

# The Potential of Artificial Intelligence to Develop the Education System in Egypt<sup>1</sup>

Dr. Adel Muhammad El-Adl<sup>1</sup>

Professor of educational psychology

Faculty of Education - Zagazig University

*Abstract*, the use of Artificial Intelligence (AI) in developing new teaching-learning solutions is gaining momentum towards transforming the education system in Egypt. Schools are beginning to shift from conventional methods of teaching to smart education to enhance students' learning experiences. Reviewing the literature on machine learning, personalized learning, and Bloom's taxonomy, and using qualitative approach; we set out to examine the following: How are the educational technology departments in Egypt using AI to change the ways teachers teach and students learn? What are the untapped AI-technologies that have the potential to transform the Egyptian education system? We conducted in-depth interviews with five specialized experts working in the field of technologies related to artificial intelligence and five leading Egyptian educational technology experts who work in developing artificial intelligence-based education systems for schools. Deploying grounded theory, we found that personalized learning, recommendation systems, and adaptive assessments are helping students and supporting teachers. In an emerging country context, we demonstrate the educational technology departments' view of AI and the experts' view of AI. The gaps between these views indicate the immense potential of AI which can be tapped by educational technology firms in their future applications. The study recommends that artificial intelligence has profound implications for the transformation of the education system in emerging countries.

Keywords: Artificial intelligence; personalized learning; smart education

## *Introduction*

Recent years have witnessed burgeoning changes in the development of learning pedagogies that are greatly enabled by information and communication technology (ICT) (Sinha & Bagarukayo, 2019; Tijani,

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<sup>٢</sup> ت: Email:eladladel@gmail.com 01220705100

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Obielodan, & Akingbemisilu, 2020). By providing an enriched environment, technology has made a profound impact on individuals' learning experiences. Using technology, students get a blended experience of learning inside and outside the classroom. Thanks to intelligent teaching systems, technology architecture, and artificial intelligence (AI) capabilities, new teaching and learning solutions are being developed and tested globally (Chen, MdYunus, Ali, & Bakar, 2008; Pedro, Subosa, Rivas, & Valverde, 2019). This new ecosystem is created by innovators in order to develop an inclusive learning environment. This advancement in the education system is essential because education aims to develop the individual to drive future growth, thus ensuring the prosperity of societies and nations (King, 2011). The future of work is very dynamic, and to be able to succeed in times like these, people must be flexible and adaptable. Skills such as critical thinking, leadership, communication and teamwork are crucial to nurturing young minds. Furthermore, students should be encouraged for lifelong or continuous learning that will help them adapt to the changing work and life environment (United Nations 2019).

ICT powered learning management systems help teachers enhance students' learning experience (Sandhu, Sankey, & Donald, 2019). For example, it was found that when an economics teacher engaged students using a computer-assisted method, they took half the time to complete the curriculum compared to the traditional method of teaching and the students performed similarly in both methods (Schute, Glaser, and Raghavan 1998). These teaching systems were developed by integrating the disciplines of psychology, computer science, and education (Thai-Nghe 2011). While psychology sheds light on how individuals think, learn and behave, AI algorithms see themselves learning from human intelligence. This computer-based learning enhances the teaching and learning process by predicting student performance and creating personalized learning experiences (Thai-Nghe, Drumond, Krohn-Grimberghe, & Schmidt-Thieme 2010).

Proponents of artificial intelligence and machine learning hold great promise for enhancing the field of education; However, its current application is limited. Classification and decision making are at the heart of applying AI technology. Although current learning management systems are easy to use, they lack the adaptability for self-learning that forms the core of AI. An AI system in its true sense must be dynamic and able to update itself through continuous interactions with learners and dynamic resources in its environment (Mitchell 2017; Pedro et al. 2019).



