

Review

The Information Age for Education via Artificial Intelligence and Machine Learning: A Bibliometric and Systematic Literature Analysis

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ABSTRACT

The subject of integrating AI and ML into education is booming, but we still need more research on the real effects on students' learning outcomes and the long-term consequences of this trend. Our work fills this need by proposing a new technique that follows the PRISMA guidelines and combines bibliometric analysis with a Systematic Literature Review (SLR). The first step was a thorough bibliometric investigation, which uncovered important countries, schools, publications, keywords, and writers working in the field of artificial intelligence and machine learning for educational purposes. This stage highlighted the international and multidisciplinary character of AI/ML research in education by providing a bird's-eye view of the field's current state. A careful SLR of 22 chosen academic publications was the next step. This comprehensive analysis clarifies the present uses, new tendencies, difficulties, and potential future paths of AI and ML in the classroom. Results from this mixed-method study highlight the revolutionary potential of AI and ML for education and provide a thorough road map for academics, policymakers, and teachers. Predicting academic success, improving e-learning experiences, and preparing future generations for AI's integration in various fields like healthcare are just a few of the many areas where AI has had a profound and varied influence on education, as explored in this review's extensive article collection. Not only does this research provide a foundation for successfully using AI and ML technologies in education, but it also highlights the revolutionary potential of AI in changing educational environments.

Keywords

Artificial intelligence; Machine learning; Education; Systematic literature review (SLR).

INTRODUCTION

The advent of AI and ML has been a game-changer across many industries, changing the way we work and interact with the world around us. In addition to their meteoric rise in popularity, these technologies have ignited a creative explosion with game-changing potential for the educational system [1]. In order to harness the promise of AI and ML to improve educational results, tailor students' learning experiences, and refine pedagogy, researchers in the field are researching how to incorporate these technologies into educational technology [2]. New aspects to teaching and learning have been introduced by the integration of AI and ML into education. Intelligent tutoring systems (ITS) are a major use of AI. These systems utilize AI algorithms to personalize information and provide individualized assistance, leading to

more involvement, education, and growth [3]. With the advent of data analytics tools powered by AI, teachers may now make informed decisions based on hard evidence [4]. Patterns are starting to show themselves in this sector that is growing at a fast pace. For example, NLP has grown in popularity for automating processes like grading and providing feedback, which relieves teachers of some of their work [5]. Furthermore, online education systems are quickly integrating chatbots and virtual assistants powered by AI to provide immediate support, answer questions, and improve the learning experience as a whole [1].

Despite the great potential, there are still obstacles to integrating AI and ML into education. The massive amounts of data involved have prompted ethical concerns about privacy [6]. Concerns over

fair access to educational resources driven by AI are further heightened by the persistence of the digital divide [7]. It seems that AI and ML have promising futures in educational technologies. Research is ongoing with the goals of improving algorithms, removing biases, and further increasing personalization [5]. To guarantee that students from varied backgrounds have access to solutions driven by AI, it is necessary for educators and tech developers to work together [8]. The purpose of this article is to examine the impact of AI and ML on classroom instruction from every angle. The present trends, challenges, and future directions of this ever-changing subject are uncovered by this study, which examines several academic papers, research projects, and contributions. There has been a dramatic uptick in innovation in educational technology with the incorporation of AI and ML. The purpose of this comprehensive literature review is to lay forth a plan for how academics, educators, and policymakers might use AI and ML to shape the educational landscape of the future.

This research is groundbreaking since it uses the PRISMA approach to conduct a Systematic Literature Review (SLR) in addition to bibliometric analysis [9]. This study identifies key players, trends, and future directions in the integration of AI and ML in education by a unique mix of bibliometric analysis and thorough literature evaluation. By showcasing the revolutionary possibilities of AI and ML in the field of education, the article offers insightful commentary for scholars, politicians, and teachers. One notable aspect is the extensive a compilation and study of publications that provide a comprehensive view of the effects of AI on education, and that address both current and future trends, as well as ethical concerns. The report adds something new to the literature on educational technology thanks to its all-encompassing and futuristic viewpoint.

