Artificial Intelligence in Learning and Teaching

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Abstract: *Learning is multi-dimensional. The intricate layers of listening, watching, reading, writing, evaluating, thinking, and many more aspects come together to make learning an intimate experience for each student. It's quite interesting to understand all the elements that shape the way we teach and learn. These elements when partnered with Artificial Intelligence (AI) create powerful and supportive learning experiences. Machine intelligence is adaptive and augments our natural style of learning. AI is capable of identifying unique patterns and make decisions that are useful to both educators and students. AI-assisted learning creates a holistic learning experience. It provides suggestions to improve learning styles as well. AI models are designed after understanding various types of learning methods. Learning sciences evaluates learning in different environments. It discusses questions like how we learn and how we apply what we learn. There are myriad ways to start learning something new. But the challenge is that there is an overwhelming number of resources to choose from. Reading as a process won't be fruitful if the learner is unable to identify or relate to the information. This chapter describes the current state of Artificial Intelligence (AI) and its profound impact on education, learning, and teaching.*

Key Words: *Learning, Teaching, Artificial Intelligence, Education, Chatbots.*

I. INTRODUCTION

AI is a domain of research with multiple sub-domains. Each sub-discipline has a history and requires its own expertise and dynamics. It's important to understand while assessing the effective impact of AI in educational policy. As AI emerged, Symbolic computation was one of the key approaches in the 1950s. The primary idea was that apart from just computing numbers, computers can process bits of knowledge. In the past, most educational AI applications were knowledge-based and representational. But, the latest development in AI is mostly data-driven machine learning architecture. This programming paradigm is new to most professionals and requires a different set of skills and competencies from what was traditionally required. Educational institutions and schools can utilize AI to transform the learning of the future. The inclusion of AI will shape the very way how competence and learning works. A lot of AI systems have been developed in the past to aid education but only a few of them have displayed a clear tangible impact on learning and education. Benefits are lacking as the context of learning is different across schools, colleges, and countries. AI can be effectively adopted and shaped with the knowledge of local capacity. New scaling methods are needed which is possible only with the collaboration of teachers and educators.

However, it was realized that the Symbolic approach required tons of domain-specific knowledge. This gave rise to the manipulation of knowledge representation in the 1980s. This representational AI focused on automatically processing expert decision-makers. Since the 1980s, large companies have developed and deployed many such 'expert systems' also known as "good-old-fashioned AI". The representational AI approach remained dominant in the educational sector. An educational model called Intelligent Tutoring System (ITS) stored student's current knowledge and the knowledge to be learned. This model assisted the learners towards their learning goals. Then came the third approach of AI, the Artificial Neural Networks. This became highly influential as scientists pointed out that human-like rational thinking can be modeled with such technologies. The 1950s saw the rise of several of these artificial neural networks. Connections between active neurons reinforce learning in these networks. This concept comes down after analyzing biological neural networks. This is also referred to as Hebbian learning. To conclude, the current AI revolution is primarily data-driven AI.

II.OBJECTIVE

This chapter describes the current state of Artificial Intelligence (AI) and its profound impact on education, learning, and teaching. Every new technology comes with its share of hype and skepticism. Although AI has its presence around for several decades now, recent technological breakthroughs are accelerating AI into different areas. Moreover, the pandemic massively shifted the education landscape and forced educators to rely on virtual learning technologies. This chapter emphasizes what this could mean for education, learning, and teaching. It examines the educational consequence of the latest technologies on institutions and how students learn.

Higher education has already begun to adopt Artificial Intelligence. Its effective application is considered as a means to

improve the quality of learning and teaching. In addition to that, challenges faced by students in adopting emerging technology in terms of administration, learning, and students' support are discussed. We investigate how institutions need to evolve and increase their speed of adopting new technologies in the day-to-day operations. The education leaders should be able to predict the future nature of education in the world once AI becomes the baseline of our universities. AI has the potential to optimize both teaching and learning while benefiting students and teachers alike.

III. THE RISE OF AI IN HIGHER EDUCATION

The adoption of new technologies in educational institutions has always been subject to debate. Both the administration and the general student body were skeptical when calculators and spell check software were introduced. Programs like search engines, predictive text, speech to text, text to speech, zoom ability, and many more assistive technologies were initially developed to help people with a disability. It was later when all these technological solutions found their place in personal computers, wearable devices, or handheld devices.

Compared to the past, students are better placed now in front of a wide array of possibilities. Educators are inspired to apply human-AI interaction to augment teachers and learners for a more engaging process. The type of technologies available today has immediate power to change the way we access, read, memorize, and create information. It's just a matter of time. MIT scholars suggest that by the end of this century this may turn into a reality.