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### *Literature Review*

#### *Artificial Intelligence*

The fourth industrial revolution is especially based on knowledge. Artificial intelligence as one of the innovative technologies has a critical position in the Fourth Industrial Revolution (Russell & Norvig, 2019). Machine learning lies at the heart of artificial intelligence technologies. With deep learning and the endless algorithms, life becomes more flexible, fast, comfortable and risky (Ermağan & Ermağan, 2022). On the one hand, while new jobs are being produced, on the other hand, some professions are either decreasing in importance or disappearing. It must be stated that such a reality seems far (if not impossible) yet. This vital problematic raised the question: “Can robots really destroy humanity?”. Experts make statements as optimistic and pessimistic, statements made and the events encountered both increase people’s attention and worry about the issue. In other words, generating ideas about the future of the relationship between humans and AI will be to note the trajectory of human beings (Tegmark, 2017). On the back cover of Kurzweil’s book, Bill Gates wrote: The author’s new book, which makes people curious, predicts a future where information technologies develop rapidly enough to allow humanity to transcend the biological boundaries and transform our lives in ways that we cannot even imagine today. Such that, two Microsoft executives Brad Smith and Harry Shum suggest that AI can replicate the characteristics of humans and that users will become twins with AI in the next 20 years (Microsoft Corporation, 2018). Nevertheless, it is a fact that with the algorithms used by computers, solutions can be found to many problems of humanity.

It is also a fact that artificial intelligence applications make life easier. Main application areas of AI can be sorted as speech recognition, image processing, natural language (tongue) processing and reasoning. In daily life, it is mainly used in the following areas: Cyber security and defense industry, voice assistants, language translations, suggestion systems, navigation, social security, healthcare, e-Commerce, assistant robot applications (Pannu, 2015).

Artificial intelligence is defined as a wide-ranging branch of automated decision making without human involvement. It covers different areas from conditional logic to neural networks. Machine Learning (ML), a subset of AI, means decisions or predictions made by data-driven technology. Machine learning methods powered by AI include deep neural networks (DNN), also known as deep learning (DL) (Figure 1). Machine learning,



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eventually simulating the conduct and guidance of a human tutor in this context (Abdullah, 2021). The researcher envisaged personalized tutors who adapt to each student's needs or teach student groups based on gender classification, level of achievement, lesson time, etc. Artificial intelligence techniques include interpreting complex student answers, getting to know learner's performance, and understanding when/why the understanding of a student has fallen, and providing hints about the same. Approaching, learning, planning, language processing, and responding are the main objectives of artificial intelligence research (Woolf, 2015). The education sector can effectively employ AI. In this context, Xu (2019) evaluated the effect of AI on education.

Artificial intelligence research has culminated in advances and inventions in the recent past resulting in computers, software, and other devices demonstrating human-like intelligence distinguished by cognitive abilities, comprehension, adaptability, and decision-making capability. AI techniques has extensively been embraced and used in learning, particularly by teaching institutions, in various forms. Initially, AI took the shape of computer technology and then transitioned to internet advertisement platforms, advanced education systems, and finally embedded computer systems. Among other advancements, AI allowed humanoid robots and web-based robots to execute the roles and duties of teachers individually or with instructors. These tools have helped educators conduct various administrative tasks, such as efficiently reviewing and marking assignments and ensuring greater teaching material quality. Therefore, courses have been tailored to students' new needs to improve their learning experience.

Contact North Contact Nord—a distance education and training network—addressed some features, facts, and challenges regarding artificial intelligence techniques in teaching and learning (Contact North Contact Nord, 2018) as follows:

- AI is challenging to implement at the institutions that attempt to initiate and expand AI systems. Such defies include: who will manage and defend an AI initiative.
- Artificial intelligence refers to computer systems that mimic human actions. Hence, as a whole, AI denotes the computer systems that carry out tasks that typically require human expertise.
- The long-lasting goal of developing learning programs in response to



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extensive practice for previously unnumbered subjects, and empowering students to follow their progress however they choose. Instruction-mode customized to meet the needs of students of varying capabilities may be a machine-assisted method for making all levels grow together in one classroom some uses of digital technology have already had a big effect on education, and as AI develops in the future, adaptive programs can only be useful and common.

3- It Can Point Out Places Where Courses Need to Improve Often instructors don't know what they don't know and thus fail to highlight or point out issues with their students may not see in their lessons. Since the solutions already exist, creative and innovative uses of artificial intelligence are also generating ideas Coursera is using big MOOCs. When students are all discovered to have given incorrect answers on a homework assignment, the machine notifies the teacher with a solution tailored message so they won't duplicate their errors.

