

Future of Education in the Age of Artificial Intelligence

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Abstract— Artificial intelligence (AI) has emerged as a transformative technology in various industries, aiming to mimic human cognitive responses through machine learning and neural networks. Its rapid inclusion in sectors like technology and agriculture showcases its potential to handle complex tasks efficiently. The educational sector has also recognized the potential benefits of AI and endorsed its integration to enhance teaching and learning experiences. Artificial Intelligence in Education (AIED) has been a subject of research and development for over two decades, aiming to harness AI's power to improve education at all levels. However, challenges hinder its effective deployment in real-world scenarios. This report explores the potential impact of AI on education, discussing the concept of AIED and the possible changes it may bring. It also highlights key challenges and concerns surrounding its implementation. While AI offers exciting possibilities, further exploration is needed to fully understand its advantages and potential drawbacks.

Keywords - Artificial intelligence, AI in Education, Intelligent tutoring system, AIED, Future of education, ITS

I. INTRODUCTION

Artificial intelligence (AI) has emerged as the revolutionary technology of the decade leaving its impacts in almost all diverse fields. It is the branch of computer science that tries to mimic the cognitive response of humans with the help of concepts like machine learning, deep learning, and neural networks. In recent years the world is facing rapid hikes in AI inclusion across various sectors. New changes have been introduced, beginning with technological industries such as information technology and progressing to the non-technical agriculture sector. The AI-powered tools are handling complex tasks that would consume heavy effort and time by any human. Experts believe this to be a significant showstopper in the near future.

In addition to industrial implementations, emphasis is placed on the educational sector. AI is considered a potentially useful technology to bring about effective changes in education. UNESCO [1], UNICEF [2], and many other university organizations like the European University Association have endorsed the inclusion of AI in education to improve the standard and quality of teaching. Artificial Intelligence in Education (AIED) is a profound concept that has been under research and development for more than two decades. This aims to effectively harness the power of AI to improve the teaching and learning experience across different stages of schooling and university education. However, despite the achievable potential improvements, there are challenges that

currently serve as roadblocks to effective deployment in real-world scenarios.

This report will discuss the state of education in the foreseeable future, where AI could potentially be the prominent driving force. Section II provides a prelude to the AIED concept, while Sections III and IV discuss the possible changes that would be implemented in education as a result of AI's intrusion. Section V discusses key challenges and concerns, followed by a conclusion in Section VI that provides an idea of how AI shall dominate.

II. ARTIFICIAL INTELLIGENCE IN EDUCATION

Artificial Intelligence in Education (AIED) is a profound concept that has been positioned with the task of personalizing education for individual learners [3]. The project commenced in the late 1980s with the aim of creating an intelligent tutor capable of deeply understanding the learner and providing personalized education. With advancements in technology over time, the definition of this goal took on new meanings, aligning with rapid technological growth. For the past 30 years, immense focus has been placed on solving the Bloom's 2 sigma problem in personalized teaching. In recent times, with the help of highly powerful AI engines, the work under AIED can be categorized into four subdomains [4], which deal with providing personalized learning for students and reducing the administrative burden on teachers. This involves the use of intelligent tutoring systems, adaptive learning platforms, natural language processing, computer vision, and image & voice recognition to improve educational outcomes. Improvements are made with the basic understanding that developments for one stakeholder (teacher or student) will affect the other in a sensible manner. Intelligent Learning Environment (ILE), a concept within AIED, has shown improvements in the efficiency of classroom teaching environments [4].

The importance of AI in education can be understood by analyzing the statistics on the distribution and availability of teachers globally. Fig.1 [5] shows the predictive statistics on teacher recruitment between 2020 and 2030, published by UNESCO, to fulfill the education pledge. UNESCO aims to ensure inclusive, equitable quality education and promote lifelong learning opportunities for all by 2030. According to UNESCO, there will be a need for 68 million new teacher recruits worldwide before 2030 to achieve its education pledge of providing quality education to the entire global population,