Tech giants like Google, Microsoft, Apple, and Facebook are investing heavily and competing in the area of AI. Quantum computers are being built that are a million times faster than any other contemporary computer. Sooner than later, this wave of investments and interest in AI is bound to hit universities around the world. A hybrid of the human brain and machine often referred to as a Cyborg will challenge teachers to come up with new ways of learning and teaching.

With an increase in the number of students, staff costs, class sizes, and broader financial pressures universities are finding attractive solutions in teacher bots and related technologies. Massive Open Online Courses (MOOCs) have already caught the attention of university administrators across the globe. The beauty of open courses is that there are no fees or entry requirements. Students with internet access can enroll themselves from any part of the world. The program looked promising but came with challenges as well for the teachers. Assisting large groups of students, conducting assessments, providing personalized feedback, and that too across different time zones was taking a toll on teachers. MOOCs still has a long way to go before it gets the love of both students and educators alike.

Experiments are being done to replace teachers with robot teachers or 'teacher bots' with the development of non-invasive brain-computer interfaces. IBM's supercomputer, Watson, is already capable of providing a virtual teacher presence throughout the course duration and also monitor when a student is learning tasks and is fully focused on the content. Teacher bots are already dealing with administrative supervision, feedback, and content delivery to become a promising alternative for traditional teaching assistants. But, how to use it for the benefit of students is still an area of research.

Teacher bots are a combination of hardware and software that is designed to take up the role of a teacher assistant in organizing content and providing instant solutions to a wide array of predictable queries. It monitors, assesses, facilitates, and manages student learning within the online scope. Existing AI solutions are currently monitoring our strengths, weaknesses, choices, movements, achievements, providing feedback, customizing news alerts and predictive texts, and much more. These projects are capable of managing our lives. Teacher Bot is a smart algorithmic interface that leverages all these AI functionalities for personalized education.

IV. AI IN LEARNING AND EDUCATION

In education, AI applications are classified based on the primary user of the system. Primarily there are the student-facing AI, teacher-facing AI, and system-facing AI. The student-facing AI can be further sub-divided into systems that teach students directly and systems that support any learning activity. Currently, higher education is harnessing the following four key areas of AI.

Personalized and adaptive systems:

Adaptive learning gauges an individual's learning capabilities and provides customized learning content. The system uses trained AI computer algorithms that first understand the learning styles, strengths, weaknesses, and proficiency of a student before providing them with the right resources and material. "Everybody's a genius. But, if you judge a fish by its ability to climb a tree, it will live its whole life believing that it is stupid"-Albert Einstein.

Every student has a different learning cycle based on living conditions, intelligence, and environment. The conventional idea of education where one classroom would fit the needs of all is gradually losing its significance. Every individual is different and one learning style can't fit them all. That is where AI and immersive technologies are catering to the need of each student by gathering data on a student's ability and learning pace. And, this approach is not only taken up in schools and colleges, but also in corporate setups. One such example is the Singapore-based Vere360. The platform uses VR and AI to offer quality education in skill development and social issues. It even integrates with several partner clients to create useful educational content that students can access over a Virtual Reality education app.

Botsifty, an AI-based chatbot in education evaluates student capability by showing them texts, pictures, videos on related topics and asking them questions on the same. Such AI tools of education challenge the smartest students in the class while not discouraging the lesser smart students. This is possible because each student's learning style is recognized and a personalized learning environment is created based on the individual's intellect. Adaptive learning technology works with some key ideas:
a) Quality of learning material.
b) AI-based platform's ability to identify, evaluate, and adjust to an individual's growth.

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c) Measuring performance and monitoring progress.

AI-powered adaptive systems learn from custom experience without any manual intervention. Such platforms are enhancing student experiences with immersive technology. Human learning is rapidly evolving. Personalized learning systems are taking to orchestrated interactions and replacing conventional methodologies.

University admissions are tough for students especially for those who come from a technologically and financially challenged background. To help with this, BioBeyond, an adaptive learning platform offers students with quality resources to access entry-level Biology courses. This online application provides valuable feedback to students on which particular sections they need to work on. Another such adaptive learning platform, Dreambox Technology, provides personalized instructions to students. Over time, Immersive technologies are not only being adopted in schools and universities but also by many organizations. Several enterprises are moving to AR/VR training tools to provide simulation training. Retail giant, Walmart already has a simulation-based training process to prepare store workers to handle the rush efficiently during the busy holiday season. Machine learning service providers bring immense improvements and innovation to the education sector.

