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Rise of the robots: What it means for educators

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Abstract

The proliferation of artificial intelligence (AI) and robots is precipitating profound shifts in several sectors, including education. A pressing inquiry arises among scholarly communities: To what extent will the advancement of technology supplant or surpass the conventional responsibilities of educators? The process of dissecting and analysing this subject is intricate, with many layers to consider. Demonstrating this phenomenon, a British educational institution has recently designated an artificial intelligence (AI) robot named Abigail Bailey as one of its "co-headteachers." Abigail possesses sophisticated machine learning skills that enable her to process extensive information efficiently, akin to AI systems such as ChatGPT that simplify user interactions through algorithmic-generated answers. This breakthrough raises the question: Does this mark the beginning of a period in which robots assume a prominent position in education, hence threatening the traditional duties of educators? This opinion piece explores the essential factors that need to be taken into account.

Introduction

The landscape of education is witnessing a revolutionary change with the advent of robotic teachers and bots, reshaping the traditional methods of teaching and learning. These technological marvels, born out of the marriage between artificial intelligence (AI) and robotics, are not just futuristic concepts but practical tools increasingly being incorporated into classrooms worldwide. Understanding what they are and the role they play is crucial in comprehending their future trajectory in education.

Ro(bots) are physical machines that can interact with the physical world. They often have mechanical components like arms, wheels, or other forms of mobility and can perform a variety of tasks ranging from industrial manufacturing to household chores (Catlin et al., 2018). Bots, short for robots, in the context of computing, are software applications that perform automated tasks over the internet. Unlike physical robots, they exist purely in the digital realm.

Modern robotic teachers are physical entities, often resembling humans, equipped with AI technology. They are designed to interact with students, deliver educational content, and perform tasks traditionally associated with human teachers (Tang et al., 2023). Unlike static robots of the past, these advanced machines can move, gesture, and exhibit a range of facial expressions, making them more relatable and engaging for students. Chatbots (a type of bot), on the other hand, are AI-driven software programs designed to simulate conversation with human users. In educational settings, they function primarily on computers or mobile devices, providing students with a conversational interface for learning. Chatbots can answer questions, provide explanations, and guide students through learning materials, much like a personal tutor.

The AI programs powering the robots and chatbots use natural language processing (NLP) to understand and respond to student queries. They can handle a range of tasks, from assisting with homework and grading assignments to facilitating revision and offering additional learning resources. Their ability to provide immediate, on-demand assistance makes them an invaluable resource for students. The AI programs enable robots to learn and adapt to the needs of individual students. They can assess students' strengths and weaknesses, customize teaching methods, and provide personalized feedback (Ifelebuegu et al., 2023). For instance, a robotic teacher in a language class can converse with students, correct their pronunciation in real-time, and adapt conversations to suit each learner's proficiency level.

This marriage of AI and robots is playing a central role in driving this transition, presenting potential opportunities for a customized and personalized learning experience (Edwards & Cheok, 2018; Huang et al., 2023; Ifelebuegu et al., 2023). The utilization of robots as tutors represents a significant advancement in the field of educational technology. According to Rosanda and Istenic Starcic (2019), advanced AI algorithms enable the provision of tailored educational experiences by robotic tutors. Educators have the ability to assess a student's ongoing development, identifying their aptitudes, as well as areas in need of improvement, in a timely manner. This enables them to customize instructional approaches and content to suit the individual student's needs. The provision of personalized attention at this level guarantees that every student is able to advance at their most effective rate, potentially narrowing the disparity between high-achieving students and others who may require further assistance. However, similar to other technical advancements, the integration of AI robots in education presents a range of problems and potential benefits (Grace et al., 2018; Green et al., 2019; Hu et al., 2023).

The applications of AI robots within the field of education are not only a hypothetical notion, but rather an emerging actuality. A notable recent advancement in this field occurred in October 2023 with the incorporation of artificial intelligence (AI) into the administrative framework of Cottesmore School, a United Kingdom educational institution in West Sussex. This integration has resulted in the appointment of an AI robot named Abigail Bailey as a 'co-headteacher'. The robot has been bestowed with a name as a tribute to a former headmistress, and it provides assistance to the present headmaster across several domains. Abigail Bailey possesses superior machine learning abilities, which facilitate the efficient analysis of large-scale datasets. This capability mirrors the operations of chatbot services, like ChatGPT, where users interact and receive feedback from the system. Previously, a humanoid robotic teacher called "Musio", which uses AI to engage in naturalistic conversations in English, has been used to improve students' language skills (Hooper, 2018). Similarly, "Pepper", a creation by SoftBank Robotics, has been employed as a teaching assistant, demonstrating the capability to engage students through interactive learning activities (Pandey & Gelin, 2018).