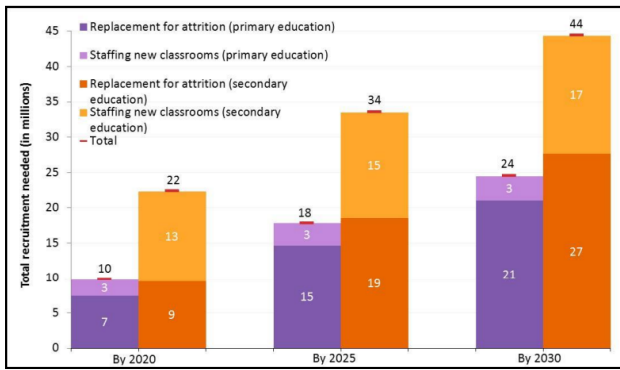


Fig. 1. Total new teachers recruitment needed to satisfy education pledge of UNESCO

regardless of biases. On the contrary, Fig.2 [6] presents statistics on the global count of available teachers from 2000 to 2014. It is clear that the number of available teachers has been increasing, from 62.62 million in 2000 to 84.50 million in 2014. The average annual increase is just over 2%. At this rate, it would be challenging to meet UNESCO's requirements. Recognizing the roadblocks and challenges in increasing the teacher population, organizations like UNESCO, UNICEF, and EUA are suggesting and endorsing the inclusion of AI in the education environment. By leveraging AI's ability to reduce teacher effort, create quality content, and provide personalized learning, this resource gap can be significantly addressed and reduced. Considering all the aforementioned facts and factors, it is evident that the world is moving towards including and implementing artificial intelligence concepts and techniques in education. This session discusses advancements with high potential for future implementation, along with the accompanying challenges and considerations in the subsequent sessions.

The educational environment must adapt to changes when the impact of modernity becomes deeply ingrained in reality. Internet technology has been around since the late 1960s, primarily used by researchers and scientists. It became widely accessible to the general public in the 1990s and early 2000s. However, it took a significant amount of time for the traditional educational framework to effectively incorporate computers and the internet into the classroom environment. It has been a common trend for general technological advancements to take time to be integrated into the educational system. However, all these delayed influences were set aside when a global lockdown was imposed due to the Covid-19 pandemic. This forced people to stay at home for extended periods and compelled children to engage in online learning from home. The restrictions on mobility broke down the barriers to technological advancements, leading to the rapid implementation of distance learning within a short period. Tech giants such as Google and Microsoft seized the opportunity and implemented virtual learning environments. Additionally, several other Ed-Tech companies/platforms like Coursera, EdX, Khan Academy, and Udacity focused on enhancing their virtual learning platforms

during the same period. This highlights the understanding that the education framework cannot remain constant in terms of methods and practices and is prone to changes in accordance with global developments. This aligns with the statement that Artificial Intelligence will dominate the education industry and bring about significant enhancements.

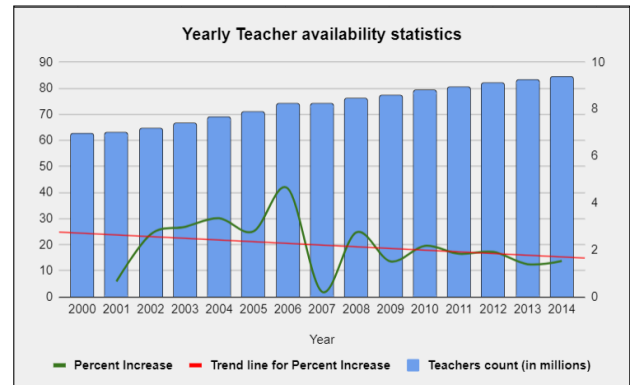


Fig. 2. Trend of available teachers - 2000 to 2014 [6]

With the launch of GPT-4, an AI language model, the futuristic goals of AIED have started to converge into action. This AI model uses generative pre-trained transformations with the help of Natural Language Processing (NLP) to understand and provide interactive answers to user requests/queries. With over 175 billion training data parameters, the model processes immense information in fractions of seconds to respond to user requests. Although the target audience for this AI model was developers and researchers who could utilize the model's ability to build innovative applications and tools, its publicly available chatbot has become a potential unofficial educational tool for students and teachers. Students use this pre-trained tool as an alternative to search engines to gain information quickly in a human-like response format. On the other hand, teachers utilize this knowledge base to enhance the quality of learning content. Since this is a highly advanced and new way of interacting with information, rather than directly referring to books and articles or searching for digital articles on the web, there are no exact usage instructions. People use this according to their own needs, sometimes ignoring the concept of fair use. It has been noted that some students use ChatGPT to write assignment reports for them, while others use it to generate examination answers. Taking into consideration such unfair usage, AI cannot be judged to have a negative impact on teaching. On the contrary, this gives rise to new questions and perspectives on how AI could be used. Accounting for all the above aspects, two research questions seem more reasonable to analyze:

- 1) How AI is going to impact the ways of learning and teaching?
- 2) How AI will impact what we are learning?