Evaluation and assessment:

With the advent of the pandemic, distance learning has become a necessity. During this period, technologies like AI and machine learning (ML) are innovating the process of student assessment by giving it a major leap. The process of testing involves classroom instruction and the real-life challenges that students face. So, mere information recollection is not enough. Teachers are looking for a way to holistically measure a student's knowledge and skill. Timing is also crucial when it comes to assessment. Educators don't need to always wait till the end of a school year or semester to test individuals. A test should be readily available when a particular candidate is ready to demonstrate a skill in a particular area. Technology innovation is removing the dependency of pen and paper from the testing process. Adaptive tests can be designed right away to evaluate students at the right time. Computer-based personalized tests provide an actionable and more specific measure of a student's skill. While students take tests that are tailored to gauge their skill level, teachers can gain deeper insight into a particular student's progress. Additionally, both educators and students are equipped with accurate data to carry forward any necessary educational measures. They don't have to rely anymore on inconsistent paper-based reviews.

AI-based evaluation increases engagement and alerts an educator in case of any drop-in engagement activity. Performance can be easily connected to engagement levels when it comes to classroom learning. Teachers don't have to spend hours hard scoring anymore. They can quickly analyze large pools of score-constructed responses to understand specific patterns or overall performance. This helps to monitor individual learning progressions and create custom learning paths for each candidate.

Augmented and virtual reality-based assessment challenges students with real-world scenarios that allow educators to measure student success over a wide range. Students are required to apply their knowledge to real-life situations that they may encounter in their academic or professional careers. So, it's beyond doubt now that such pen-and-paper alternatives expose students to wider varieties of experience, information, and technical approaches. This approach also helps to level the game for less-privileged students who may not have the same opportunities as their well-to-do or privileged counterparts. Research made on the AI-based assessment process for engineering students proves that personalized feedback with qualitative and quantitative information has turned out to be useful. Though another observation coming from digital learning systems is that students are experiencing negative emotions in higher education. Digital interfaces are expected to avoid generating destructive emotions such as frustration, neglect, uncertainty, discomfort, and need for confirmation. In short, immersive technologies equips educators to accurately and fairly assess a student's knowledge and skill. It also helps to draw a more effective path towards knowledge.

Profiling:

AI predictive applications are models that actively track student engagement, knowledge, and academic performance. These systems constantly keep a watch on the likelihood of any candidate dropping out of an education program. Their primary function is to detect students at risk and generate timely alerts to educators and administrators. Predictive modeling and classification algorithms have played a key role in this area. AI-enabled student profiling and modeling solutions pull out a student's past academic achievements, school expenses, and whether they received any financial aid or not. So, it relieves the administrative and academic staff from a lot of manual work.

Intelligent tutoring system:

Intelligent Tutoring System (ITS) is a software program that gives instant and personalized feedback or instructions to students without the need for any human intervention. ITS has been used to teach certain subjects like grammar and algebra. However, it's tough to build this computerized system due to its complexity. AI techniques are applied to four key interacting components.

a) Knowledge base - a platform that stores domain knowledge.
b) Student model - this represents the student's current ability and knowledge state.
c) Pedagogical model - a module that contains a description of teaching methods, a summary of an individual's learning gains, an implementation guide, and a library illustrating the current teaching method being followed.
d) User interface - the platform that allows seamless interaction between students and ITS.

Although the knowledge base is the pivotal part of ITS, other components also play an important role across various approaches. ITS is yet to catch traction across schools and educational institutions. The reason for its unsatisfactory use may be due to missing evaluation studies and issues with the student model.

A myriad of ITS has been experimented with since the 1970s and many useful interactions between academic research and application-based research took place. But from a cognitive perspective, some crucial issues remain. One of the problems was that the system's feedback was not immediate. Any delay in system response is not accepted by many users. The systematic consideration of the emotional and motivational aspects was also a standing challenge for administrators. And lastly, the interaction between the content of the tutorial knowledge and the student model needs more promising evidence.

V. HOW ARTIFICIAL INTELLIGENCE WILL IMPACT TEACHING TIME

Teachers can save time using emerging technologies and redirect their energy towards student learning. Complex administrative burdens and increasing needs of the student are stretching the working hours of teachers beyond the normal. The latest McKinsey survey already points out that teachers are working for more than 50 hours a week and that the numbers have increased by 3% over the last five years. 81% of teachers are considering leaving their teaching jobs owing to massive workloads. All of them don't report about their late-night lesson plans preparation, marking papers, or endless paper-works. But the high attrition rate is a clear indication of burnout and real pressure on teachers. Numerous researches suggest that 20 to 40 perc ent of valuable teacher hours are spent on redundant activities that can be easily automated. The time saved can be effectively reallocated to support student learning and growth.