Within contemporary academic discourse, a pertinent inquiry reverberates: In light of rapid technological advancements, is it conceivable that robots may ultimately replace human educators? The response to the question is intricate and encompasses several aspects (Virgillito, 2017; Selwyn, 2019). As these innovations make inroads into education, there is a growing curiosity about whether future classrooms might lack human touch. In historical context, with the advent of the printing press, scribes feared unemployment. However, the opposite transpired: literacy soared, and the number of writers multiplied. Should today's educators harbor similar apprehensions about their professional relevance? This article explores the changing interactions between robots and human teachers in the future educational scene.

AI robots in education

The subjects of "Human versus Robot," "Machine versus Man," and "Traditional Pedagogy versus Digital Automation" have been the focus of scholarly discussion in recent years (Virgillito, 2017; Sperlinger, 2020; Johnson & Acemoglu, 2023; Joseph et al., 2024). The concept of robots replacing human positions has elicited a range of perspectives, both in cinematic representations and scholarly and professional discussions. Considering the ongoing technological advancements, namely in the fields of AI and robotics, it is

improbable to foresee education being unaffected (Mubin et al., 2013; So & Lee, 2023). Goldman Sachs predicts the potential loss or diminishing of over 300 million jobs if AI lives up to its current hype (Kelly, 2023).

Undeniably, robots present a series of advantages in the educational landscape. They have the capability to offer bespoke learning pathways, meticulously analysing a student's proficiencies and areas of development to modulate lessons instantaneously. This custom instruction can significantly enhance learning outcomes, particularly for learners who might not excel within the conventional educational frameworks (Chen et al., 2023; Ifelebuegu, 2023). Furthermore, in geographic locations that grapple with a dearth of educators or subpar educational resources, robotic solutions could bridge these vast divides, ensuring uniform and quality instruction.

A multitude of research highlights the advantageous impacts of AI-powered robotic instructors on student academic achievement. According to existing research, robotic teachers have the potential to enhance student connection, motivation, and engagement within a learning setting. By providing students with a personalized and adaptable learning experience, these robots enable them to progress according to their own requirements and preferences. In addition, the fast feedback provided by AI robotic educators enables students to promptly identify and correct faults. The use of AI robotic educators can enhance a student's academic experience by incorporating captivating and immersive educational approaches, resulting in a more efficient and effective learning environment (Robertson, 2022; Ifelebuegu et al., 2023).

With the promise of delivering personalized learning experiences and the potential to break down geographical and economic barriers in education, the implications of AI robots in teaching and learning are profound. As we contemplate the future of these technological marvels in the classroom, it is essential to project both their transformative potential and the challenges they might introduce.

Robotic tutors and personalized learning

One of the most groundbreaking applications of robots in education is their role as tutors. Using sophisticated AI algorithms, these robotic tutors can deliver personalized learning experiences. They can analyze a student's progress, strengths, and areas of struggle in real time, tailoring lessons accordingly (Conti et al., 2020). The provision of personalized attention at this level guarantees that every student is able to advance at their most effective rate, potentially narrowing the disparity between advanced learners and those who may require further assistance.

Robots as learning companions

Beyond the traditional tutor-student dynamics, robots are emerging as learning companions (Aziz & Ghanimi, 2020; Cagiltay et al., 2022, Huang et al., 2023). These interactive and engaging robots have the potential to foster a student's curiosity and enthusiasm for a certain subject. The use of gamification through robotics can serve as a powerful tool for students by transforming the learning process into an engaging and participatory experience. In their latest publication, Huang et al. (2023) introduced an innovative framework known as iSTAR (Intelligent Human-Machine Synergy in Collaborative Teaching), which focuses on the integration of human and machine collaboration in educational settings. This framework underscores the combined use of three distinct technologies: digital twins, avatars/agents, and physical robots, to enhance the teaching and learning experience. These technologies can work collaboratively with human educators, offering a multi-faceted approach to educational delivery.

Special needs and therapeutic education

Robots have demonstrated significant potential in facilitating support for special needs. Robots have been found to offer a valuable means of facilitating social skill development and repeated learning activities for students diagnosed with autism (Alabdulkareem et al., 2022). Several researchers have explored the applications of socially assistive robots, including humanoids, in teaching and learning (Papadopoulos et al., 2020). By providing constant and non-threatening contact, robots can effectively support students in their developmental journey. Due to their consistent behavior, they serve as an optimal learning companion for students who may encounter difficulties or feel overwhelmed by human interactions.