A bibliometric analysis and a comprehensive literature review will constitute the two main parts of this review in order to accomplish the aims of this research. These inquiries pertain to the bibliometric analysis, the first stage of the evaluation. In order to achieve the goals of this evaluation, the following questions have been formulated:

1) What are the leading countries, educational institutions, journals, authors, and keywords associated with the integration of Artificial Intelligence and Machine Learning (AI/ML) in the field of education?

Secondly, these questions are addressed to answer the Second Phase of the Review (SLR):

2) What AI and ML applications and impact related to the influence of AI on education?

3) What are the most important variables regarding AI and ML in education?

4) What are the most significant trends and findings concerning the influence of AI and ML in education?

5) What challenges are associated with the influence of AI and ML in education?

6) What are the future directions for AI and ML's impact on education?

II. MATERIALS AND METHODS

A. Research Design

By breaking the research down into two primary parts—a bibliomet-

ric analysis and a systematic literature review—this paper will be able to accomplish its goals. These inquiries pertain to the review's (the bibliometric analysis's) earliest stages.

We conducted a thematic analysis of AI and ML integration in education using a systematic approach to find commonalities, differences, challenges, and opportunities for the field's future. As part of the process, we performed a comprehensive content analysis to identify and categorize these elements. After reviewing a number of academic papers, we were able to pinpoint specific challenges associated with using AI and ML in the classroom. Limitations in technology, moral quandaries, and implementation challenges were all part of the list.

After that, we sorted the trends and themes by their traits and how often they appeared. As an illustration of the trend toward more customized learning experiences, the use of artificial intelligence in individualized education may have been a recurrent theme. Data privacy and the appropriate use of AI in educational settings are two examples of the many ethical issues that have been highlighted as potential roadblocks.

The results of this topic analysis gave us a thorough understanding of the difficulties faced by those working with AI and ML in the field of education. To ensure the effectiveness and accountability of developing and integrating AI and ML technologies in educational settings, this understanding is vital for guiding future research and implementation strategies.

A. Methodology for Conducting a Search

A thorough search for scholarly articles and conference proceedings about artificial intelligence and machine learning as they pertain to educational technology was conducted using Scopus. On September 12, 2023, the study was conducted. The search criteria that were used are detailed below. A preliminary search of the Scopus database yielded 5,117 items in the first bibliometric research. The dataset was obtained by the researchers using Scopus analysis. The mapping and occurrences between the findings were shown using the (Vosviewer) program. Based on what was found in the research. Through its data presentation capabilities, the VoSviewer software made a substantial contribution to the field of artificial intelligence and machine learning integration in education, drawing attention to the top countries that have excelled in this area. The use of this bibliometric tool allowed for a detailed and comprehensive portrayal of the intellectual landscape shaped by countries like the US, India, and China, as shown by their massive publishing volumes (1149, 636, and 417, respectively). The United States recognized its dominant position and attributed it to its substantial financial resources and rigorous research activities; the visualization capabilities of the VoSviewer helped to explain this. The paper also praised China and India for their exceptional contributions, citing their strong STEM education systems and large amounts of government support.

The software's visualisation features also helped to highlight the unique contributions of certain European nations, such as the UK, Germany, Italy, and Spain. Each of these countries contributed fresh approaches to education, innovative ways of using AI and ML in the classroom, and cutting-edge technology tools for this field. Canada, Australia, and Japan were also singled out for special recognition for their significant contributions; after all, these countries brought

unique skills and perspectives to the table.

In conclusion, the use of VoSviewer was critical in illuminating a complex strategy for incorporating AI and ML into the realm of education. This points to a future where the transformative power of AI and ML propels educational methods that are more personalized, effective, and comprehensive.

