Position Papers of the 20th Conference on Computer Science and Intelligence Systems (FedCSIS) pp. 9–14
DOI: 10.15439/2025F7856
ISSN 2300-5963 ACSIS, Vol. 44

Examining the Increasing Use of Artificial Intelligence in Education, A step Closer to Personalized Learning

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***Abstract*—This study, conducted within the Erasmus Programme "Language, Education and Society," investigates the growing use of Artificial Intelligence (AI) technologies in education and explores the future of learning through the lens of AI and advanced Machine Learning (ML) methods i.e. Reinforcement Learning (RL) and deep learning. AI is the automation of cognitive processes traditionally associated with human intelligence. It encompasses the development of computational systems capable of performing tasks that require knowledge, reasoning, learning, and decision-making when carried out by humans. In the educational context, AI offers transformative potential by enabling personalized learning pathways, automating instructional processes, and enhancing the adaptability and effectiveness of pedagogical strategies. This research explores how AI technologies, including ML and RL, are currently being leveraged to optimize educational practices, and it highlights the growing intersection between AI advancements and the evolving demands of the educational sector.**

***Index Terms*—Artificial Intelligence, Machine Learning, Reinforcement Learning, Personalized Learning, EdTech, Intelligent Tutoring Systems, Smart Content, Educational Innovation, Digital Education.**

I. Introduction

ARTIFICIAL Intelligence (AI) and Machine Learning (ML) have profoundly transformed nearly every aspect of modern life, including healthcare [14], transportation [1], resource management [2], agriculture [3], autonomous systems, and self-organizing processes [4]. In recent years, education has emerged as one of the most dynamic and rapidly evolving domains for AI integration. These technologies are reshaping traditional educational paradigms by enabling personalized learning experiences, intelligent tutoring systems, automated assessment, and adaptive learning environments [5].

Another highlighting factor is the growing commercial demand for AI in education, as evidenced by substantial investments from both public institutions and private enterprises. Leading technology companies—such as Microsoft, Google, Meta (formerly Facebook), and Amazon—have been investing billions of dollars into the development of AI-powered tools that span a broad range of applications, including computer vision, natural language processing, predictive analytics, and virtual assistants. Notably, many of these investments also target the education sector [7]. For instance, Google's AI-driven "Read Along" app helps young learners improve reading fluency using real-time speech recognition, while Microsoft's "Immersive Reader" enhances reading comprehension across multiple languages and learning abilities. A notable case study is IBM's Watson Education platform, which leverages AI to provide teachers with data-driven insights into student performance, helping educators tailor instruction to meet individual needs. Similarly, platforms like Carnegie Learning and Squirrel AI in China utilize AI algorithms to provide adaptive learning pathways that respond to each student's pace and level of understanding.

The COVID-19 pandemic [8] significantly accelerated the adoption of AI and EdTech solutions globally. With the abrupt shift to remote learning, educational institutions faced an urgent need for scalable and effective digital tools. During this period, AI-based solutions saw a surge in demand for supporting virtual classrooms, automating administrative tasks, and facilitating online assessments [9]. A 2021 survey conducted by the University Professional and Continuing Education Association (UPCEA) revealed that 51% of American faculty members became more optimistic about the future of online learning compared to their pre-pandemic views, signaling a long-term shift in the perception of technology-enhanced education. Furthermore, the rise of "edutainment" — the blending of education and entertainment — has fueled greater acceptance of AI in learning environments. Educational apps, games, and interactive platforms powered by AI, such as Duolingo and Khan Academy's Smart Feedback system, are increasingly popular for engaging learners of all ages. The convergence of AI and education represents a paradigm shift in how knowledge is delivered and consumed. As the demand for lifelong learning and skill acquisition continues to grow, AI is poised to play a pivotal role in shaping the future of education, making it more personalized, inclusive, and data-informed [10].