Although modes of classroom and learning structure might change with emerging technologies, it's unlikely to replace teachers any soon. AI or any other technology fails to emulate the core of a teacher's work: building a positive environment, inspiring students, coaching, mentoring, and seeing the world from a student's perspective. Not everything can be automated. Technology can facilitate good teaching, but can never replace the teachers. To make the best of this technological opportunity we'll outline four imperatives that need a closer look.

Where Teachers Spend Most of Their Time:

Targeted research needs to be done and teachers need to be surveyed to understand what activities demand most of their time. Research is required to find out the areas where teachers spend the most and the least amount of time. We need strong evidence about what is it that's working well for them and what is challenging them the most. Feedback must be collected and analyzed to find out what technologies are the teachers currently using to practice skills and discover new content. Grading and lesson planning might become less strenuous for a teacher in a more automated world. Some findings have already clearly pointed out across the board that teachers are spending more time in evaluation, preparation, and administrative duties than in direct instruction and engagement with students.

How Technology Can Help:

Based on expert interviews and evaluation of existing technologies, automation potential across each task can be assessed. Additional surveys concluded that areas such as administration, preparation, feedback, and evaluation have the biggest potential for automation. Companies like Google, Facebook, and Microsoft openly distribute frameworks, tools, and learning materials that can be easily used by novice developers to create basic AI systems. Higher secondary school students can easily build basic machine learning systems and chatbots using this approach within a matter of few hours. Machine learning for kids (machinelearningforkids.co.uk) is one such step in this direction. The platform allows children to develop programs in Python, Scratch, and APP inventor using simple programming interfaces. AI4k12.org is another initiative that offers an active mailing list for educators who would like to implement AI projects.

Where Technology Can Save Most Time:

Preparation is something that every teacher has to deal with before even getting to the classroom. Teachers end up spending more than 12 hours a week in preparation activities. Technology and automation are capable of cutting this time down to half. Even if it doesn't cut down on time, technology will help teachers come up with more effective lesson plans and approaches. For example, collaboration platforms can enable teachers to access and search through relevant content shared by other teachers and administrators.

Technology will be of little help when teachers are directly engaging, instructing, coaching, or advising students for their behavioral and emotional skill development. Although studies indicate that technology-rich environments have improved student learning, these developments are yet to be realized on a large scale. There is a disconnect somewhere because in reality students using laptops or tablets in the classroom are performing worse than those without. Providing technological hardware to the classroom is easy but integrating student-learning goals with effective software to be in sync with the curriculum is difficult. Additionally, training teachers to adapt to the new process is even more challenging. So, technology is not going to replace direct instructional time any sooner. Although the role of the teacher will shift from being just an instructor to a coach and facilitator, they still need to be in the classroom.

As a pilot approach, instead of teaching in the classroom and providing students with homework, self-paced videos can be given initially as homework to give basic instructions and have students practice in the classroom in the presence of a teacher. The classroom environment would help fill every gap in understanding with the teacher's support.

Improving Educational Outcomes:

The teaching process is incomplete without feedback and evaluation. Only when the teachers see that their students know the concept, they can move on to the next lesson. Technology was always there even before AI to provide computer grading usin g a multiple-choice questionnaire. But, with AI, more is possible now. Computers are capable of checking long-form answers across all subjects using natural-language processing architecture. The software can look through multiple essays to provide trends and targeted student feedback which will help teachers to tailor and review. Combining such technologies in the workflow is

capable of bringing down evaluation and feedback time of teachers by more than half. Administration work is dreaded by teachers all around the globe. Paperwork always causes anxiety. Teachers would love to rather spend that time interacting with students. There is software to automatically fill out forms, maintain inventories, and list products or equipment. They are even capable of replacing orders automatically. Time spent on administrative activities can be brought down by 25 to 30 percent using automation.

Re-allocation of Time:

Now that technology will save substantial teacher time, how to put it back to good use? It can be given back to teachers to allow them to spend quality time with family and their community. This may improve the attractiveness of teaching as a profession. Additionally, much of the time saved can be put back into improving education through direct mentoring, coaching, and personalized learning. Automation can help remove the biggest barriers of materials, time, and resources that stop teachers from wanting to spend more time on personalized learning. Because, in the past, when teachers believed that they were offering personalized feedback, students didn't agree with such claims.