This paper concentrates on the facts and predictions that could answer the above 2 questions.

III. IMPACT OF AI ON HOW TO TEACH

Concepts such as Intelligent Learning Environment (ILE) and Technology-Enhanced Learning (TEL) have been extensively analyzed in the past decades. Research and experimental studies on these concepts have revealed increased efficiency in teaching and learning [4]. Several research studies [7] [8] [9] have discussed and explored the implementation of ILE and TEL concepts in modern classroom environments to enhance the quality of education. With the successful implementation of AI language models observed by the end of 2022, the integration of AI into the classroom environment has accelerated. By examining AI tools and aids discussed in academic journals, certain implementations have a high likelihood of being executed in the near future, potentially leading to significant effectiveness. The four possible implementations are as follows:

- 1) Reducing Teachers' workload with TEL
- 2) Personalized Learning Platform for Students
- 3) Research Enhancement platform
- 4) Automated assessment and Grading

A. Reducing Teachers' Workload with TEL

Studies and surveys conducted among the teaching population have revealed that approximately 45% to 55% of teachers' efforts are dedicated to activities that do not involve direct lecturing [10] [11]. In other words, nearly half, and in some cases more than half, of teachers' time and effort are spent on administrative and course organization tasks. In certain countries like Japan and Korea, the amount of effort allocated to non-lecturing activities is twice as much as that spent on actual teaching. These non-lecturing activities include creating course content, organizing assessments, grading assignments, engaging in institutional-level administrative tasks, providing student counseling, and more. These activities consume a significant amount of effort and reduce the time available for meaningful student-teacher interactions that enhance conceptual understanding of the subject matter. Consequently, there is a need for alternative frameworks and techniques to handle these secondary activities and reduce teachers' workload. Implementations of TEL and ILE can effectively decrease the efforts spent on these secondary non-teaching activities.

Teachers may produce the full course or lecture content in a few hours with the aid of TEL implementations, which would normally take days to accomplish. With the huge breakthrough that occurred with the implementation of the AI language model (GPT-4), engineers are now focusing on technologies that might lessen instructors' efforts. Current accessible tools are in the early phases of successful application, but the concept offers the greatest potential for future study. TEL tools might be used to develop course materials and course plans, perform administrative activities such as keeping records for various classes, and so on. The ability to give customized course plans and materials with the ability to adjust content development is seen as an advanced aspect. AI-powered TEL is now in the early phases of deployment, and its effective

integration into global classrooms will be determined by institutional attitudes. Despite all of the positive benefits that may be obtained through the foregoing, there are problems and concerns that will postpone this integration, which are discussed in the Discussion portion of this article.

B. Personalized Learning Platform for Students

Personalized learning platforms for one-to-one tutoring have been one of the goals of AIED for over a decade now. Benjamin S. Bloom conducted a study [12] on the effectiveness of one-to-one tutoring compared to group instructional methods of learning. The analysis resulted in the explanation of the 2 Sigma problem.

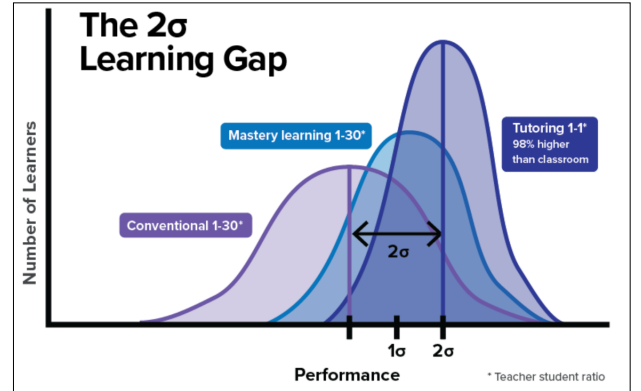


Fig. 3. Bloom's 2 Sigma Distribution of student performance

The conclusion of Bloom's research, sometimes referred to as the Bloom's 2 Sigma Problem, is summarized in Fig.3. It can be understood from Bloom's study that, the average performance and understanding of students in group interactive learning environments (classroom learning as group) are lower than that of students exposed to individual tutoring. The median of the performance distribution between the above two groups have a difference of 2 sigma, i.e., 2 standard deviations of the actual group learning distribution. So it is significant that individual tutoring could elevate the understanding of performance of students.