The rest of the paper is organized as follows. The next section provides a brief technical introduction to AI technologies enabling readers to grasp the argument. The section III is the main section that presents use cases to understand the

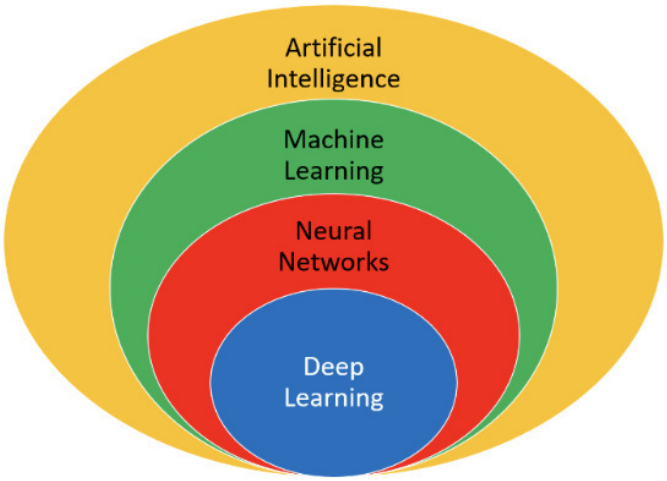

Fig. 1: Overview of AI technologies

increasing use of AI and its impact in Education. We discussed the challenges, limitations and future directions in section IV while we conclude the study in section V.

II. Technical Background

This section presents a brief introduction to Artificial Intelligence (AI) and Machine Learning (ML) technologies Figure 1.

AI is the technology that enables machines to think like humans. It can be a computer or robot able to learn, reason, solve complex problems, and can understand languages. AI tools have powerful features to recognize patterns much faster than use that help AI based systems to make decisions and this happens as AI mimics the cognitive abilities of human brain. AI-powered systems learn how humans think and process information, hence enabling them to perform tasks smartly and more efficiently. It is important to understand how AI is being implemented. AI is practically the sum of many technologies including machine learning, computer vision and natural language processing. Similarly, machine learning is the sum of many categories including supervised learning, unsupervised learning, semi supervised learning, Reinforcement Learning and Deep Learning. Among these types, RL and DL are the most advanced form of AI which enables AI to mimic a human brain's neural network. Reinforcement learning a branch of machine learning, is goal-directed learning from interaction. Reinforcement learning involves improving performance through trial-and-error experience [14]. A method with a software agent that interacts with an unknown environment, selects actions dynamically and discovers which action yields more reward [11]. Reinforcement learning focuses on teaching algorithms to make choices by providing positive feedback for preferred actions and negative feedback for unwanted ones. Similarly to how behavior is influenced by rewards and consequences in psychology, this method allows systems to gradually develop the best strategies through a process of trial and error as shown in Figure 2. The reward system

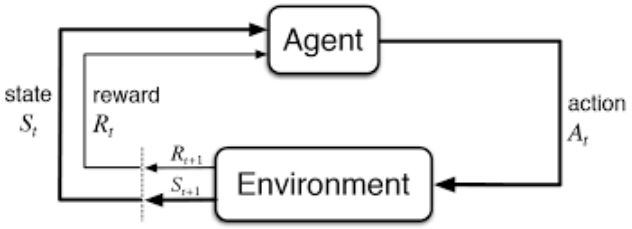

Fig. 2: Working of an RL agent presenting agent-environment interaction [11].

is crucial for guiding the agent's actions toward achieving the final goal. It serves as a feedback mechanism, clearly indicating whether a chosen action has led to a positive or negative outcome. By understanding this, the agent can adjust its strategies effectively, ensuring progress and success in reaching its objectives.

Similarly, deep learning is the latest AI tool which has brought transformation how machines train, learn and interact with environment and complex data. It is the type of learning which mimics Neural Networks (NNs) of the human brain and thus enabling machines to autonomously uncover patterns and make informed decisions from huge amounts of data [6]. NN is the main part of the deep learning algorithm, consists of layers of interconnected neurons working in collaboration to process input data. In a fully connected Deep Neural network (DNN) data flows via multiple layers and every neuron do nonlinear transformations, permitting the model to learn intricate representations of the given data. In a DNN the input layer receives data and this data is then passes through hidden layers and these central layers further transform the data using nonlinear functions. At the final stage, the output layer generates the model's prediction or output.

III. Decoding AI in Education

This section presents the various use cases that we consider to explain the increasing use and impact of AI solutions in education.

