Artificial Intelligence as a Disruptive Technology in Education

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Abstract

21st century is a synonym for change in all aspects of life and economic activities. Accelerating change is caused by development of new technologies that radically change how humans communicate and cooperate. On average, formal education in comparison with other economic sectors is lagging behind in adoption of contemporary technologies in educational processes.

One of the biggest potential impact that will radically change the landscape of education is implementation of artificial intelligence. That radical change makes artificial intelligence disruptive technology with unforeseen consequences for students, faculty and society in general. The bottom line is that educational system will be forced to adopt to new technologies, abandoning traditional teaching and pedagogical practices that were in the center of education for centuries.

This paper gives a short overview of disruptive innovations and technologies with the focus on artificial intelligence as a disruptive technology. Special focus is given to the limits and obstacles of introduction of artificial intelligence in educational processes and educational system in general.

Keywords: *artificial intelligence, disruptive technology, education.*

1. Introduction

Disruptive technology is viewed as a key factor for making sustainable businesses. The core to disruptive technology is not sustainability but transformation of existing business practices and models. Such radical transformation, if unnoticed, can threaten existing organizations in all aspects of economy and society in general. Artificial intelligence (AI) is not necessarily disruptive – disruption is in the function of context or, as Christensen et al. emphasize, that "a given innovation can be disruptive to one firm but sustaining to another firm" [1]. In context of education, artificial intelligence represents the powerful disruptive factor because it has a potential to change the role of teaching personnel, students and educational institutions.

2. Disruptive technology

2.1. Disruptive technology – theoretical framework

Disruptive technology as a concept was first introduced by Bower and Christensen [2] who contrasted disruptive technology to sustaining technology where sustaining technology refers to the incremental improvements of existing products while disruptive technology refers to introduction of different concept of value or creation of new market. Disruptive technology can be viewed as any technology with different value proposal that challenges traditional markets with better products and services at the lower price. Inability to notice disruptive technology on time can lead to company's bankruptcy or even disappearance [3].

2.2. Potentials in education

Historically speaking, education did not substantially change since ancient times; it has only seen incremental changes that have not been sufficient to face the rapid technological development and consequently, transformation of entire society. That situation requires redefinition of entire educational system [4]. Is disruptive technology the answer? Related to higher education, there are many technologies that are seen as disruptive, such as: On-line Learning, Competency Based Education, The Internet of Things, Virtual Reality, Collaboration Platforms and Artificial Intelligence [5][6]. These technologies make education process more convenient for students and thus challenging conventional educational practices offered at the universities.

On the other hand, lower levels of education are not that much challenged by disruptive technologies because they are not yet challenging traditional learning resources [7]. In other words, teachers and books are still at the center of learning process. Disruption in education will be characterized by [8]:

- better service models that are built around improved educational program quality
- more personalized and real life educational processes
- development of high value, niche programs aimed at specific groups of users

3. Artificial intelligence in education

3.1. Application of the concept

By definition, artificial intelligence refers to "the ability of a digital computer or computer-controlled robot to perform tasks commonly (AI) associated with intelligent beings" [9]. Artificial intelligence systems can be categorized in two broad groups: applied AI and generalized AI. Applied AI is developed with the clear focus in mind, i.e. to control cars, trade stocks or make medical diagnosis. On the other hand, generalized AI doesn't have specific focus and it usually refers to the concept of machine learning [10]. Generalized AI differs from the approach it has to learning. Most common approach to machine learning is supervised learning where AI system learns with outside assistance from predefined set of data. The contrast to supervised learning is unsupervised learning where AI system does not use existing data for learning but is aimed at recognizing patterns among data that previously were unknown [11][12].

3.2 AI in education

While artificial intelligence is penetrating all aspects of our society, educational institutions are still resisting AI influence. Contemporary classroom didn't substantially change from the one that existed in the past mainly because our existing educational models and systems are still stuck in their traditional forms, hindering the true adoption of AI systems [13]. Instead of traditional assessments, which rely on small samples of what students have been taught, Artificial intelligence in education (AIEd) - driven assessments can be built into meaningful learning activities, such as games and collaborative projects [14]. Such activities are likable to students therefore enhancing their learning process making it natural and boosting their enthusiasm for learning. The major advantage is that this approach makes education nondiscriminatory and tailored to each individual. That idea is disruptive in essence, because it radically changes approach to knowledge transfer and evaluation. The concept of AI in education perfectly fits the framework of disruptive innovation proposed by Christensen et al. who state that "when initially introduced, disruptive innovations are inferior to incumbent products on accepted performance dimensions, but they offer a novel mix of attributes that appeals to fringe customer groups, notably those near the bottom of the market" [1] where fringe customer groups are hard to categorize under some common attributes because they are not so homogenous as core customer groups [15] - i.e. regular students and teaching personnel in public school system.