On the other hand, Fig.4 shows the dispersion of student-teacher ratio around different regions. The distribution map makes it abundantly evident that there are regional variations in the ratio. The typical value is in the 25–40 range. This inherently implies that a teacher typically oversees at least 25 students in nations all over the world. In addition, there aren't enough teachers to handle all the children, according to the UNESCO statistics from Fig 1. Providing individualized and tailored learning for all of the children would be a challenging objective given the teacher shortage.

Intelligent Tutoring System (ITS) is an extreme implementation of ILE. AI-powered ITS can potentially handle the tedious task of providing personalized learning. Noticeably efficient tools powered by GPT-4 have published their initial releases. The algorithmic execution of tools varies depending upon the concentrated key feature, whereas the tools are alike

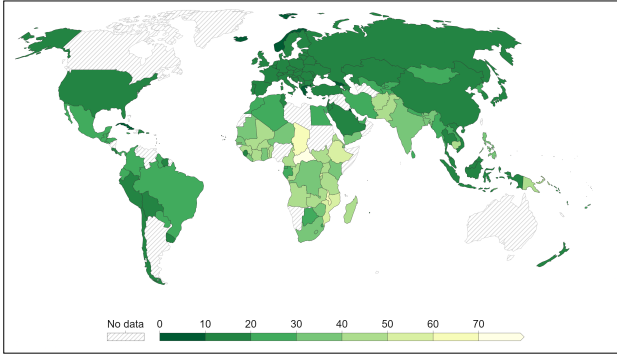


Fig. 4. Global Student teacher ratio map

in terms of satisfying the goal. The major benefits of ITS are the ability to provide personalized education for students depending on their learning curve. The tools can adapt to the user's understanding and backtrack the progress optimizing the learning experience. Additionally, bias in education can be dealt with using ITS tools. Educational bias still exists in the form of gender, race, sexual orientation, socioeconomic status, culture, and so on. An AI model shall not concentrate on these biases, instead providing a uniform platform experience to all. Discussing all the above advantages, the power of AI in this sector is yet to be researched intensely in the future, but the involvement of AI can be considered to be assured.

C. Research Enhancement Platform

Accounting for the possible impacts of AI in education, considerable concentration should also be laid on academic research. Research is the backbone of content-wise development in education. Current research can potentially convert into future standards in respective fields. Academic research involves heavy effort and time. In-depth researches consume a significant amount of research time in the literature review. The literature review is the first and most important step that helps collect all necessary data, and methods for further research proceedings. The intensity of literature analysis is directly dependent on the complexity of the problem statement undertaken for the research.

Finding the best methods for certain procedures would need referring to multiple literature works. Searching for appropriate research literature through traditional and standard methods of using publication databases like Google Scholar, Springer, and IEEE are time-consuming. AI tools with the power of intense data processing and retrieval, potentially could reduce the time spent on pre-research engagements. This implementation has higher potential but is at the early stages of research and development.

D. Automated Assessment and Grading

Assessment is considered one of the 3 main pillars of education. Assessment is a measure of testing the understanding of a student towards any subject. Designing perfect assessments that can evaluate conceptual understanding requires time and effort. The standard of assessment is highly dependent on the

knowledge and effort of teachers. A significant amount of teachers' time is spent preparing the assessment and grading them. This time dependency could be eliminated with the help of AI tools. These tools with the power of intense data processing capacity combined with Natural Language Processing (NLP), and neural networks, could analyze the course content and prepare an assessment respective to different grades.

Additionally, platforms for the personalization of assessment could evaluate students' conceptual understanding in an advanced manner. With personalized data collection, the user study patterns shall be analyzed and modeled to reciprocate the extent of exposure to content. This model can be later used for designing an assessment to check the understanding of the respective user, in this case, a student. This is a basic implementation of possible personalization. Concerning the assessment, the grading process can be automated. NLP enables AI to understand human-generated texts. In addition to just automating multiple choice questions, descriptive questions involving student explanations can be evaluated and graded.