A. Personalized Learning

The first case is personalized learning that we can say is one of the best and innovative uses of AI in education. The concept of personalized learning is getting attention worldwide and it can be realized with the help of modern AI and ML tools as demonstrated in Figure 3. Personalized learning is a learning method to employ AI and ML specially Reinforcement Learning (RL) that considers the requirements of every individual student. Personalized learning means that each student's learning experience and skills are customized to adopt their needs. Personalized learning provides an opportunity to grow using their own skills and learning experience.

The AI-powered personalized learning gives flexibility to students in various aspects like: the use of material, quality of material, speed to learn, and way of teaching. Although there are various benefits of personalized learning as highlighted,

Fig. 3: Benefits of AI on personalized learning

there are also some limitations. For example, the implementation of personalized learning is a time taking task and it is difficult without the use of AI technology. Similarly, the cost associated with the implementation of technology-based infrastructure is another issue. Lastly and importantly, the training of teachers and relevant persons on the use of modern technology is another challenge that needs to be addressed.

B. Task Automation

The second case is how AI methods can be useful for task automation. The presence of adaptive learning platforms based on AI technology, can analyze student data, for example, their learning pace, strengths, weakness and performance. This information is feedback to AI systems for task automation to obtain personalized pathways for every student, providing suitable and adaptive activities, resources and contents based on their specific needs. These systems are also known as Intelligent Tutoring Systems as they offer individualized support and guidance to students [19]. Another advantage of these systems is their ability to assess an individual student's understanding, identify areas of weakness, and provide corresponding feedback, and exercises for practice. The intelligent tutoring systems adapt to every student's progress and adjust the learning material accordingly.

C. Smart Content Creation

The next use case is about the innovative use of AI technology for smart content creation in the context of education and learning. There are many examples like Information visualization, digital lesson generation and frequent content updates. Moreover, AI algorithms are also helpful in content optimization and content curation as illustrated in Figure 4. AI technology provides huge potential in improving content creation processes, assisting students to develop engaging and suitable content for their study objectives and tasks.

In addition, content creation using AI tools also saves time and offers an effective way to generate relevant contents in a short time. AI-based content optimization ensures that the content resonates with the study goals. At the same time students get valuable contents creation experience with the use of AI for content creation curation and optimization. It is important to embrace AI tools and students can use them to their learning advantage. Smart content creation based on AI technologies is the way forward for content creators students who seek to develop impactfull and engaging content in a time-oriented task.

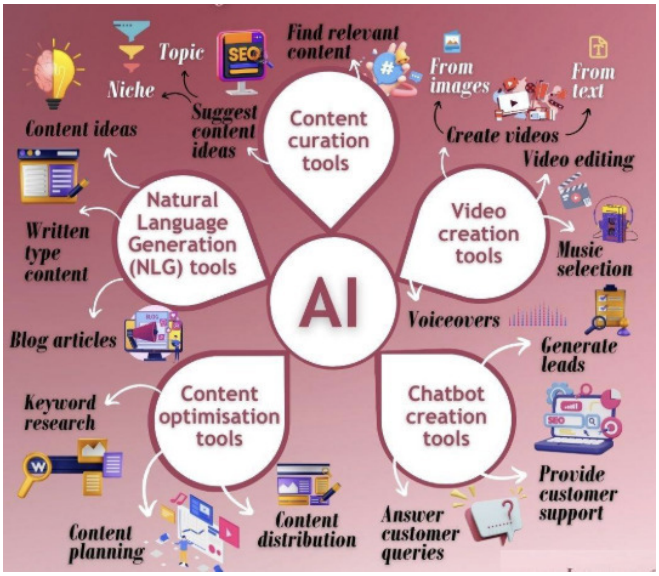

Fig. 4: AI tools for contents creation

D. AI in Examinations

An important phase of the education system and learning process is the examination. AI technology can assist both teachers and students in the examination process because it is possible to track the performance of students in examinations. The AI-enabled systems then help teachers by providing them detailed analytics of each students' performance and the performance of the whole class as well. These analytics will assist teachers in understanding which arguments or concepts are difficult for students and consequently can develop new strategies to help students in grasping highlighted topics. Similarly, AI tools are also useful to students by providing them feedback over examinations. These modern technologies not only help students in pointing out their weak parts but also assist them with personalized schemes to understand a specific topic with maximum attention and retention. Moreover, AI-powered systems can alert teachers if a student or group of students is lagging behind others in some subjects.

