considered as AIinED end users but also main players in the implementation and development of AIinED. We have included and cited in this paper only documents that we found as most relevant and with greater impact on the topic.

This method allowed us to comprehend and record closely-related elements that conventional research investigations would not have been able to. However, some elements were better suited to certain themes than others. For example, while literature evaluations were helpful in identifying reasons for closure, we largely relied on empirical works for the consequences of closure, especially its impacts.

All searches were carried out between February 2021 and October 2022. Studies and policy documents concentrated on educational contexts or issues only were included.

3 RESULTS

3.1 Education on AI for AIinED

In 2021 Stanford University published the AI Index Report [12] examining the state of the art of the education on AI in the United States of America and the European Union (27 members). Its Chapter 4 “AI Education" is focused on higher education in these places. Based on this report, the following positive and negative trends can be summarized in Table 1.

Table 1. Trends in AI Education in the EU and the USA.

Region / Type of trend	EU	USA
Positive trends	The number of courses related to AI is increasing rapidly. The number of PhD-level AI-related courses increases.	
	The number of AI related courses is gradually increasing in both graduate and undergraduate programs through the years.	The number of undergraduate courses increases faster than the number of graduate courses, allowing the undergraduate programs to catch up with the graduate programs on AI topics. The number of schools teaching and researching in the field of AI is increasing.
Negative trends	The number of PhD students who have studied AI and found jobs in the industry increases.	
	Germany, France, Netherlands, and Sweden hold at least half of the AI-related programs (undergraduate and graduate) in the EU.	AI focused courses in North America are popular in many universities across the country.
	There is a significant imbalance in EU universities between the number of AI-related undergraduate and graduate programs, and the number of the undergraduate programs is 3-4 times less than the graduate programs in the EU.	Whereas in the US, the numbers of undergraduate and graduate AI-related programs are almost equal.
	In the EU, AI education is focused mainly on programs related to Robotics and Automation.	In the USA, AI education is focused on programs directly related to AI/ML, Theory and Algorithms, and Robotics/Vision. This can be explained by the fact that most of the AI-related programs in the U.S. are concentrated in the computer science departments.

The trends in table 1 show that the education system will experience an insufficiency of experts to work on and with AIinED as well as course designing and teaching. This lack of experts will continue until the number of undergraduate AI-related programs is not too much fewer than the number of graduate programs, while all the programs continue to grow to reach the critical mass to produce enough experts. According to the data in [12] this problem will persist for a longer time in the EU than in the USA. Although the trend shows an increased number of AI-related programs in both USA and the EU, their number is still not yet enough to produce a critical mass of experts who can be engaged with AIinED development within the education systems. Another obstacle that slows the process down is the concentration of AI-related programs in a few scientific areas, but AI is being implemented in almost every sector of the economy, and hence the AI topics need to be integrated into a wide array of programs.

3.2 Risks of AIinED implementation

The implementation of AI in education will change not only the way of teaching and learning, but also the role of the educators and the way that educational institutions work ([13], [14]). The adoption of AIinED may also lead to risks [15] and those risks might emerge, change, and disappear through the years. It is vital that those risks can be identified in time and appropriate solutions can be proposed by policymakers and stakeholders to mitigate them.

A regulation of the European Parliament [16] and of the Council of Europe says: “AI systems used in education or vocational training, notably for determining access or assigning persons to educational and vocational training institutions or to evaluate persons on tests as part of or as a precondition for their education, should be considered high-risk, since they may determine the educational and professional course of a person’s life and therefore affect their ability to secure their livelihood. When improperly designed and used, such systems may violate the right to education and training as well as the right not to be discriminated against and perpetuate historical patterns of discrimination.”

When a list of possible risks is set, it must be considered the different points of view of the “players" in the process. The risks may have different impacts on educators, students, AIinED developers, education institutions, and society.

When technology is implemented in an important sector in the society, such as education, there are often unrealistic expectations. Most of the strategic documents point out what AI will do, but not what it has done. There is a lack of understanding among society in general what AI technology can do. When it comes to AIinED, specifically, some people may have unrealistic expectations that AI could solve all the problems, which is not true, while others may be skeptical about the potentially negative impact of AIinED. The skepticism should not be ignored, and the main risks in AIinED come from two processes inherent for AI - data collection and errors.

The data collection is also referred to as digital data trace when talking about technology enhanced learning [17]. In schools, data is usually collected automatically through learning management systems, education apps, student advising systems etc. [18].

The possibility of errors cannot be neglected and must be made aware to everyone - data can be corrupted or faked, models can be not effective enough or break down under certain scenarios, and conditions can change (national policies, requirements for students and quality of education etc.).

With the growth of AIinED, people may become more and more dependent on AI in decision-making, but the AI system may make unexpected decisions leading to irrational actions. To prevent such consequences, reactive planning is recommended. The risk management structures must maintain a broad perspective. Different scenarios could be modelled and evaluated where and when a breach of confidentiality, integrity and availability may happen.