Practical skill development

The 21st century has also seen robots playing a role in cultivating practical skills, especially in the realm of STEM (Science, Technology, Engineering, and Mathematics) education. Robots can offer hands-on learning experiences, allowing students to understand complex concepts by seeing them in action (Greca Dufranc et al., 2020). Robotics kits and platforms enable students to construct, program, and experiment, hence promoting critical thinking, problem-solving, and engineering skills. According to Nourbakhsh (2015), the utilization of educational robots as teaching aids has significantly influenced innovation and the development of learners' talents, particularly in STEM subjects.

Overcoming geographical and economic barriers

One of the most transformative potentials of robots in education is their capacity to democratize learning. In regions where access to quality education or qualified teachers is limited, robots can step in, offering consistent, high-quality instruction. In addition, the availability of online connectivity enables a robot situated in a remote village to possibly have access to high-quality instructional materials, levelling the playing field for students worldwide (Edwards & Cheok, 2018).

Although robots have great promise in the field of education, it is important to note that teaching encompasses more than just the transfer of knowledge. It involves the provision of mentorship, emotional assistance, and the development of interpersonal abilities. Human educators have a crucial and influential role in the emotional and psychological growth of students. They serve as a source of inspiration and motivation and possess a deep understanding of the complex intricacies of human behavior and emotions. The existing capabilities of robots do not extend to encompass emotional intelligence, which involves the capacity to empathize, motivate, and establish human connections. The next section expands further on the key values that human educators bring to the education scene.

The unique value of human educators

Human educators, with their unique blend of skills and qualities, offer something to the classroom that AI robots cannot yet emulate. Their capacity to empathize with students, adapt teaching methods based on individual needs, offer personalized guidance, and nurture critical thinking are indispensable aspects of holistic education. These attributes, which revolve around emotional intelligence, creativity, and adaptability, set human educators apart from their AI counterparts (Selwyn, 2019).

Undoubtedly, AI robots exhibit considerable promise in enhancing the educational domain, yet it is important to acknowledge that they are not devoid of constraints. Understanding intricate human emotions or engaging in profound social exchanges can be challenging for AI. The profession of teaching encompasses more than the mere dissemination of knowledge; educators frequently assume the roles of mentors, advisers, and emotional support for their students. The assertion that AI robots might potentially supplant human educators oversimplifies the complex and diverse responsibilities that instructors have (Han et al., 2023; Tlili et al., 2023, Rudolph et al., 2023).

In addition to the transmission of knowledge, instructors assume crucial duties in fostering inspiration and providing mentorship to students. Robots are unable to achieve the authentic human connection, characterized by their intricate emotional subtleties and capacity to evoke intense emotions. While certain administrative and repetitive tasks within education can be delegated to automation, this does not lessen the importance of teachers. Instead, it refines their role, potentially giving educators more opportunities for research, creative pedagogical innovations, and fostering deeper student relationships.

At the core of education, teachers emerge not just as knowledge facilitators but as guiding beacons, sometimes even echoing parental sentiments within the educational realm. As education undergoes metamorphoses with advancing times, recognizing and honoring the diverse, influential roles educators undertake becomes even more crucial. They do not merely teach; they shape futures. And in this intricate endeavor, while robots can be invaluable aides, they cannot replace the human essence of teaching. In light of societal evolution and the dynamic nature of educational approaches, it is crucial to comprehend the intricate and diverse responsibilities that instructors assume in shaping the future of their students and, therefore, the global landscape. Despite the rapid innovation and proliferation of AI in educational tools, the World Economic Forum forecasts a 10% increase in jobs within the education sector by 2027 (see Rudolph et al., 2023). This prediction emphasizes the enduring and essential role that human teachers play in the field of education.

The torchbearers of knowledge

At the most fundamental level, educators bear the responsibility of transmitting knowledge. This encompasses more than just memorization or traditional instructional methods; it involves promoting comprehension of intricate ideas, stimulating inquisitiveness, and cultivating a sincere passion for the discipline. According to Hattie (2009), this essential role transcends the mere dissemination of facts; it involves molding character, fostering curiosity, and igniting a lifelong passion for learning. Teachers, as described by Hattie in his seminal work "Visible Learning," are at the heart of the educational process, playing a pivotal role in influencing student outcomes. A mathematics educator, for example, not only imparts numerical knowledge but also fosters the development of analytical reasoning skills. A literary instructor not only engages with canonical works but also fosters an awareness of artistic expression, cultural understanding, and the complexities of human emotions.