The scenario or problem as shown in Figure 5, can be considered as the problem of personalized learning, task management or subject selection. We have different tasks and we have to make task selection using RL policy and feedback to RL agent after selection of the particular task. This is an emulated environment where different students have to learn and perform different tasks. The performance of a student varies from task to task and similarly, the outcome of each task in terms of score (S1,S2,S3,S4) may be different for different people. The probability distribution for the reward corresponding to each task is different and is unknown. The problem for an AI agent is to learn which task to select in order to get the maximum score in a given amount of

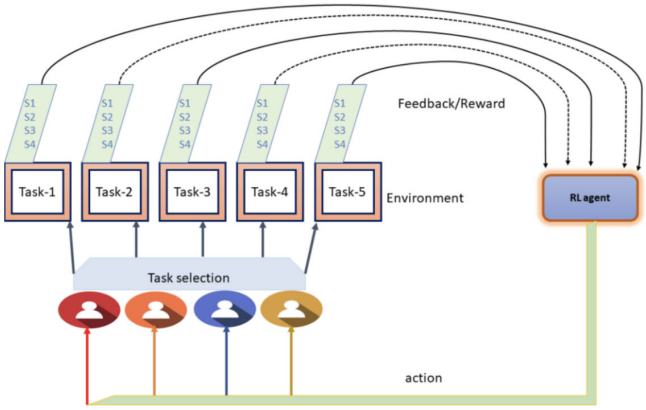

Fig. 5: An AI based subject selection system [20]

Fig. 6: An AI based subject selection system [20]

time. This problem statement is identical to a single step Markov Decision Process (MDP). The score list (S1,S2,S3,S4) measures different skills of a person during the execution of a task. The better score in skills indicates more interest and better performance for a particular task and lower score indicates that a particular task is unsuitable for a person. After a lot of interaction with the environment, the RL agent learns the most suitable task for a student.

This scenario can be modeled as a problem as a MMDP with a single state. There are in general K number of tasks and it is possible to select anyone and each task has a certain probability of returning a reward (score). Therefore, we have a single state and K possible actions (one action for each task). At each time period the agent selects one task and it receives feedback in terms of different scores (reward). The goal of the agent is to learn the best task/subject for each student in in order to maximise its long term reward. A suitable machine learning algorithm like Boltzman sampling, Epsilon decreasing, Random, Softmax, and Thompson sampling algorithms can be used to solve this MDP problem.

E. Secure and Decentralized Learning Systems

Artificial Intelligence, when integrated with emerging technologies such as blockchain, can contribute to the development of secure and decentralized learning systems [21]. One of the major concerns in digital education environments is the security and privacy of learners' data. AI-driven platforms, enhanced with decentralized technologies, can provide a transparent and tamper-proof infrastructure for storing educational records, certificates, and learning progress. This ensures that students have full control over their data and can securely share their academic achievements with educational institutions or employers without relying on centralized authorities.

Furthermore, decentralization promotes inclusivity and accessibility by enabling peer-to-peer learning networks, where educational content and credentials are distributed across secure nodes rather than hosted on a single centralized server. AI algorithms can monitor and verify these exchanges, ensuring content quality and relevance while maintaining integrity and trust in the system. As a result, secure and decentralized learning systems not only protect student data but also foster global collaboration, democratizing access to education across borders and socioeconomic boundaries.

F. Customized Data-Based Feedback, Closing the Skill Gap

The final use case examined the role of AI in delivering customized feedback to students by analyzing large datasets of their learning behavior, performance trends, and engagement metrics. This real-time, data-driven feedback is crucial for identifying individual strengths and weaknesses, which helps educators design tailored learning pathways for each student as also indicated in Figure 6. AI systems can generate predictive analytics that forecast student outcomes and suggest timely interventions, thereby preventing learning delays or dropouts.

Moreover, this personalized feedback mechanism plays a vital role in addressing the skill gap between academic training and real-world job market needs. AI can map students' learning progress against industry requirements and recommend specific skills or courses to align their competencies with emerging market demands. Educational institutions and employers can also benefit from this data, as it enables more accurate student profiling, workforce readiness assessments, and targeted curriculum development. In conclusion, AI-enabled customized feedback serves as a bridge between education and employment, helping students acquire relevant skills and enhancing the overall effectiveness of learning systems.