The unpreparedness of the educational institutions and national policymakers can lead to significant negative consequences and misunderstanding of the potential of AIinED. The organization should secure a reliable relation between the data, the model, and the system. The organizations must develop appropriate conditions for continuous adaptation.

The human factor is another significant concern when it comes to the implementation of AIinED. The lack of experts with competence in AI technology and educational skills is considered to be critical. The experts are expected to define teaching-learning problems, develop models, and collect the “right” data. Collecting the “right " data is one of the several data challenges when addressing some big questions on AIinED. There are no direct and simple answers to these questions: “What data should be collected?”, “How data should be collected?”, “How much data should be collected?”, or “What data is correct data?”. In addition, data could be manipulated, deepfaked, or poisoned, and its interpretation can be biased. The data could be a source of disinformation or blackmailing, and even for propaganda or unregulated monitoring and control. Therefore, data validation should be implemented by the learners and the educators, otherwise, they could lose trust in the AIinED tools.

3.3 Learners, teachers, society and AIinED

Most of the strategic documents issued by EU and UNESCO ([2],[19],[20],[21], [22]) are focused on the benefits that artificial intelligence will bring to the students. They put the students as the center of the AIinED system. However, AIinED will affect not only the students but also the teachers, and it should contribute to the well-being of the society. The development of successful policies for AIinED should consider the students, the teachers, and the society as a whole, and their points of view and the benefits for each of these groups should be accounted for. AIinED will enhance the learning for not only the students who are in formal education, but also students of all ages through vocational education and life-long learning programs. Students’ performance is the most fundamental assessment metric for AIinED, and it could be reflected in a diverse set of data such as course grade scores, standard school and state exams, attendance and tardiness records, school reports, and comparative rankings relative to peers. Other qualitative data such as interviews and surveys could also be used.

3.3.1 AIinED and the students

AIinED will lead to personalization of the education with its center to be the student, but the student must not be considered as an object rather than a subject with their emotions, dreams, understandings, and most importantly their talent. The conceptional model of an AIinED system having the student as the center, as illustrated in Figure 1, should stimulate the inherent creativity of the individual and give enough space and availability for collaborative work and socialization. To achieve that, AIinED systems will need data and infrastructure (AIinED hubs equipped with powerful computing power), leading to the development of algorithms that will be applied to models integrated in the education system and used by the student. The rectangular and straight arrows in the figure represent the data flow. The student will play a main role in such a structure as a user but will also generate data and ideas for system upgrade and development through their creativity. The creativity in the model is considered an intangible output and will also impact the student and hence the whole system. This is illustrated through the curved arrows in figure 1. A similar approach is considered by the US National Security Commission on AI in its final report issued in March 2021 [23].

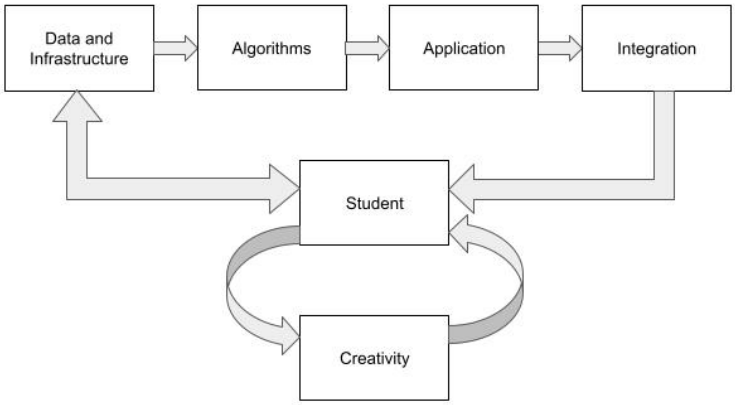

Figure 1. Conceptual model of an AIinED system.

This approach can lead to creation of an AIinED ecosystem consisting of Infrastructure/Hardware, Data, Software, AIinED platform, Applications, Users (students, teachers, society).

The application of AIinED will have a profound effect on the workforce development by 2030. AIinED will lead to faster and easier adaptation of students to the work environment after graduation, while preparing them for the professions of the future.

Higher education should be at the heart of the implementation of artificial intelligence educational tools, which should encourage the widespread use of artificial intelligence-based digital tools in educational processes, but also in the administration of higher education institutions, some of which could be introduced in K-12 public education.

3.3.2 AIinED and the teachers

In the age of information technology, specialized knowledge, and skills, especially those related to high-tech areas, such as AI, are characterized by a special dynamic of acquisition and updating, which in turn is directly dependent on the development of creative and proactive thinking from elementary and middle schools. The traditional model of K-12 teacher training is to train the teachers in colleges and universities, and these teachers are trained in a given discipline and will teach in that discipline for decades. This conservative teacher training model may pose potential issues when adopting new technologies. For example, the adaptation to the latest technological disciplines may be difficult and slow; the most sought-after course subjects may not be offered enough to satisfy the demand, and the teachers qualified to teach those courses may not be available. There is currently a shortage of teachers in key subjects related to AI such as information technology, various types of programming and programming languages, computer science, and electronics. There is also a shortage of teachers on the foundational subjects related to information, communication, mathematics, and physics. The shortage of teachers in these fields is partly due to their knowledge and skills becoming outdated, while some students' digital skills may be superior to those of some teachers. Meanwhile, textbooks on high-tech subjects become obsolete rapidly or there might not even be a textbook on the latest subject, given the extremely rapidly changing technological world. Similarly, the curricula in advanced high-tech