The retrieved documents were sifted for crucial data using a list of keywords and Boolean operators, such as “artificial intelligence,” “machine learning,” and “educational technology,” to get more precise findings. Take TITLE-ABS-KEY (technology, education, artificial intelligence, and machine learning) as an example. In this case, for example, AND (LIMIT-TO (EXACTKEYWORD, Subjects: “Artificial Intelligence,” “Machine Learning,” “Learning Systems,” “Students,” and “Education” with a publication year greater than 2009

Finally, we limited our search to the categories of social sciences, computer science, arts and humanities, and publishing in the year 2023.

under the “arts” subarea. Furthermore, just periodicals and items such as AND (LIMIT-TO (DOCTYPE, “ar”) OR LIMIT-TO (DOCTYPE, “cp”)... were included in the conference papers.

directions regarding the influence of AI and ML on educational technology were discovered and investigated as follows:

- Method: Content analysis was employed to systematically identify and categories the common themes, trends, challenges, and future directions regarding the influence of AI and ML on educational technology.
- Process: Publications were reviewed to extract specific challenges related to AI and ML in education, such as implementation hurdles, ethical considerations, and technical limitations. These themes, trends, challenges, and future directions were categorized based on their nature and frequency of occurrence.
- Outcome: This analysis provided a clear understanding of the obstacles faced in the field and guided future research and implementation strategies.

B. Inclusion and Exclusion Criteria

To carry out this research, a predetermined set of inclusion and exclusion criteria was utilized.

In conducting our Systematic Literature Review (SLR), we implemented a meticulous approach to assess the quality and trustworthiness of the selected studies. Initially, our inclusion criteria were based on the publication years, specific keywords, language (English), and relevance to the subject area of AI and ML in education. From the initial pool, we successfully downloaded 30 papers for a more in-depth evaluation.

Our rigorous quality assessment criteria were pivotal in refining this selection. We scrutinized each study’s design, emphasizing the clarity and appropriateness of research questions and hypotheses. The sample size of each study was evaluated for its adequacy and representativeness. Moreover, we closely examined the methodologies used for data gathering, ensuring their suitability for the research questions and their potential to yield unbiased and comprehensive results.

A critical aspect of our assessment was the validity and dependability of the results presented in these studies. We thoroughly evaluated how convincingly the data supported the study’s conclusions, ensuring logical consistency and justifiable inferences.

This exhaustive process led us to a final selection of 22 high-quality publications. Each chosen study met our stringent criteria, ensuring that our SLR rests on a foundation of reliable and significant research. We have documented this selection process in detail, and an analysis of each included paper can be found in Supplementary. This approach has ensured that our literature review is not only comprehensive but also rests on the most trustworthy and relevant research in the field of AI and ML integration in education. The criteria are outlined in Table 1.

Critical Appraisal and Discussion

To shed light on the current status of research on the subject, the synthesized data will be analyzed and argued critically. Examining major discoveries and their implications, as well as identifying any gaps in the available research,

C. Quality Assessment

Assess the trustworthiness of the chosen studies and ensure the quality of the assessment. After applying the inclusion and exclusion criteria, the range of years, the specific keywords, the language of the articles, and the subject area of the publications, only 219 papers were discovered. Then we tried to download these files, but only thirty were successfully downloaded. This SLR contains just 22 publications after analyzing studies based on criteria such as study design, sample size, data gathering methodologies, and validity and dependability of results. Supplementary illustrates the analyses of the papers included in this research.

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework is a rigorous methodology designed to ensure transparent and comprehensive reporting in systematic reviews and meta-analyses. It is widely recognized for its structured approach to research and is particularly useful in evaluating randomized trials and other types of intervention research.

The PRISMA framework is fundamental to enhancing the quality and reliability of systematic reviews and meta-analyses. By adhering to its guidelines, researchers can ensure that their studies are conducted and reported with the highest level of rigor, thereby contributing valuable and trustworthy findings to the scientific community.

Fig. 1. PRISMA framework.

As shown in Fig. 1, the PRISMA framework was applied to depict the approach of this review.

III. RESULTS

In order to get a comprehensive comprehension of our study subject, we have used a dual-method strategy that combines bibliometric analysis with a Systematic Literature Evaluation (SLR). By combining the comprehensive insights obtained by bibliometric analysis with the profound knowledge provided by the SLR, we are able to capitalize on this combination.

By smoothly shifting from the bibliometric analysis to the SLR, we

guarantee the coherence of the storey. The bibliometric analysis is used to identify trends and patterns that provide a macro-level context for the discussion of the granular insights obtained from the SLR. By using this methodology, we not only bolster the logical consistency of our results but also get an all-encompassing comprehension of the field of inquiry.