IV. IMPACT OF AI ON WHAT TO LEARN

Artificial Intelligence is expected to grow by a factor of 37.3% yearly between 2022 to 2030 [13]. The projected market value of AI in business in any sector is \$407 billion by 2027 [13]. AI is expected to be incorporated in every business field in the future. In the current decade, AI is showing immense growth and development. Technological experts predict AI to affect 15% of the global workforce by 2027, this would affect 400 million individual job positions. Industries have understood the power of AI, and effective implementation performed with proper research could reduce the cost of operations and administration by significant margins. The above facts and predictions indirectly imply that intense AI incorporation is not far from the near future. All these industrial adjustments affect the global workforce, making the masses with inefficient work skills jobless. Education is the prominent concept of mankind, that initially concentrates to prepare individuals to understand their respective environments. Now, considering the above key aspects in terms of AI incorporation in the future, education systems, and education curricula should adapt to the foreseeable advancements. Educating students with century-old techniques and old facts would compare to powering a modern car with horses than placing a powerful engine inside the hood.

The challenging aspect of this adaptation in the education system is caused due to lack of sources to analyze the effect of feasible principal changes. Lack of standards, use of black-box protocols, non-disclosed data prevention methods, differences in international laws, and ethical governance makes AI non-generalizable. Hence, ambiguity prevails in understanding AI, elevating the bias in determining new educational standards to be incorporated. In addition to changes in methods of learning, there arises a need for adapting the learning curriculum to prepare students to encounter the future where AI is likely to dominate. Analytical studies on this topic to determine exactly what would be needed in future education are scarce. The

following recommendation in the content enhancements is the result of a collective analysis of expert suggestions in the field rather than research outcomes.

A. Adaptations to AI Inclusion

Irrespective of the subject area, the curriculum should add modules that develop students' knowledge of AI. It does not require every human to know how AI is programmed and how applications could be developed using AI. But in the future era of AI, people working in all industrial and business sectors irrespective of the service type would have to deal with AI tools that reduce their time on tasks. Adapting to such AI inclusions would require foundational knowledge which could be introduced in schools and universities through practical and theoretical sessions. Concentration should be laid on making students understand what is AI and educating them with ways to use the power of AI.

B. Being Human in the Loop

Having humans in the loop of AI assures certain moral decorum being expressed by the tool/ technique. Designing and development of AI models are immensely complicated and consume great effort. At some point, people would trust the pre-existing systems to develop new technologies which would be possibly only overseen by humans rather than being involved in development. This aspect of human involvement might result in a reduced team effort by humans but makes the new tool to be technically foreign. Future education should teach students about the hierarchical position of humans in the AI loop along with possible areas where anthropogenic impact is mandatory.

C. Ethical Use of AI

From deepfakes to voice scams, the unethical use of AI has increased in recent times. Any advanced technology is prone to be used unethically by people who seek money, fame, and power. AI is not an exception in this case. Using such technologies fruitfully depends on the imagination and understanding of the potential, which cannot be influenced by education to a certain extent. But, education could define how technology shall not be used for the benefit of everyone. Ethical considerations should be developed in students from the initial stages.

D. Being Creative

Creativity is the key factor that is differentiating human thinking and machine thinking till now. AI could analyze and understand all that a human can understand but lacks the ability to develop creativity. Contradictory statements define AI to replace the creative workforce first, but technically AI just collects different unique features created by humans and combines them optimistically to fake creative sense. Taking this into consideration, school education should encourage students to be creative rather than following traditional academic workloads that were initially developed to produce the best clerks out of school rather than intellectuals.

E. Adherence to Automation

Initially, CNC technologies already automated physical effort-consuming jobs during the industrial revolution. Extremely advanced AI could automate even logical effort-consuming tasks, for example, general payment clearance and check validation in banks. So, understanding automation and developing skills to manipulate and evade automation could eventually reduce stress due to recessions.