specialties / disciplines may become outdated rapidly. To address these issues in technology enhanced AI based education, we should find solutions in innovative educational models that integrate high-tech vocational education with higher education, supported by business and industry. Such a symbiosis requires a close collaboration between the K-12 teachers and business experts and university teachers. Business experts could provide the classrooms with the latest technology, while sharing their personal growth, initiatives, and professional success. Meanwhile, the teachers from higher education can visit the K-12 classes to share their academic spirit, creativity, and motivation. Such outreach activities may encourage the students to pursue a career in academia one day.

Through innovative educational processes, teaching methods, school leadership and learning strategies, AIinED may lead to a model for building a new educational paradigm, through which students can improve their educational outcomes and increase critical thinking and creativity. Every school has the potential to achieve these goals by introducing innovative elements in these solutions. These solutions would take resources (money and personnel, and time), so it may not be readily available to every school at once, although we hope that all schools could have the resources to implement the solution.

3.3.3 Recommendations

To overcome the negative trends of education on AI, which is and will be the critical link to develop the needed expertise for AIinED, we recommend the policymakers to encourage, motivate, and educate for wider implementation of education on AI. Education on AI should be integrated into as many technical and teacher training programs as relevant. The policymakers and industrial stakeholders should foster the environment to attract more students to continue their study in AI-related PhD programs.

In section 3.2 we described the general risks currently inherent to AIinED. To mitigate the risks, the national policymakers and education institutions need to be transparent and raise awareness on how AIinED will affect education, what the role of the learners and teachers will be, and what the scope of AIinED is as in [24]. A good example is the ethical guideline for teachers and trainers designed by an expert group of the European Commission [25]. The awareness campaign should set realistic expectations for the public and increase the level of trust in AIinED. Policymakers need to develop and implement AIinED risk management policy with clear and executable procedures, which leads to higher consistency and less uncertainty. They need to research and adopt appropriate measures to overcome the unpreparedness of the educational institutions, to come up with a governance structure that allows proactive and appropriate decision making to manage the risks of adopting AIinED. They also need to foster educational opportunities and provide rigorous hiring practices at K-12 schools and universities.

The implementation of AIinED is going on a trajectory with many crossroads on the way. Therefore, policymakers should aim for standardization in AIinED. AIinED must contribute to enhancing basic digital skills and competencies from an early age. Digital literacy means the ability to fight disinformation, compute for disciplines, and know and understand data-intensive technologies including artificial intelligence. We also need to ensure that women, persons with disabilities, and other underrepresented groups are equitably represented in digital studies and careers. AIinED should be safe, reliable, trustworthy, transparent, ethical, equitable, not discriminating, and complying with regulations while encouraging innovation and allowing healthy competition. AIinED should be used to improve human rights and fight against discrimination. Countries sharing such values and visions should collaborate and contribute to creating a new educational paradigm. Cross-national data collection and access should be made possible but only after assembling, accepting, standardizing, and legitimizing the above-mentioned AIinED principles to ensure responsible AIinED.

4 CONCLUSIONS

Artificial Intelligence in Education (AIinED) is inevitable in the future of education. AIinED will not only affect the education systems and organizations but also lead to changing the paradigm of education. There is no doubt that AI technology can be a powerful tool. When applied in education, it will not only bring benefits but also cause inherent risks and challenges. Although hundreds of guidelines have been proposed globally, it remains uncertain whether they are sufficient to meet those challenges. Our study is based on analysis of the most relevant and sufficient policy documents issued by the main world stakeholders (UNESCO, EU Commission, EU Parliament, US National Security Commission on AI) as well as peer-reviewed research papers focused on the state of the art of AIinED in the USA and EU. Our study identified the positive and negative trends in offering Education on AI in the USA and the EU member states. The empirical studies and the research and review papers led to the identification and

generalization of the main risks and the causes of such risks that accompany the implementation of AIinED. Three main stakeholders (the students, the teachers, and the society) in AIinED are identified, studied, and then described in a conceptual model of an AIinED system, where the students are at the center. This model describes how AIinED can be implemented by relevant stakeholders and with needed resources at the school level. This model could serve as a guideline to scale up such implementations in more schools. The paper also made recommendations on how policies could facilitate the implementation of AIinED in a safe, ethical, and equitable way.

ACKNOWLEDGEMENTS

The authors are grateful to Fulbright Bulgaria for the support and providing thriving conditions for this study.

Associate professor Vladislav Slavov would like to express his gratitude to Mr. Roozbeh Aliabadi, CEO of ReadyAI for the support and the confidence.

The authors are thankful for the financial support provided by the Faculty of Automatics at the Technical University of Sofia to make this study published.

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