Today, teachers and students use gadgets and smart boards in classrooms mainly for routine teaching activities, while in essence, the whole structure of the educational process remains pretty much the same regardless of potentials of contemporary technologies. Contemporary technologies enable teachers and students to exploit worldwide knowledge where the only limitation represents vast amount of available data and data sources – big data. AI in that manner represents the solution to big data issues. However, these technologies have yet to blend into widely adopted systems to facilitate teaching [13]. Major obstacle to wider penetration of AI systems in education are teaching professionals that are not ready to introduce AI into their teaching process. However, penetration of technology to teaching processes is substantial making more free time for teaching personnel so that they can dedicate more of their time to tasks for which human intelligence is still required [16].

AI concepts in education should include knowledge representation and communication, problem solving approaches, dynamic student modeling, human cognition, intelligent user interfaces, intelligent help systems, use of strategies etc. [17] aimed at simplification of learning process. As Self [18] states that at the heart of AIEd is the scientific goal to "make computationally precise and explicit forms of educational, psychological and social knowledge which are often left implicit".

Today, AIEd is implemented in classroom through tutoring systems, personalized learning, testing systems and systems for automating routine tasks such as generation of test questions and grading activities. But there is still no consensus about the true effectiveness of AI based instruction [19].

The bottom line is that the role of the students and teachers is transforming; students are becoming active participants in the creation of teaching process while the teacher is becoming a mediator in knowledge acquisition. In other words, the role of the teacher continues to evolve and will eventually be transformed, in the way where their time will be used more effectively and efficiently, and where their expertise will be better deployed, leveraged, and augmented [14]. In doing so, they will use AIEd in their everyday routine activities, but will retain their skills and abilities to convey the knowledge to the students. Successful AIEd should have appropriately developed knowledge models – pedagogical, domain and learner model of the world that connect approach to teaching, subject taught and the student [20]. Ultimately, combining the best of human and machine for the benefit of the student is the true goal of artificial intelligence in education [16].

3.3. AI in education – advantages and disadvantages

3.3.1. *Advantages*
Generally speaking, AI can be used to prevent organizational or general knowledge being lost when specific knowledge sources (s.a. ex-employees) are no longer available. That kind of preserved knowledge can further be developed enlarging its useful lifespan. Direct advantage of AIEd implementation can be seen in cost reduction through automation of the processes (i.e. automation of enrolment activities related to new students). AI is also appropriate for situations with high degree of uncertainty in decision making processes making decisions faster and more reliable [21].

And maybe the most important advantage of AI in education is related to personalization and customization of teaching process and the learning content. AIEd would improve objectivity and equality making decisions on more objective parameters that include not just knowledge demonstration but also current mood of students or some other background distraction factors that can influence learning process. Also, as AIEd are artificial forms, they are available to teaching personnel and students 24/7. In addition, AIEd makes virtual reality integrative component of learning environment. That enables students to experience their learning subject making learning activities more interactive. Also, with automatic translation tools, implementation of AI also narrows the language gap for foreign students [22].

3.3.2. *Disadvantages*
Disadvantages can be grouped into technical and nontechnical disadvantages. Technical disadvantages arise from the fact that current AI systems are based predominantly on predefined datasets and their relations that potentially can be misrepresented. As the whole idea of AIEd is based on finding the optimal solution to specific problem it's success is questonable especially because in many aspects of AI applications there is no consensus on what is considered to be an optimal value [21]. As majority of educational system users represent vulnerable populations (s.a. children), intensive use of ICT (AIEd) is very addictive and can result in poor academic performance or depression [23]. Although occupations in educational sector are rated as low risk occupations to be replaced by ICT solutions [24] there is very big concern that large scale introduction of AIEd will lead to increased unemployment of teaching professionals [22]. Another potential limitation of AIEd is that it can also inhibit student engagement. This limitation is largely dependent upon physical manifestation of AI systems. Virtual agents, which are prevalent form of AI in educational system, are a software systems installed on existing commercial devices like PC-s, tablets of smartphones. Usage of such devices can lead to productivity paradox in students where investment in AI and ICT in general does not necessarily improve students' academic results [25][26]. Potential solution to that problem are physically embodied robots that offer important advantages over virtual agents: they are more suitable for teaching processes that require interaction with the physical world, promote social engagement and therefore better learning that leads to better students' performance [27]. Physically embodied robots also can act as human teachers "to direct child's attention during the task" although this ability of robots should be significantly improved or otherwise students might lose their interest in learning process [28].