V. DISCUSSION

The assimilation of artificial intelligence into education in the future, possibly to be dominated by AI, is discussed in the above two sections. The mentioned advantages and feasible implementations might provide a perspective that AI is flawless when incorporated into education. But some concerns ought to be handled well before making AI a driving factor of future education. This section defines the challenges and possible ways of handling the same.

A. Reliability of AI Generated Data

AI tools that use the ITS and TEL concepts are highly dependent on the model training. The models are exposed to black-box training in case of these implementations. The problem with this kind of training lies in the fact that the data, sources, methods and algorithms used for such training are not disclosed properly.

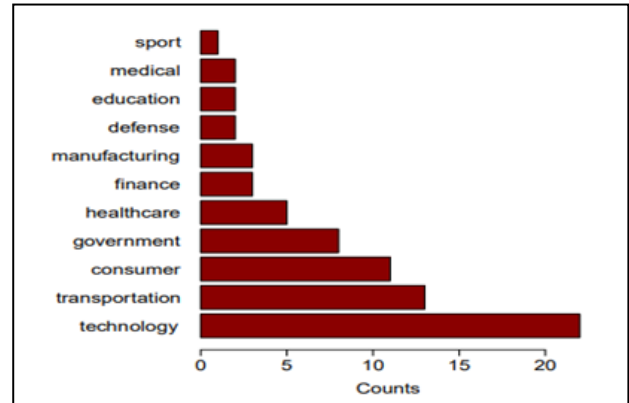


Fig. 5. Reliability incidents till 2021 caused by unreliable data generation by AI [14]

Among 156 AI related incidents recorded till 2021, 72 incidents were caused due to unreliable data generation by AI. Fig.5 represents the statistical distribution of the respective 72 incidents. ITS chat-bots and TEL tools use pre-trained data to generate user desired outputs. In case of ITS chat-bot, the model generates answers based on the training data and the data collected from user interaction. Since the training is performed by human involvements, the process is prone to human and data error as all the data available possess certain degree of noise. An effective way to tackle this kind of data reliability issues would be to provide a reliable resource as reference as shown in Fig. 6. Here the browser powered by AI provides information along with citation to reliable source for reference.

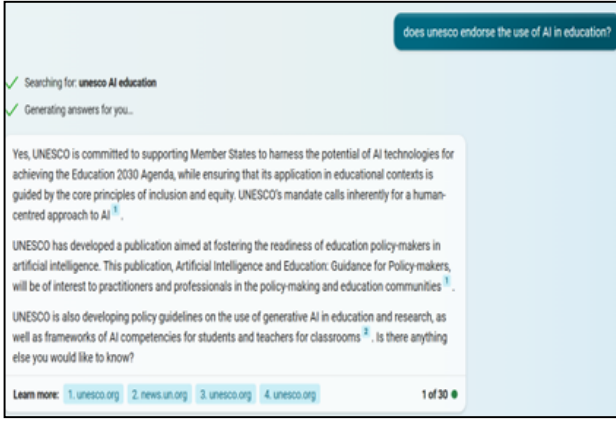


Fig. 6. Search engine response highlighting source for reference : Bing

B. Degradation of Cognitive Responses

In the modern era, people expect faster responses to tasks, concentrating only on the results rather than the actual process. Similar behavior can be observed among younger generations. Providing these students with the power of AI could make them less cognitive by providing all the needed answers rather than making students explore and find the correct one on their own.

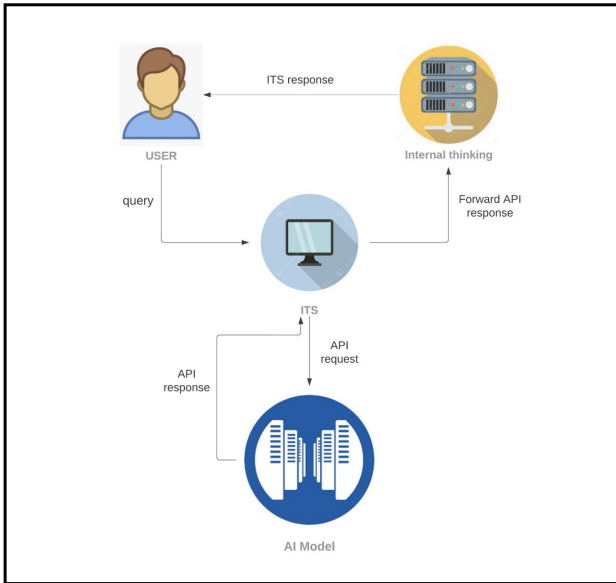


Fig. 7. Internal thinking by ITS

To minimize the occurrence of such incidents, AI tools should prioritize helping students comprehend the concepts instead of simply offering answers to their questions. These tools should employ a "think before speak" technique. Fig.7 represents a non-technical simplified diagram of this think before speak approach by ITS tool. As observed from the picture the ITS tool should process the response received from the AI model and internally process it at the "Internal Thinking" stage, where comparison of user input/answer towards the