In order to strengthen the interrelationship between the two approaches, cross-referencing is used throughout the work. The bibliometric analysis identifies significant advances and themes in the subject, while the SLR provides comprehensive analyses of chosen publications that dive into these issues. By using cross-referencing, it guarantees that the more general patterns detected by bibliometric data remain firmly grounded in the specific evidence presented in the literature review.

A. The First Phase (Bibliometric Analysis)

In the rapidly expanding area of Artificial Intelligence (AI) and Machine Learning (ML) in education, bibliometric analysis, a powerful method for evaluating the academic environment, has emerged as a crucial instrument. As educational technology continues to change and adapt conventional teaching methods, researchers and educators seek a deeper knowledge of the trends, key contributors, and information dissemination networks within this dynamic sector. By analyzing publications, citations, and patterns of cooperation, bibliometric analysis offers a systematic way for mapping the intellectual structure of AI and ML in education. In this introduction, we explore the relevance of bibliometric analysis in AI and ML in education for uncovering critical insights that will impact the future of education in a digitally driven world.

1) The top countries in the field of AI/ML integration with education

Bibliometric analysis offers a way for mapping the intellectual structure of AI and ML in education by examining publications, citations, and cooperation patterns. In this introduction, we go into the area of bibliometric analysis in AI and ML in education, exploring its relevance in uncovering critical insights that will impact the future of learning and teaching in a digitally driven world.

Moreover, to provide in-depth information in this analysis, the VOSviewer software was used to present the top countries in the field of AI and ML in education.

A bibliometric examination of the integration of AI and ML in education reveals that the United States, China, and India have a significant impact on the intellectual landscape, as shown by their respective considerable publication counts of 1149, 636, and 417. The leadership position in the subject may be attributed to the United States' substantial financing, intensive research endeavors, and a well-established ecosystem that fosters innovation in both education and technology. Due to strong government funding in AI, China's emphasis is distinguished by its rapid technical advancements and extensive practical implementations. Concurrently, the robust STEM education system and emerging technology startup ecosystem in India contribute substantially to its prominence in this field. Although European nations such as the United Kingdom, Germany, Italy, and Spain produce fewer articles, their contributions are distinct, including practical technological applications in Germany and novel teaching approaches in the United Kingdom. Significant contributions are also made by Canada, Australia, and Japan, each of which brings

unique capabilities and viewpoints to the topic. The worldwide dispersion of research and innovation underscores a varied and complex strategy for incorporating AI and ML in the field of education. This bodes well for a future in which educational methodologies are more individualized, effective, and all-encompassing, propelled by the revolutionary capacity of AI and ML technologies.

2) The top educational institutions in the field of AI/ML integration with education

Bibliometric analysis provides a methodical approach to mapping the intellectual structure of AI and ML in education by assessing publications, citations, and patterns of collaboration. To kick off this introduction, we discuss how artificial intelligence (AI) and machine learning (ML) may be used in the field of education to find important insights that will shape the way we learn in the future. sector. Looking at Table 2, we can see who has written the most on how to incorporate AI and ML into the classroom. The research examines the top ten writers who have made significant contributions to the ever-evolving area of machine learning and artificial intelligence in the classroom. The field of artificial intelligence and machine learning in education is defined by the work of a large number of influential individuals from a wide range of nations and organizations, who work alongside these well-known authors.

prior knowledge. This reference looks at how well an I-MIB assessment strategy works for undergraduates. The text [27] highlights the fact that machine learning research is quite diverse, with differences in things like sample size and approach selection. In order to improve online education, namely by making the most of instructional resources and activities, section [28] discusses the benefits of granular data analysis. Section [29] makes a prediction on how 5G and the IoT will impact the field of education. According to [30], AI helps STEAM students become more knowledgeable about AI and strengthen their critical thinking skills. Lastly, Popenici [31] highlights the importance of ethical concerns and knowledge preservation, predicting that AI-powered software would inevitably supplant traditional methods of instruction in higher education. The articles provide an in-depth analysis of the far-reaching effects of AI on the classroom setting.