4. Future prospects of AI in education

The current limitations of technology prevent AIEd from replacing human teachers but research and development in the fields of robotics and AI point out that that kind of future is possible if not imminent. For example, Saudi Arabia was first country to give a robot citizenship [29]. In 2015. SoftBank Robotics made commercially available first social humanoid robot that is just one way forward to the development of robots with ability to become your romantic partners [30] that is the engineering task far more sophisticated from development of robotic teachers. Furthermore, recent advancements in non-invasive brain-computer interfaces and AI are opening new possibilities to rethink the role of the teacher, or make steps towards the replacement of teachers with teacher-robots, virtual "teacherbots" [31][32]. This important crossroad requires careful consideration and analysis from an academic perspective, because there is a tendency to look at technological progress as a panacea to issues that have arisen from old, traditional teaching practices [33]. With the advancement of technology, educational goals are also altered as the overall educational process must be changed accordingly.

The future of education is intrinsically linked with developments of new technologies and computing capacities of the new intelligent machines. The current education system is not aligned with the "real world" where contemporary technologies have dramatically changed the way we live and work, making the traditional education system a remnant of the past [4]. The traditional education system is

based on national curricula and grades with strong emphasis on theoretical framework. Today, students are becoming subjects of their own education with the focus on skill development [34].

One of the grand challenges in education also is to recognize that citizens of the 21st century require different skillset than did citizens from earlier centuries. 21st century skillset includes cognitive skills (non-routine problem solving, systems thinking and critical thinking), interpersonal skills (ranging from active listening, to presentation skills, to conflict resolution) and intrapersonal skills (broadly clustered under adaptability and self-management /self-development personal qualities) [35]. These skills will be crucial for people to be competitive in future work market. It is, therefore, important for students to develop above mentioned skills through their education. To make this viable it will be necessary to redefine existing curricula [36]. At the minimum students need to be taught how to collaborate with AIEd, learn from it, evaluate information it provides, use it wisely, and contribute to it with well-vetted information [37]. In addition to that, it is inevitably that students will actively use AIEd in their future lives and therefore they should "be able to understand what impact the technology will have on society", especially because future work will be dominated by technologist who "have a societal obligation to drive positive change as much as possible" [38]. They have to rely on learning how to learn, and not so much on what to learn. Content is no longer as important as is the way in what something new will be learned, especially because with the assistance of AIEd entire knowledge will be one click away.

For educators, demanding technological progress and potential "threat" of AI to existing educational system requires rapid revision of what is taught and how it is presented to take advantage of evolving knowledge [37]. That is why their role, and also their education, is drastically changing. Communities of researchers offer distinct clues to further refine individual instruction in online environments and also require far deeper knowledge about human cognition, including dramatically more effective constructivist and active instructional strategies [39]. So, to answer challenges posed by disruptive technologies, educational institutions must redefine everything they are offering (the value proposition of their customers – parents and students) and change the mode of delivery of educational content, that is, redefine their processes in general [4]. That is why, in field of education, improvement in AI has to be open to new possibilities and challenges for teaching and learning, with the potential to fundamentally change governance and the internal architecture of education institutions [33].

5. Conclusion

Current educational systems all over the world are inert to changes in global environment. Traditional forms of education are still dominant although they are becoming more and more challenged by new technologies and societal trends. In the next 15 years most of new jobs will be more cognitively demanding, that emphasis will be on social skills what will consequently lead to creation a learning society [20]. AI will take over majority of routine jobs making schools learning communities. In the short term, teaching professionals are not threatened by the AIEd but it can be expected that their role will transform from teachers to coaches because knowledge dissemination will be left over to artificial intelligent forms.

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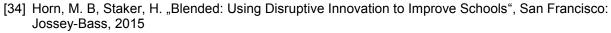[8] Abel, R. "What is Disruptive Innovation in Education?" IMS Global, 2013,

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