4- Students Could Get Additional Support from AI Tutors Though there will inevitably be more stuff that teachers can't deliver yet, the future will see more students educated by "tutor-machines" (the non-physical) Artificial intelligence-based tutorials and tutorials have since been created to assist students in elementary arithmetic, literature, and other subjects. Programs will give students foundational skills, but real-world instructors must complement them with higher-order thought and imagination. Only because these problems cannot be solved in a short time does not mean they cannot be solved in the future. From recent technical progress, the use of state-of-of-the-the-art tutoring services is now beyond the realm of possibility.

5- AI-Driven Programs Can Give Students and Educators Helpful Feedback Students are as well as professors have more control of their coursework which has the added benefit of AI benefits. Improvement in the assessment of academic progress also includes reviews on the program's overall effectiveness. AI is used in both on- and off-campus classrooms to measure students' success and inform teachers about any issues they might be having. This kind of AI assists students in providing the kind of service they need. educators view possible problems with instruction for students who might be experiencing difficulties with learning Since the AI systems focus on providing individual course guidance, they're about all aspects of life. Some academics are designing programs that allow students to determine which majors have been fruitful and underdeveloped areas of study. Future students will no longer be trained but will need to be prepared for a bold new

landscape of college majors.

6- It Is Altering How We Find and Interact With Information Knowledge smarts like this make it possible for us to work on both personal and career matters, as well as how we go about our educational pursuits. The use of artificial intelligence would alter the way knowledge is stored and accessed in future students. Students today are perfectly willing to do something as long as it's "creative."

7- It Could Change the Role of Instructors AI instructors will step in when necessary to give students the freedom to explore on their while also providing plenty of instructional support and using their insights to the class. Technology is a significant contributor to many of these changes in the classroom, particularly in the rapidly growing segment of schools that have fully embraced the flipped learning method. Since intelligent systems are now commonplace in education, there will still be an ongoing debate about the appropriate nature of what Instructors should be doing and how they should be evaluated, so it will continue to be a topic for leaders and organizations for some time. We have already mentioned that

Artificial intelligence will take on such activities as grading, including giving the pupil a better learning experience, and also serve as a replacement for real-world tutoring. Though AI may be used in many other areas, it should not be seen as a panacea for all problems in education. Artificial intelligence devices may be designed to be an instrument for students to help find answers and do fundamental research for instructors. If in most cases artificial intelligence (AI) shifts the facilitator's position, instructors would be dispensable.

8- AI Can Make Trial-And-Error Learning Less Intimidating A lot of trial and error is involved in all forms of study. Failure or not understanding the solution is a huge obstacle for many students. Some people get upset when they are placed in positions of prominence, such as when they are required to meet influential individuals like teachers or bosses. Placing sophisticated software to assist students in learning is much more appealing than coping with the pain of trial and error. AI offers students an experiment that can be conducted in a free and relaxed way, particularly when it comes to learning. Trial and error is, of course, the natural process for AI.

9- Data Powered by AI Can Change How to Support Students Artificial intelligence has changed the way colleges are gathering and delivering data

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on their prospective and existing students. At any level, computer, from attracting students to guiding them across the curriculum, the computer science department makes the college more customizable to the needs and interests of students.

10- AI May Change Where Students Learn, Who Teaches Them, and How They Acquire Basic Skills This initiative will put in place a digital platform that would allow students to learn from anywhere in the world, using software and help from mentor support to replace human teachers at times when they aren't in class. Digital teaching systems improve fundamental abilities. When the popularity of these programs and the individuals with whom they provide a close relationship grows, moreover, the variety of resources they have tends to broaden. (Pp.98- 99).

### Methodology

#### *Study Design*

A descriptive analytical approach was used to illustrate the faculty members' perspectives and teacher regarding practices related to teaching methods, faculty members' practices generally, and the role of applying artificial intelligence techniques in e-learning management systems. The researcher conducted the study by identifying the problem, developing the questionnaire, selecting appropriate samples, collecting data, classifying and coding the data, and then describing, analyzing, and interpreting results.

