



Harnessing Artificial Intelligence in Education for Preparing Learners for the 21st Century

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Abstract- Artificial intelligence (AI) learning systems have the potential to help learners cope with the demands of future work requirements. Learning with AI systems can usher students to develop 21st-century skills more effectively by providing individualized, engaging, flexible and inclusive learning environments. AI in education (AIEd) has been advantageous in maximizing student learning outcomes and can prepare students to thrive and contribute to the growing knowledge society and the future of automation. This paper provides a discussion of the 21st-century skills and some flaws in the current education system to help students develop advanced skills. It also briefly elaborates the concept of AIEd concerning the development of 21st-century competencies. Highlighting the existing application of AI learning tools and their potential, the paper explains their advantages in helping students develop the skills. Before concluding, it discusses some limitations of the learning systems.

Keywords: 21st Century Skills, Artificial Intelligence Learning Systems, Artificial Intelligence in Education, Current Education System.

I. INTRODUCTION

The 21st-century skills are vital for the current rapidly changing work environments (Luckin et al., 2016; Van Laar et al., 2017) and the future age of artificial intelligence (AI). Education must prepare students to contribute well in the forthcoming future of digitalization and automation in which individuals must solve complex problems with their innovative reasonings, disciplined thinking about vast amounts of knowledge and collaboration (Woolf, 2010a). Unfortunately, the current education system has some flaws and was designed to meet the demands of the industrial economy, developing the skills valuable in a society of industries, bureaucracies, and ledger ink rather than to prepare students for growing age of automation (Seldon & Abidoye, 2018; Andreas Schleicher, 2018).

AI applications have benefited applied science, healthcare and finance (Baker & Inventado, 2014). Similarly, harnessing the power of artificial intelligence in education (AIEd) can help students develop 21st-century skills, essential for them to drive the upcoming era of AI instead of marginalized by the machines. Unlike one-size-fits-all teaching practices, AIEd can foster deep thoughtfulness and model-based reasoning, e.g. analyzing causal relationships, critical thinking, problem-solving, and bridging inferences (D'Mello & Graesser, 2012).

The paper briefly explores 21st-century skills and links to flaws in the education system to prepare students for the coming age of AI. Along with the concept of AIEd and its advantages to equipping students with 21st-century skills, it highlights AI learning systems and their current applications in some educational institutions. Limitations of AIEd would also be the scope of the paper before the conclusion.

The 21st Century Skills

The unprecedented advances in technology especially the growing infiltration of AI in almost every sector and technological advancement in robotics, the internet of things, quantum computing and more would

drastically change the fabric of future working environment and society. To cater to the need of changing working context and actively participate in growing knowledge society, today's education system is challenged to equip learners with a variety of competencies and abilities, commonly termed as 21st-century skills. Generally, 21st-century skills include collaboration, digital literacy, citizenship, communication, creativity, problem-solving, critical thinking, and productivity (Voogt & Roblin, 2012). However, different groups put forward their understanding of 21st-century skills. For instance, The National Research Council has categorized 21st-century skills into three major areas; (a) cognitive skills (cognitive knowledge, creativity, processes and strategies) (b) interpersonal skills (collaboration, teamwork, leadership), and (c) intrapersonal skills (positive self-evolution, intellectual openness, and work conscientiousness) (Silber-Varod, Eshet-Alkalai, & Geri, 2019).

Since current literacies in reading, writing, and numeracy will not be enough to survive in the future of ever-growing digitalized world of machines, Joseph E Aoun puts forward "humanics", as a set of 21st-century skills to prepare the current generation for the future (Aoun, 2017). He categorizes "humanics" into two clusters. In the first category of "new literacies", "data literacy" skills, he considers are fundamental to help learners read, analyse and systemically use mass information. Another is "technological literacy", an essential competency to give learners a platform to develop coding and engineering principles to understand the working mechanism of digital machines. To collaborate and understand the human world "human literacy" is another category of new literacies. Another group of "humanics" is the "cognitive capacities" or mindsets of thinking about the world, in which he separates four skills. The first type is, "System thinking" which relates to the abilities to make connections of an enterprise or any subject among its functions. The second is a competency of "entrepreneurship" which refers to creative approaches and innovative mind towards work and economy. The third is "cultural agility" which he explains sets of skills to carry on different tasks and responsibilities in complex, global changing environment and understand cultural diversity. The last competency is "critical thinking" which helps people engage in rational analysis and discernment.