2) Obstacles to the widespread use of AI and ML

All the research points to one conclusion: AI will change the way schools operate. While most students encounter problems in their own classrooms, Liu [10] draws attention to issues related to interpretability and data availability in prediction assignments. Institutional governance and design are being impacted by new opportunities and restrictions in higher education, according to Singh [11]. By investigating algorithmic practices in traditional and online learning environments, Xu hopes to address a wide range of educational demands [12]. The line [13] recognizes both the strengths and weaknesses of machine learning in academic event prediction, including the dangers of errors and the complexity of the data. The need for physical campuses has been diminished due to technology advancements, which are discussed in section [14] as contributing to the advancement of education. This article emphasizes the need

of include AI instruction in formal curricula, especially with AI's increasing application in therapeutic settings. In order to effectively solve digital problems in the classroom, Hessen [16] stresses the importance of evaluating educators' digital competence. One research that looks at how colleges and universities might adapt to new technology and generate digital innovation is Estrada's [18].

For example, in prediction tasks, the data is readily available and easy to understand ([10]). Talks about how algorithms may be used in both traditional classrooms and online learning to meet a variety of demands in education, and how new opportunities and constraints are changing the way institutions are run and designed [11, 12]. Onyema [13] notes that although machine learning has its uses, such as predicting academic events, it also has its limits, such as the possibility of errors and complicated data. The impact of technological developments on education is being highlighted by Jokhan [14], who notes that physical campuses may become less necessary in the future. In view of AI's rapidly expanding medicinal uses, Pucchio [15] stresses the need of incorporating AI education into official course offerings. According to Hessen [16], evaluating educators' digital competence is crucial for successful digital problem-solving in the classroom. Additionally, Vidal [17] emphasizes AR's immersive potential but notes issues with multitasking detection, advocating for the use of algorithms that use deep learning. In this part, we'll look at how universities and colleges may take advantage of digital innovation and new technology.

3) Strategies and suggestions for the future

These studies provide light on the potential future impacts and directions of AI in education and offer insight into those possibilities when taken as a whole.

In [10], the authors discuss the significance of instructors' prompt intervention and the function of AI in shaping students' knowledge acquisition. The use of AI to foretell pupils' abilities encourages preventative lesson planning, according to studies [11]. In order to better learning systems and adapt to changing educational situations, this chapter examines the use of Natural Language Processing (NLP). Prior research has shown the potential of machine learning to improve academic prediction and decision-making [13]. A flexible and internationally relevant curriculum is required for the digital age due to the substantial impact of online learning. Pucchio [15] stresses the significance of educating the next generation in light of the growing usage of AI technology in therapeutic operations. To ensure a high-quality education that addresses digital issues, clause [17] stresses the importance of evaluating teachers' digital competence. Electrical circuits may be better studied with the help of Estrada's [18] unique teaching system, which combines remote learning, artificial intelligence, and augmented reality. Rocsana [19] highlights the need of educational institutions using efficient technologies and clear principles for future benefits. Artificial intelligence (AI) solutions developed for one organization may have wider uses, according to Olga's study [20]. By considering obstacles and changing government rules, AI is used by [21] to foretell how higher education will evolve in the future. calls for further study on the use of AI and

ML at universities, particularly in nations with low or medium incomes. Research on the effects of online proctoring (OP) on various parties and moral dilemmas by Coghlan [23] Further information on how to include demographic data and how to expand algorithm parameterization may be found in [24]. Maclellan [25] investigates teacher development using apprentice learning paradigms and offers a novel framework for creating experimental design teachers. Part [26] delves on data mining's potential applications in assessing students' progress and enhancing the quality of educational programs. A number of e-learning systems and technologies might benefit from the AI-based solutions proposed by Caitlin [27] in her future study. To enhance data security and educational methods, William [28] suggests combining blockchain technology with the IoT. Dake [29] explores the potential improvements to the learning and teaching processes that may occur with the coming of 5G networks. How [30] investigates several scenarios in which STEAM teachers may use AI-thinking via the use of simulations. The need of doing an ethical investigation on the constraints of AI progress and the potential monopolization of human knowledge and viewpoints is emphasized lastly in [31].