#### *Data Collection Approach*

Using a qualitative method of data inquiry, we conducted in-depth interviews with two distinct categories of individuals. five specialized experts working in the field of technologies related to artificial intelligence and five leading Egyptian educational technology experts who work in developing artificial intelligence-based education systems for schools. They were interviewed to develop an understanding of how these machines systems are designed and how they work. Though these firms are start-ups, they have gained a massive outreach to millions of students across the country due to technology proliferation.

#### *Analysis*

The interview accounts were transcribed. Given the interpretive nature of the study, we followed a grounded theory approach outlined as open, axial, and

selective coding (Corbin & Strauss 1990). Open coding allows for a higher level of abstraction for an iterative coding process that began by fracturing the transcribed data sentence-by-sentence. Convergent and divergent themes emerged from the qualitative data. For example, when coding for personalized learning, responses from different interviewees were sorted and categorized. Similar or different concepts were identified; ideas were grouped together and conceptually labeled to form categories that were integral to the data (for example, how educational technology firms use AI to help students, how educational technology firms use AI to support teachers). Once the categories were identified and their properties broadly defined, the categories became the basis for further in-depth development.

Next, axial coding was employed to subcategorize the data within each category (for example, personalized learning, adaptive assessment). Finally, through selective coding, all categories were unified around a core category representing the central phenomenon of the study, that is, how AI-based technologies are being used by the educational technology firms to change the ways teachers teach and students learn and what is the untapped potential of AI not harnessed yet by these firms. This grounded theory approach allowed factors to emerge more inductively with respect to the study context and the constant comparative method ensured consistency in the qualitative process.

### *Findings*

Results of the preceding data analysis were categorized as follows: how educational technology firms use AI to help students, how educational technology firms use AI to support teachers, the expert's view of AI in education, and the untapped potential of AI for Educational Technology firms.

#### *How Educational Technology Firms Use AI to Help Students*

AI in education is most widely used to personalize learning as noted by all respondents from the educational technology firms. Teachers play a significant role in the learning experience of students. However, with increasing classroom strengths, it is difficult for teachers to focus on each student's development on a continuous basis. Further, students have different learning styles and pace. Thus, a one-size-fits-all learning approach may not

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be the best method for all students .

Towards this, educational technology firms use rule-based algorithms to detect a student's learning path and provide customized learning content. These firms have a comprehensive database of millions of questions, elaborate coverage of concepts depending on the education level of the student, animated videos, game quizzes, and flashcards .

“The teacher explains the concepts; each concept is tagged according to the difficulty level, students take a quick quiz and instantly know the result, for the questions where they went wrong, they get motivating remedial methods to strengthen their concepts. This creates a smooth learning curve, keeps them motivated, and improves their learning experience.

AI helps in identifying the right practice question from your set of questions. Thus, the personalization of content is enabled by subject matter experts coupled with the power of data science. Based on the individual's strengths and weaknesses, appropriate recommendations are provided by the AI-system. There is an overlap between the personalization engine and recommendation system as recommendations are personalized to the student's problem areas. Recommendations include practice questions similar to the questions wrongly answered by the student, remedial videos, and suggestions to refer to particular sections in the textbook to improve the learner's understanding.

The system provides a higher level of difficulty. The questions are retrieved randomly by the system from the larger pool of questions in the database based on the level of difficulty. This process goes on until the stipulated number of questions (determined by the teacher) is reached. The weighting of questions depends on the level of difficulty .

Thus, the assessment is adapted and personalized based on the level of the student's understanding and problem-solving capability.

Educational technology firms integrate personalization engines into smart classes and the learning management system of the school to provide analysis and recommendations suitable for each student's learning style. This customization is based on student's learning profiles that include their strengths and areas of improvement. The firms have reported increased student engagement and performance across varied levels of K-12 education owing to the personalization of the learning journey. Further, the adaptive

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method of assessment provides an instant result to the students, highlights their mistakes, recommends methods for improvement, and demonstrates each student's position relative to others in the class. The report also maps students' understanding to Bloom's taxonomy and provides detailed solutions for all questions.