The extra time can also be utilized to develop social and emotional learning. Additionally, pupils can be trained to equip themselves to thrive in an ever-expanding automated workplace. Teachers will now have the time to nurture one-to-one relationships with students, help them collaborate, encourage perseverance, and self-regulation. Strong bonding with teachers enhances student learning, especially those coming from low-income families. So, automation can prove to become a powerful factor in reducing education inequalities. Finally, teachers get more time to collaborate and associate. Collaborative lesson planning and peer coaching ensure better performance for students. Such practices will propel teachers to develop and improve their craft.

How to Make This Work?

The big question remains. Harnessing the power of technology in schools is no small task. To achieve this seemingly difficult task, all stakeholders must come together. Be it the technology companies, governments, school administration, educators, or students; they all must commit to making this work. Schools have to adopt the new process wisely by starting with an easy solution and having a target investment on the mind. Teachers and administration must work together to harness the latest technology and share what is working with their counterparts.

Schools that are trying to adapt to the latest technology stand a better chance to access more funding than others. Under-resourced schools can gain immensely in terms of increased investment. The additional monetary inflow can then be directed to further improve student outcomes by saving teacher time. Easy approaches to start with will provide early momentum. Proven software workflows which can replace simple evaluative tools and administration tasks can immediately help educators with their daily chores. This will also fuel their appetite for more advanced solutions.

One of the major problems that schools face today is that they are presented with a wide array of technological solutions. While some of them are fantastic, a lot of them deliver much less than what they promise. It is of immense importance to share only that which works and discard the rest. Best-practice solutions should be available to teachers at all types of schools. And finally, increasing the capacity of school administrators and teachers to harness the latest technology will ensure maximum gains. A balance needs to be maintained while introducing new technologies and integrating them with existing ones. School and college associations must accept tools that are widely adopted for better consistency. However, teachers should have the right to pilot any new alternative. Their voice should be a deciding factor for guiding technology companies into product development. Effective execution of the above four imperatives can help automation become a boon for educators and not otherwise.

VI. HOW TO MAKE AI MORE RELEVANT TO LEARNING AND TEACHING

The involvement of AI in higher education is still in its preliminary stage, mainly due to low demand from educational institutions. To understand the problem closely, implementors have to understand the phenomenon of learning and teaching comprehensively. Be it the teachers, students, or people in the administrations; everybody's perspective is different. Addressing all the differences will help us benefit from the opportunities that lie ahead. Communities of educators need to be brought together from relevant areas such as sociologists, lawyers, psychologists, anthropologists, social informatics, and other fields representing social sciences and humanities.

Educators are not showing much interest to demystify the potential of AI. Their involvement is key to the success of this program. Rather, they pay too much attention to the negatives of AI such as its potential to replace teachers and other ethical issues. Educators must be presented with a clear distinction between the advantages and disadvantages of AI solutions. Instead of criticizing from the sideline, teachers need to collaborate with computer scientists and learn what potential improvements AI has to offer. Professionals from varied backgrounds must come together to explore the best practices and emerging trends.Mass level behavioral patterns can be studied and predicted.

But, individuals still carry the freedom to respond differently to the same stimulus. One cannot ignore the emotional influence that a learning process can have. Students often perform better and learn quicker when they sense that the teacher cares. Every individual has their own interest and approach to learning. Because of these emotional aspects, students need to relate to their teachers in some way. And that is why, although AI can effectively automate a minor part of the learning process, social interaction and human relationships still retain an upper hand.

AI service providers have to work in collaboration with educational institutions. Already, tech giants like Amazon AWS, Google, and Facebook are offering their services for free to reputed universities and in return, they are fed with a massive amount of useful data to train the AI algorithms. So, it's a win-win situation for both the higher education community and the global tech providers. Educational institutions are playing a vital role as data providers. So, both parties must work in harmony in the future as well to help refine the automation processes.

VII.CONCLUSION

Technology can never replace the role of educators, teachers, or mentors. They can only improve the process and methodologies while tracking performance and recommending improvements over time. AI and ML promise to make the life of teachers and instructors easier but not replace them. However, all educators have to learn the new trade and change their traditional ways of teaching. Any redundancy in the system will be removed. Empathetic teachers will become even more important in a robot-heavy society to manage the emotional aspects of a student's life. Everyone is skeptical about how AI is different from other technological innovations of the past. People want to know the major limitations and whether it's truly capable of supporting and developing human capacities. Many more questions challenge researchers, policymakers, and education managers. And, it's equally essential to address most of them if not all while writing the future pages of this uncertain chapter.

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