correct data is performed. The final ITS response would be an instruction that would help the user to proceed further with the problem/question rather than directly getting the answer from ITS at the first-place. This approach ensures that students do not receive the precise answer they seek, but rather receive sequential guidance that gradually converges to the appropriate answer enhancing their cognitive responses.

C. Replacing Teachers With Potential AI

With the rapid advancement of technology, existential questions arise regarding the potential of AI. Some argue that teachers will never surpass the knowledge and efficiency of machines, leading to the belief that AI will eventually replace teachers. While this viewpoint may be valid from a technical perspective, replacing teachers with AI would undermine the entire educational framework. While AI tools possess impressive capabilities, they cannot stimulate critical thinking, instill moral understanding, or explain societal and cultural behaviors. Teachers serve as the vital bridge between students in the educational environment. Physically replacing teachers with AI would create a void, isolating students from the human interaction and guidance they need. While this topic may be subject to debate, it is important to recognize that teachers should never be completely replaced. However, the workforce composition may be influenced by the integration and utilization of AI tools by educators.

D. AI Experiments & Ethical Concerns

The competitive mentality between developed and developing nations has existed for a significant period of time. However, this drive for success and ambition can sometimes lead to unethical actions. An example of this is seen in a middle school in China that introduced AI headbands for students to wear during lectures [15]. These headbands collect brain signals, convert them into digital output, and calculate the students' level of concentration in class. While the application may appear interesting, morally it is problematic. The headbands indicate the level of concentration through colored lights on the band. However, wearing such a device and attending classes can increase stress levels for students. It is common for individuals to experience fluctuations in concentration, regardless of their knowledge level. Therefore, expecting students to maintain the same level of concentration throughout the entire day is unrealistic. This experiment had negative mental effects on some students, and the physical discomfort caused by wearing the headbands further compounds the issue. Experiments like this should not be conducted solely for the purpose of displaying dominance. While the potential of AI is significant, it comes with a greater responsibility. Educational institutions should act ethically and consider the moral implications of any actions taken when incorporating technology. The well-being and psychological welfare of students should always be a top priority in the pursuit of technological advancements in education.

E. AI Aversion

After the release of ChatGPT, institutions around the world banned the use of such chatbots on their institutional networks. When teachers discovered students using these tools to complete their homework and reports, initial panic led to the implementation of restrictions. In the modern era of science, educators should not act as gatekeepers of information but rather as facilitators. While many university organizations imposed restrictions hastily, without taking proper measures, some university professors around the world approached these tools differently. Some professors instructed students to prepare reports on specific topics using AI models. However, the assignment was designed in a way that the report would not solely focus on the topic. Students were required to initially receive a draft from AI and then provide their individual opinions on the AI response, supported by proper citations (ChatGPT, citation). This approach enables students to develop technical proficiency and enhance their conceptual understanding. Instead of disregarding technological advancements, educators should embrace these changes and adapt to them as early as possible.

VI. CONCLUSION

Artificial intelligence can undoubtedly be referred to as the technology of the century. It offers numerous benefits across various industries, facilitating the successful execution of complex tasks. The growing interest from prominent industrial giants further emphasizes the future significance of AI. In the realm of education, AI has the potential to revolutionize the traditional system, providing students and teachers with new avenues for learning and understanding. Next-generation approaches such as smart content, gamified learning environments, visually interactive modules, and personalized tutors are now within reach. However, before generalizing these concepts, it is essential to address certain implementation concerns. Research on modern AI in education is still in its nascent stages and requires thorough exploration. It is too early to conclusively determine whether these modifications will prove advantageous or potentially detrimental, but their impact has already begun to emerge.

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