#### *How educational technology Firms Use AI to Support Teachers*

In addition to providing a personalized learning experience to students, the educational technology firms also provide elaborate reports for teachers with the feedback of student's performance on a continuous basis. AI-enabled systems track information of each student such as time spent on each problem, the number of times hints were requested, wrong/correct answers, preferred learning style, and overall performance. When a teacher conducts a quiz in class, these systems also provide analytics to the teacher in terms of metrics such as the number of students who could (and could not) answer each of the quiz questions and which questions most students could (and could not) answer.

#### *Adaptive assessment*

The adaptive assessment system relieves the teacher from various repetitive tasks, standardizes evaluations, and minimizes human error. An intelligent adaptive system helps save a considerable amount of the teacher's time by preparing a dynamic question paper for each student. The assessment report provides insights in terms of variation in students' performance, key areas where students lack understanding, and remedial measures for improvement. Further, reports provide a time-versus-marks distribution, that is, the amount of time (in seconds) the student has taken to respond to each question. This helps the teacher to judge whether the student has guessed the answers or understood and responded to the question. Teachers can expend more time and effort in providing personalized learning experiences to the students.

#### *Present level of AI*

AI-powered conversational systems are helping educators in rote learning and basic/repeated conversations with students. For instance, a school in Egypt is using a robot to deliver lectures in class. These systems work well but in a very narrow and constrained domain. Concepts, questions, and their respective answers in a specific chapter are limited. Hence, mundane or repetitive queries can be easily handled by the conversational tools and

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personalization engines.

Assessments are gaining immense popularity in conducting exams based on existing question banks, in correcting answer sheets and providing feedback on relevant resources to refer to, in order to improve. However, these systems are fixed and not very intelligent.

### *Untapped potential of AI*

AI-systems augment human capabilities by sensing, comprehending, learning, and acting (Daugherty& Wilson, 2018). Such heightened computational power has enabled advanced levels of data analysis towards complex and context-specific decision making. There have been burgeoning advances in the domains of image processing, pattern recognition, and natural language processing over the past few years. deep learning and reinforcement learning have become increasingly common in data-rich contexts and brought aI closer to true intelligence which is the ability of machines to mimic human intelligence. However, with respect to the technology firms in the Egyptian education sector, most firms are in their infancy stage of AI. This is because these organizations are focusing primarily on data science and supervised learning based on pre-classified datasets.

### Discussion

AI has been remarkably successful in computer vision plotting, that is, detecting the face and the outline of the human body or any object as noted by one of the experts: Face recognition systems and eye-movement detectors used in some institutes abroad provide accurate information regarding the attention levels of students.

Likewise, natural language processing is one of the most promising applications of AI; however, it is highly complex due to its complicated and unstructured nature .

Thus, any technology functioning on unstructured data such as image, voice, or video, would entail a high level of AI complexity. While these AI-technologies are available in the computer science domain and are being used in some developed countries, they have not been yet synchronized by the educational technology firms into their products in Egypt.

Thus, in its present application in educational technology firms and scope for

future growth, an expert noted:

AI is a statistical technology that gives the right picture of the population in a graphical form but only a good teacher will help students overcome the learning struggle. If AI systems have a knowledge base beyond what exists in the teacher's head and enter a mode of self-learning, only then AI systems will augment the teaching-learning process in true sense.

AI has the potential to transform systems and processes to complement and augment teaching capabilities. Teachers will find more time to engage in resolving ambiguities among students, emphasizing deep learning, exercising judgment in difficult cases, and dealing with different types of students, towards delivering better teaching outcomes. As data-driven interfaces will perform analysis of student data and recommend knowledge bytes, teachers will gravitate towards developing humane aspects in students such as life skills, interpersonal skills, creativity, and empathy. (Tijani, Obielodan& Akingbemisilu, 2020).