In general, most of 21st-century skills definitions and frameworks are interlinked with each other (Spector & Ma, 2019). Changing working scenarios have made 21st-century skills essential to remain in a position to earn livelihood in the future era of automation. The rapid growth of technology has challenged employees to develop exceptional technical skills and competencies to cope with the growing demands of job requirements (Ahmad et al., 2013; Carnevale & Smith, 2013). Besides, the development of the global knowledge society has been urging learners to develop advanced competencies to participate in the community actively.

Flaws in the Current Education System to Develop the 21st-Century Skills

There are some flaws in the current education system to prepare learners for the upcoming era of widespread automation. For example, many classrooms are still following the old track of the 19th and 20th-century classrooms settings; standing in front of the classroom, teachers read out their scripts (Woolf, 2010a). Students passively catch a bunch of information during the lectures and work individually on their assignments that hardly develop deep understanding or any relevance to the application of concepts to actual-world problems (Woolf, 2013). According to research findings (Arum & Roksa, 2011), forty-five percent of the sample undergraduates "exceedingly small or empirically nonexistent" gains in complex reasoning, critical thinking and written communication in the first two years of their college studies. Even after completing four years of college studies, the same survey found that thirty-six percent of the participants hardly showed any development of the skills. Instead of developing all the aptitudes of the students and prepare them for changing working requirements, universities like schools have been adhered to set methods of providing education. They are not improving the curricula for active learning (Seldon & Abidoye, 2018).

Most educational institutions apply outdated curricula and pedagogical methods which mostly pay weight to transfer bodies of information into students' minds (Aoun, 2017). Instead of nurturing skills, like critical thinking, communication and metacognitive skills, college education too often focuses on the ingestion of content (Aoun, 2017). Mastery of facts and knowledge which is still common practices at many educational institutions fails to prepare learners to thrive in the future society and workplaces, as advanced machines, robots, AI are smartly capable of mastering facts and information most efficiently. Plagiarism and cheating is also a prevalent problem in the present education system (Seldon & Abidoye, 2018). Besides, assessment

methods and criteria are too weak and biased (Tversky & Kahneman, 1974) that hinder learners from developing skills. Large class size is also a problem that often inhibits most students from expressing their comments and creating difficulties for teachers to diagnose and attend to individual student's needs.

Concept of AIED vis-à-vis the 21st Century Skills Development

Defining AI is quite challenging even for experts in the field (Luckin et al., 2016). However, AI can be defined as a tool that has been designed and developed to assist in or replace decision-making processes through analysis of data, and prediction of the best value for a designated outcome variable, which is conveyed through a user interface (Seering, 2018). AIED specifically AI systems for learning can be proposed as technological tools programmed to interact decision-making intelligent actions and predictions through intelligence capabilities of computational systems generated after a deep systematic analysis of digital data gathered from various digital tools (i.e. visual perception, facial recognition) (Russell, 2016; ODE, 2005).

AIED augments teachers' intelligence by providing them with sets of predictions and recommendations to maximize learning (personality growth, development in the sense of self-efficacy and self-esteem) (Underwood & Luckin, 2011). AIED pivots around models which are designed by traits of students, teachers, affective, metacognitive, collaborative factors of learning, the learning environment and the context of learners (Luckin, 2010). After going through systematic analysis of various digital data (i.e. administrative, demographic, students' interactions with technology, peer interactions, students' affect), gathered from physiological sensors and sophisticated digital tools (D'Mello, Picard, & Graesser, 2007; Arroyo, 2009), AIED can enable teachers to see reliable calculations, recommendations, and predictions about better student learning outcomes

AIED would create optimal student-centered smart learning environments for allowing each student's learning personalized and tailored according to their learning preference (Seldon & Abidoye, 2018) and the development of 21st-century skills. With the techniques of AI, including natural language processing, modeling, and machine learning, AIED would provide specific knowledge about the domain, student and pedagogical strategies (Woolf, 2010b). Such smart environments will be called "learning studios" or "intelligent environments" in which personalized acoustic, temperature, seating arrangement, lighting would be aligned following the principles of student agency, choice and flexibility for optimal individual and collective learning outcomes. The AI-powered learning environment "will teach soft skills, such as creativity, critical thinking, communication, collaboration, information literacy, and self-direction, and will be open-ended and exploratory in nature, allowing learners to question and enhance their understanding about areas of knowledge in which they are motivated to learn" (Woolf, 2010a).