Standing at the helm of the educational journey, teachers act as custodians and conveyors of knowledge, bridging the gap between the wealth of past wisdom and the challenges of a rapidly changing future (Freire, 2020). In "Pedagogy of the Oppressed," Freire emphasizes the transformative power of education, driven significantly by the teacher's ability to guide and inspire. The importance of this role is magnified in an era where information is ubiquitous, making the teacher's guidance crucial in navigating the vast sea of data to distill what is true, relevant, and insightful.

The impact of a dedicated teacher can be profound and long-lasting, often becoming evident long after the student has left the classroom (Palmer, 1998). Palmer's "The Courage to Teach" explores this enduring influence, emphasizing how teachers shape lives in ways that are often immeasurable yet deeply significant.

In summary, the role of teachers as the bearers of the torch of knowledge encompasses far more than academic teaching. It is a multifaceted responsibility that entails inspiring, empowering, and guiding students. As society continues to progress, the necessity for passionate, committed, and knowledgeable teachers remains undiminished, a constant beacon in the journey of lifelong learning and personal development.

Nurturing individual strengths

Every student possesses distinct characteristics, encompassing individual strengths and problems. Educators possess a high level of proficiency in discerning these specific characteristics. Educators focus on cultivating a student's inherent abilities, whether they lie in the realms of arts, sciences, athletics, or leadership. They also recognize areas of improvement and provide additional support, be it through extra classes, personalized assignments, or mentoring.

Instilling discipline and moral values

Educators assume a pivotal role in molding the moral and ethical development of their students. Teachers establish discipline by implementing classroom laws, providing instructions for tasks, and facilitating interactive conversations. In addition, they facilitate the transmission of moral teachings, either by means of carefully selected curriculum subjects or by drawing from real-life instances, thus cultivating virtues such as truthfulness, uprightness, compassion, and tenacity (Lumpkin, 2008).

Emotional and psychosocial support

For a significant number of students, the educational environment might present emotional difficulties that are equally as demanding as the cognitive challenges they face. The period of adolescence is characterized by significant challenges, as students frequently confront a wide array of concerns encompassing peer influence and struggles related to self-identity. In such situations, educators frequently assume the additional role of counsellors (Mazzer & Rickwood, 2015). Although robots have the capability to be programmed for the recognition and replication of human emotions, the qualities of real empathy, understanding, and emotional intelligence remain exclusive to humans. Educators provide a secure environment wherein students are able to openly articulate their apprehensions, hopes, and ambitions. The enduring emotional connection, which frequently endures for the entirety of one's life, is irreplaceable.

Preparing students for the future

Beyond the confines of textbooks and exams, teachers prepare students for life. This includes soft skills like communication, teamwork, and critical thinking. Especially in higher grades, teachers also offer guidance regarding future career paths, helping students navigate the maze of higher education and job prospects.

Continuous evolution

The role of a teacher is not static. The classroom setting undergoes transformation in tandem with global developments. Teachers have embraced technological advancements, such as the utilization of smart boards, the integration of e-learning platforms, and the inclusion of social media in instructional practices. The global COVID-19 epidemic and the accompanying transition to remote learning have shown the remarkable capacity for adaptation demonstrated by educators around the globe.

Lifelong impact

Perhaps the most profound role of a teacher is the lasting impact they leave on their students. Memories of school days often revolve around particular teachers – ones who believed in a student when no one else did, ones who offered words of wisdom, or ones who facilitated comprehension of challenging subjects by means of inventive pedagogical approaches.

Moral and ethical judgments

Teaching is not just about transmitting information; it is about instilling values. Human educators can impart moral and ethical lessons, often drawing from personal experiences or cultural nuances. In essence, educators serve as the fundamental support system inside the framework of the educational system. The responsibilities they undertake extend beyond basic job titles. They exert influence on the future by impacting individual students in various manners. Understanding their role is crucial, not just for policymakers and educational institutions but for society at large. As the adage goes, "It takes a big heart to shape little minds," and teachers around the world do this with unparalleled dedication and passion. Therefore, despite the advancements in AI and robotics, it is unlikely that AI robots will completely replace teachers in the education system (Mubin et al., 2013).