IV. Discussion and Future Work

The integration of AI in education signals a paradigm shift in how learning is designed, delivered, and evaluated. Reinforcement Learning, with its capacity for modeling sequential decision-making, offers substantial potential for tailoring educational experiences to individual learner behaviors. Similarly, the implementation of AI-powered tools such as chatbots

and virtual tutors allows for scalable, continuous support that can simulate human-like interaction, providing learners with instant feedback and guidance. The adoption of AR and VR technologies introduces immersive learning environments that enhance conceptual understanding through experiential simulation. However, the widespread implementation of AI in education also raises important considerations. These include ethical issues surrounding data privacy and algorithmic bias, the digital divide that limits access to advanced technologies, and the preparedness of educators and institutions to adopt AI-based methodologies. There is a clear need for policy frameworks, teacher training programs, and interdisciplinary collaboration to ensure that the benefits of AI are equitably distributed and effectively managed.

A. Future Directions

Although, artificial intelligence and machine learning tools have shown significant applications in almost all aspects of human life and education sector is one of them. but still there are many challenges and limitations that need to be addressed as a way forward [15]. In this study, we highlight some of the key points that need to be considered to translate the potential of AI technologies into effective educational practice and learning:

Teacher Training: As we discussed, teachers skills in efficient use of modern technologies is key to implement AI tools in education and learning. Educators must be equipped with the skills and tools to understand and integrate AI technologies into their pedagogical practice [17]. Therefore, it is essential and strategic to start investing in teachers and educational staff. This process requires mandatory training and equipped classrooms and labs with necessary equipment. The training should include both technical training and the development of critical perspectives on AI's role in education.

Ethical Guidelines and Data Governance: One of the most critical aspects of the use of AI technologies in each sector is the lack of ethical guidelines and lack of formal protocols. As in any other area, there should be formal ethical guidance on the use of AI and machine learning tools in education . In addition, it is necessary to have data governance and protocols to protect both teachers and students privacy and security. In conclusion, educational institutions should make and implement policies regarding data usage, user privacy, and transparency in AI decision-making processes.

Easy Access to AI Tools: When we talk about AI applications, it is normally discussed more about its usage, benefits and drawbacks but one aspect that is comparatively discussed less is the accessibility of these technologies to the masses. We all know that in the education sectors we have students as well as teachers from diverse backgrounds in terms of many factors. Therefore, it is very essential to ensure uniform and easy access to modern resources to everyone. So it is recommended that AI-empowered educational technologies should be designed and deployed with a focus on accessibility to students from different backgrounds and regions.

Cross-sector Collaboration: We highlighted the need of teachers and educators training for better use of AI in education and quipping classrooms, labs with modern infrastructures. The training and infrastructure purchase require a considerable investment and it is important to have a strong collaboration with private sector, companies and other stakeholders. Secondly, we discussed ethical and data governance protocols which is not possible without the involvement of government institutions. In summary, partnerships between educational institutions, policymakers, the AI community, and the private sector are necessary for the responsible scaling and innovation of AI solutions in education.

Support Continuous Evaluation: To sum up all previous arguments, we can state that it is important we support the positive use of AI technologies in education and learning. In conclusion, implementations should be subject to ongoing assessment to ensure they fulfill educational goals, bring innovations, meet students and teachers needs, and adapt to emerging challenges.

V. Conclusion

In conclusion, artificial intelligence particularly reinforcement learning offers a mathematically sound and practically effective framework for optimizing learning decisions and customizing educational experiences. This study provided a comprehensive exploration of AI applications across several key areas, including personalized learning, immersive technologies, and intelligent tutoring systems. The convergence of AI with education holds transformative potential, yet it also necessitates thoughtful consideration of the ethical, infrastructural, and pedagogical dimensions involved. Future research and development efforts should focus on creating inclusive, transparent, and adaptive AI systems that complement human teaching and foster lifelong learning. With strategic planning, stakeholder collaboration, and evidence-based implementation, AI can serve as a powerful catalyst in shaping the future of education

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