Our study findings highlight that ICT-enabled education personalizes the learning process with feedback and recommendations based on student's performance. While instant feedback and corrective measures are welcoming, the abundance of remedial resources may be overwhelming for students. The student learning process is not only demanding in terms of time, physical and mental energy but also draws immense emotional energy through negative feelings of fear, anxiety, or disappointment, and positive feelings of appreciation, delight, or pride. Students may be more contented with the learning process that balances both cognitive and affective outcomes such as domain knowledge and satisfaction, respectively. This critical balance between the cognitive and affective needs of the learners must be accounted for in future studies. Further, data-driven learning management systems can indicate appropriate career choices for students based on their personality profile and performance data. End-to-end employability solutions, if embedded in tutoring systems, will enable students to identify skill requirements for a variety of career choices. Students with the help of teachers can focus on getting trained in relevant skills for the future and enhance their readiness, thus, resulting in an industry-ready talent pool.

### *Conclusion*

Education plays a critical role in molding the workforce for the future.

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Relevant education necessitates redesigning study content, recreating methods of delivery, and adopting powerful technologies to facilitate learning. In emerging country context, Egyptian educational technology firms have made modest advances in recrafting some of these deliverables. Personalization of learning and recommendation of study material tailored to the student's needs is an important outcome of AI-driven learning platforms. In addition to helping students, these platforms support the teachers in providing student analytics and adaptive assessments. While these are significant advancements in the context of an emerging economy, the study brings to light some high potential AI-technologies such as facial recognition, emotion recognition, natural language processing, and image processing, which are yet untapped by the Egyptian educational technology firms. These technologies are being used in developed countries and integration of full spectrum of these technologies will improve the teaching-learning process remarkably. Nevertheless, the present study highlights how a combination of human teaching skills and AI-capabilities has the potential to enhance the experiences of students and teachers and transform the teaching-learning process. These improved experiences will not only serve the holistic and long-term development of students but also enhance the quality of overall education.

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## إمكانات الذكاء الاصطناعي لتطوير نظام التعليم في مصر

أ.د. عادل محمد العدل

أستاذ علم النفس التربوي

كلية التربية- جامعة الزقازيق

ملخص الدراسة: يكتسب استخدام الذكاء الاصطناعي (AI) في تطوير حلول جديدة للتعليم والتعلم زخماً نحو تحويل نظام التعليم في مصر. بدأت المدارس في التحول من أساليب التدريس التقليدية إلى التعليم الذكي لتعزيز خبرات التعلم لدى الطلاب. بمراجعة الأدبيات المتعلقة بالتعلم الآلي، والتعلم الشخصي، وتصنيف بلوم، واستخدام المنهج النوعي؛ لقد شرعنا في دراسة ما يلي: كيف تستخدم إدارات تكنولوجيا التعليم في مصر الذكاء الاصطناعي لتغيير طرق تدريس المعلمين وتعلم الطلاب؟ ما تقنيات الذكاء الاصطناعي غير المستغلة والتي لديها القدرة على تغيير نظام التعليم المصري؟ أجرينا مقابلات متعمقة مع خمسة خبراء متخصصين يعملون في مجال التقنيات المتعلقة بالذكاء الاصطناعي وخمسة من كبار خبراء تكنولوجيا التعليم المصرية الذين يعملون في تطوير نظم تعليم تعتمد على الذكاء الاصطناعي للمدارس. ومن خلال نشر النظرية الراسخة، وجدنا أن التعلم الشخصي وأنظمة التوصيات والتقييمات التكيفية تساعد الطلاب وتدعم المعلمين. في سياق الدول الناشئة، نعرض وجهة نظر خبراء تكنولوجيا التعليم حول الذكاء الاصطناعي ووجهة نظر خبراء التعليم حول الذكاء الاصطناعي. وتشير الفجوات بين وجهات النظر هذه إلى الإمكانيات الهائلة للذكاء الاصطناعي التي يمكن لإدارات التكنولوجيا التعليمية استغلالها في تطبيقاتها المستقبلية. وتوصي الدراسة بأن الذكاء الاصطناعي له آثار عميقة على تحول نظام التعليم في البلدان الناشئة.

الكلمات المفتاحية: الذكاء الاصطناعي؛ التعلم الشخصي؛ التعليم الذكي.