Equipping learners with the 21st-century skills to drive the digital future instead of marginalized by the machines, harnessing the power of cutting-edge technology, especially AI, is a necessity. AIED has great potential to make us understand effective pedagogical methodologies and create a productive learning environment that enables learners to develop the skills. With the tools and techniques of AIED, we can make learning visible and precisely analyze the development of learning patterns, skills and capabilities of learners (Luckin et al., 2016). Since it is hard to measure the skills development, data captured by sophisticated digital tools would let AIED systems show evidence to evaluate the skills. According to an assessment of the skills development, teaching and learning practices would be designed for the maximum learning outcomes. Mass data collection by AIED systems will enable us to develop most suitable teaching methodology, learning methods and learning environment for developing learners' different skills and competencies in specific to the 21st-century skills (Luckin et al., 2016).

Benefits of AIED in Development of the 21st Century Skills

As many educational institutions are based on "factory model education", they pay attention to a limited range of human intelligence and potential (Seldon & Abidoye, 2018) and hardly inculcate the 21st-century skills into learners. However, with the advent of AIED, learners will not only develop modern skills but also realize their multiple intelligence (Seldon & Abidoye, 2018).

AI learning systems have great potential to promote 21st-century skills among learners by helping them develop growth-mindset. The recent development of AI-driven software, Brainology by Carol Dweck, assists learners in content to encourage a growth mindset(Dweck, 2018). With further advancement in machine learning, natural language process, learning analytics, and educational data mining, the AI learning systems would adapt to a learners' learning behaviour, goal orientation or scaffold them towards mental capabilities(Harris et al.,2009).Moreover, the systems might provide teachers specific feedback about each learner's cognitive engagement and problems-solving skills and accordingly recommend future learning activities for the active development of a growth mindset. In this regard, the development of AI-powered "Teacher Advisor" by IBM Foundation is a good omen for teachers to select optimal recourses and make learning personalized to foster a growth mindset(Nick, 2017).

For the development of social skills, several initiatives and AIEdTech products are being used. "StartEd" programme of New York's University helps learners enhance their emotional intelligence(Seldon & Abidoye, 2018).Elements of emotional intelligence, (i.e. integrity and empathy) are effectively imparted among the students with the aid of AI tools(Worth, 2018). Collaboration, gratitude and respect of others' opinion and cultural diversity are also the core values for successful thrive in the future age of automation. AI Startup "Peekapak" has developed research-based learning AI tools (digital games) to teach learners about teamwork, respect and gratitude. In Finland, "Hello Ruby" product has been used to help young learners "think through creative and artistic programmes" (Kruskopf, 2016;Seldon & Abidoye, 2018). An EdTech company, "Emerge" has taken the initiative to help students enhance tech skills by building desktop and laptop PC based on Raspberry Pi(Seldon & Abidoye, 2018).

AI learning systems will take charge of various routine,mundane tasks of the teachers, freeing them to focus on nurturing students' multiple intelligence with useful applications of AI technology(Seldon & Abidoye, 2018). Mostly energy and time of teachers are consumed covering the curriculum, maintaining performance and attendance registers etc. With the aid of digital sensors, AI machines will select tailored-based suitable teaching materials for each student. The systems will continuously monitor and assess each student's performance, affective states and even level of understanding of the concept taught after each lesson. It will mark attendance and scores on the central register according to the overall performance of each student. Besides, it will speed up the learning process with maximized learning outcomes. Hence, the free time will be utilized for the development of students' moral, spiritual sensibilities and interests.As the AIEd will create a personalized learning environment, it will designnurturing challenges, based on each students' cognitive capabilities to get creative responses in ways students might be hesitant to do in front of a classroom. AI learning tools would enable students to build their personal and social intelligence by helping them enhance their self-efficacy and abilities to assimilate digital knowledge and negotiate the digitalized world effectively.