All things considered, the findings from their research illuminate the dynamic Use of AI in educational contexts, and on the probable future directions and consequences of AI in education, providing insights on such prospective future paths.

IV. DISCUSSION

To answer the first research question, the study begins with research on AI and ML in education, which provides unique global insights into this rapidly expanding issue. The United States ranks first with 1,149 articles, followed by China with 636 papers, and India with 417 papers. This shows that there is a global effort to increase knowledge about educational technology. Among the world's leading educational institutions in the use of artificial intelligence and machine learning, Carnegie Mellon, Stanford, and MIT stand out. Renowned authors like Cynthia L. Breazeal, who has written 282 books, have a huge influence on the field. When people talk about these technologies, terms like "artificial intelligence" and "machine learning" come up. This is a perfect example of how AI and ML are playing a collaborative role in the classroom, helping to bring educational technology all around the world.

Step two involves answering the second research question by systematically reviewing the literature on artificial intelligence and machine learning in the context of education. This includes topics such as administrative automation, personalized learning, and prediction models. Technologies such as virtual educational systems and adaptive learning allow for personalized instruction. Generative Adversarial Networks (GANs) for dataset analysis, machine learning, and social networks are all part of artificial intelligence. Their versatility is shown by the usage of ML approaches like Decision Trees and Naive Bayes. Through personalized material, assessment tools, and ubiquitous learning spaces, these experiments demonstrate how AI and ML may revolutionize the educational system. Many believe that the 5G paradigm will make educational resources more widely available and easier to acquire.

The third area of research looks at the current state and future prospects of integrating AI and ML. AI enhances school administration

and encourages individualized instruction, while complex neural network models foretell student achievement. Predicting learning patterns and helping students with learning disabilities are two applications of machine learning. Technologies like virtual classrooms, AR, and AI systems that can understand and respond to students' emotions are changing the way we learn. Some of the topics covered include online proctoring, the ability of AI to predict students' grades, and personalized content driven by AI. These trends show how AI has an impact on administrative efficiency and academic achievement.

Challenges to AI and ML adoption are examined in the study's fourth area of inquiry. When it comes to data availability, governance, and ethics, transparency and responsibility are key. We emphasize the potential of AI to improve evaluation methodologies and grade forecasting. 5G networks will be a game-changer in the classroom, according to the study's predictions, which also address the need for STEAM students to be literate in artificial intelligence and its ethical considerations.

Future directions and ideas are offered by the closing research question. The healthcare industry is prepared for the integration of AI, and AI is seen as a tool for tailoring student learning and talent prediction. By highlighting concrete ideas and technical applications, the potential of AI within organizations is highlighted. Providing AI solutions for different learning platforms, reacting to difficulties, and expanding AI research are all essential for the future of higher education. 5G networks, the Internet of Things, and blockchain technology are thought to enhance the educational system. Importantly, ethical considerations highlight the requirements for AI development guidelines and different perspectives. All things considered, these findings show how AI and ML might change the game in the classroom, but they also show the challenges and ethical dilemmas that schools will confront if they adopt these technologies.

A. Collaborating across disciplines: The Secret to Harnessing the Full Potential of AI and ML in the Classroom Collaboration for Better AI/ML in Education: Complexity be damned, a diversified approach is required for the integration of AI/ML in education. The responsible and fruitful use of modern technologies depends on the concerted efforts of legislators, technicians, and teachers. While technologists bring technology expertise and creative ideas to the table, educators bring classroom experience and the ability to recognize real needs. With the help of lawmakers, we can set up enabling frameworks and prioritize ethical concerns in technology integration. **Reconciling Theory and Practice:** Joint efforts may pave the way for the application of theoretical advances in AI and ML to classroom settings. The success of these technologies in meeting the needs of both students and teachers depends on the feedback they get from educators about their usefulness. In order to make educational technology more user-friendly and effective, technologists may tweak AI/ML systems based on input from people who are actually teaching.