The complementary roles of human and robot educators

The increasing integration of AI and robots in educational settings has prompted inquiries concerning the potential responsibilities that these automated instructors may assume in conjunction with human educators. Nevertheless, instead of perceiving this phenomenon as a contest, it is advantageous to comprehend the ways in which human and robotic instructors may mutually enhance one another's abilities, so fostering a harmonious, efficient, and efficacious educational setting. In the study conducted by Huang et al. (2023), it is posited that human educators would continue to occupy a central role in the utilization of technical advancements such as digital twins, avatars, and physical robots.

Human educators have inherent characteristics that are fundamental to their being, including empathy, intuition, flexibility, and the capacity to establish authentic connections. Educators have a multifaceted role in the education system, since they not only impart information but also play a crucial role in fostering students' emotional and social development. When a student faces personal challenges, it is often the human touch, the reassuring word, or the understanding nod that makes a difference. Humans

can interpret subtle cues, from a student's tone of voice to their body language, gauging their comprehension, interest, or emotional state. Furthermore, they can inspire, mentor, and ignite passion, going beyond the curriculum to teach essential life lessons. On the other hand, robot educators bring to the table a suite of unique advantages that humans cannot match as previously noted. With vast data storage and processing abilities, they can offer personalized learning experiences tailored to each student's pace and learning style. Their unbiased nature ensures consistent instruction, free from any unintended biases. Robots can sift through vast amounts of data to provide real-time feedback and can make adaptive lesson plans based on a student's performance, ensuring that learning is always optimized. Additionally, their tireless nature means that they can be available round the clock, providing additional resources or assistance whenever a student may want it.

Consider the potential of using the respective advantages of both entities. In an integrated educational setting, the human instructor is primarily responsible for delivering instructional content, cultivating critical thinking skills, and addressing socio-emotional difficulties. Complementing this role, a robotic instructor can contribute by administering tailored assignments, promptly evaluating student submissions, and providing supplementary materials to support individuals requiring additional assistance. The integration of AI in the classroom facilitates enhanced efficiency by enabling educators to focus on more critical matters, as they can rely on AI to effectively manage administrative chores and personalized learning routes in the same way that Robot Abigail would be supporting her co-headteacher in Cottesmore School in the UK.

Moreover, robot educators can ensure that no student is left behind. In larger classrooms, where it is challenging for a single teacher to cater to the needs of every student, robots can provide the additional support required, ensuring that each student receives the attention they need. Conversely, human educators possess the ability to intervene when students require emotional assistance, direction, or motivation, which are domains where robots currently exhibit limitations.

However, as we embrace this combined approach, it is crucial to set boundaries and guidelines. The human aspect of education must never be overshadowed. Robots should be seen as tools that enhance the educational experience, not replace the intrinsic human elements. Their role should be to aid, not to lead.

The forthcoming trajectory of education does not hinge upon the dichotomy of selecting between human or robotic instructors, but rather on comprehending the potential synergy that may be achieved via their collaborative efforts. By integrating the cognitive qualities of individuals, such as emotional intelligence, flexibility, and mentoring skills, with the data-driven, consistent, and personalized methodologies employed by robots, we may provide a foundation for an enhanced, harmonious, and progressive educational setting. If appropriately cultivated, this mutually beneficial association has the potential to usher in a period characterized by deep and enhanced learning, effectively harnessing the advantages offered by both realms.

Conclusion

In the evolving landscape of education, characterized by the emergence of transformative technologies such as AI robots, it is imperative to acknowledge the vital role of human educators. Although AI has the ability to enhance and optimize certain activities, the fundamental nature of education, which is based on empathy, understanding, and authentic human interaction, remains unmatched. Teachers perform multiple responsibilities, from being knowledge facilitators to mentors and emotional anchors. Despite their numerous capabilities, robots are unable to completely imitate the intricate human touch that is crucial for comprehensive learning. In the current era characterized by rapid technology advancements, it is crucial to not only welcome novel advances but also recognize and support the enduring importance of human educators. Educators serve as more than just conveyors of information; they constitute the fundamental essence of the educational process, molding intellects and destinies in manners that are beyond the capabilities of machines.

The inquiry revolves around the potential for educators to include robots in their practices rather than the possibility of robots completely supplanting educators. Educators may secure their indispensability in the future educational environment by embracing technology and developing a comprehensive awareness of its capabilities and constraints. The fundamental essence of education perpetually resides within the realm of humanity. The proliferation of robots and artificial intelligence (AI) in the field of education represents a significant shift rather than a termination. Educators play a crucial role in navigating and embracing these changes since they possess the means to ensure that technology functions as a facilitator rather than a disruptor.

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