There has been considerable interest in developing AI-driven learning systems that act like peers and companion for life-long learning(Selwyn, 2019). The aim to build such life-long learning partner is to equip learners with skills, essential to cater to the need of the changing demands of the work environment. AI in the business sector might keep updating the AI learning companion systems about the competencies the employers are seeking(Luckin et al., 2016). Consequently, the learners would be provided with specific learning activities which might help them develop those skills and competency for better job opportunities.

Collaboration is one of the vital skills of 21st-century skills(Voogt & Roblin, 2012). Regardless of a group of learners participating in an online course or a pair of students interacting in the real-world to attain mutual learning goals, collaboration can promote higher student learning outcomes than learning individually(Dillenbourg et al., 1995).AIEd can help teachers achieve maximum learning outcomes by suggesting about a group formatting, learning tasks, and monitoring students' performance. Apart from being a tutor and coach, AI virtual agent can act as a peer for learners (Luckin et al., 2016). By understanding the level of learners, their cognitive approach, similar and different learning interests, knowledge and skills(Muehlenbrock, 2006), AI agent can virtually enable collaborative problem-solving learning environment by connecting learners. It can bring itself at the understanding level of the learners and tailor challenges in learning activities, suitable for each learner rather than for all learners. Consequently, the virtual peer can encourage each learner's active participation by making them realized that they are contributing, and their role is engaging incollaborative problem-solving learning. Such motivational approach

enables students to boost confidence and develop personal skills to participate in the collaboration. It unleashes “trapped intelligence”- allowing low-achieving learners to build their self-confidence by turning their self-belief from being a weak academic performer to a progressive student (Dede, 2009).

Limitations of AI Learning Systems

Although technology helps to develop the 21st-century skills through engaging learners in strategies including collaboration, creativity, problem-solving thinking, personal growth, responsibility and adaptability (Kaufman, 2013), the potential of AI learning systems could face limitations to harness maximum results. AI tools are not magic machines. Indeed, AI is “math and data and computer programming, made by regular humans” (Mason, 2018). Educational data can be erroneous, poorly selected or an inaccurate indicator of what is supposed to teach students (Selwyn, 2019). The data-driven AI learning systems raise problems of data integrity and robustness. Ensuring that data reflect a learner’s exact skill development and the prediction of AI learning systems about each learner’s learning behavior can be quite hard to explain. Despite advancement in AI, it can be argued that accurate AI-driven learning systems are still difficult to code, as classrooms are not computable systems and there are uncontrollable variables to monitor and manipulate (Selwyn, 2019).

“Everything is not quantifiable, calculable and amenable in education” (Selwyn, 2019). What data scientists and software engineers believe that everything is predictable, measured, quantified and statistically amenable to regulate can happen in the fields such as finance, marketing and law. In education, social-cultural and psychological factors are involved that affect the learning process and might not be detected by AI tools to form learner’s model. For example, coding an accurately nuanced and sensitive AI programme of a learner’s fragility or a genuine sense of family destitution would be quite challenging. Considering the limitation of the technology in sensing social aspects of human life, Murray Goulden warns against our welcoming gestures to the technology that fails to “understand the social practices it is attempting to appropriate” (Goulden, 2018).

II. CONCLUSION

The paper reviewed how AI learning systems can help learners develop advanced skills and competencies to cope with the changing requirements of the job market. The rapid advancement in technology has been demanding the development of 21st-century skills among learners to take charge of the future. AIEd has the potential to enhance many skills of learners by ensuring active support for collaboration and monitor its content. Learning with AI tools helps students for social, exploratory, and ubiquitous learning (Woolf, 2010a), which might be transformative in assisting them to enhance advanced skills. Moreover, AI-powered learning environments can tackle long-term challenges of education by providing an opportunity of personalized, tailored, engaging and lifelong learning to each learner (Holmes, 2019).

Preparing today’s generation for the future age of AI, we need to exploit the power of AIEd by minimizing its limitations and tackling ethical issues. Along with adopting AI tools for learning, we should come up with innovative instructional approaches to enable learners to develop 21st-century skills to solve problems in collaboration and foster their creativity, curiosity and intrinsic motivation. Reforms in the learning and teaching paradigm by harnessing the potential of AIEd should be the action-oriented strategies to empower learners and create better learning opportunities for not only nurturing various skills but also accurately understand, measure and assess them.

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