Privacy and Ethics: When thinking about how to implement AI and ML into classrooms, it is crucial to keep in mind the critical nature of ethical and privacy issues. We can design and implement new tech-

nologies with a thorough understanding of the ethical implications and privacy needs specific to educational environments if we work together. To tackle these intricate problems, it is essential to have educational stakeholders, legal experts, and ethicists on board.

In order to promote a culture of innovation and inclusivity, educational institutions may work to foster an atmosphere that values diverse perspectives and new ideas by promoting collaboration across disciplines. The creation of accessible and equitable AI/ML solutions for students from all backgrounds must prioritize inclusiveness. In addition, different viewpoints may spark creativity and open the door to new discoveries, therefore working together could lead to more original ideas.

In order for teachers to effectively use AI and ML in the classroom, capacity building and professional development are crucial. In order for educators to fully understand and make use of emerging technologies, they should seek out opportunities to collaborate with technologists. Teachers will be able to utilize AI and ML tools and be an integral part of their development and improvement thanks to this capacity-building program.

Moving Forward: When educators and technologists work together, there is a chance for more comprehensive research on how AI and ML impact education. teamwork in the lab. To ensure these technologies are in accordance with educational goals and standards, and to influence future improvements, further interdisciplinary research is needed to better understand their effectiveness.

B. Educational Applications of AI and ML and Their Real-World Consequences Ideas presented in earlier parts have many potential uses in the classroom. Educators and institutions may benefit from academic performance and outcome prediction, as shown by Liu and Gerlache [10, 24]. Schools are able to swiftly react to students who are at danger of falling behind in their coursework with the use of AI and machine learning algorithms. According to personalized learning systems [20], schools should use technology powered by artificial intelligence that tailors lessons to each student. Enhancing interest via personalization

how quickly one learns. Evaluation of educators' proficiency with technology is critical in today's classrooms [17]. Schools need to make sure their educators are ready to embrace AI-powered tools to help students succeed in today's digital world. A fresh approach to teaching is offered by the use of augmented reality with artificial intelligence [18]. Colleges and universities might use such strategies to pique students' interest and deepen their comprehension of challenging material. The increasing use of AI in classrooms raises important ethical and privacy concerns [19]. In order to protect student information and promote the use of AI, educational institutions should set clear regulations. The official curriculum has to include AI instruction since AI is becoming significant in many areas, including medicine [15]. For students to be prepared for careers using AI, schools should provide AI classes and modules. As technology for online proctoring develops, universities will need to think about privacy and ethical concerns [22]. Balancing safety and student rights requires openness and good administration. With the advent of 5G networks, educational institutions will need to make preparations for more accessible and faster content delivery [29]. They need to look at the potential for new forms of education that may be offered by

networks with high speeds and low latency. It is necessary to educate AI literacy due to the increasing number of STEAM kids who are able to think like AI [30]. Education in artificial intelligence (AI) should provide students with the skills they need to think critically and solve problems.

The focus of future research on AI and ML education systems is on innovation [22, 31]. In order to remain competitive, educational institutions need to work together on research and adopt new technology. Educational institutions may be better able to handle the ethical concerns raised by AI and embrace its revolutionary potential if they accept these practical impacts. This foresight ensures that both teachers and kids benefit from AI in the classroom.

C. Machine Learning and Artificial Intelligence: How They Can Improve Age Education

Machine learning (ML) and artificial intelligence (AI) have the potential to revolutionize education by bringing a host of advantages to the field. By catering to each student's unique learning style and requirements, these technologies facilitate more effective learning. Machine learning and artificial intelligence make it possible to automate mundane processes like grading, freeing up teachers to concentrate on engaging students and delivering quality lessons. Additionally, they make it easier for everyone to use, including pupils with impairments, by incorporating features like text-to-speech and voice recognition. Finding knowledge gaps and improving instruction are both made easier with data-driven insights obtained from AI and ML. Educational games and simulations driven by artificial intelligence provide interactive learning environments that enhance engagement. In addition, modern technologies provide chances for education on a global scale, removing geographical restrictions and making high-quality education accessible to everyone. Regardless of one's life stage, they encourage lifelong learning and professional advancement. Scalability in AI and ML systems guarantees that even a big number of students have consistent educational experiences. Through the use of data analytics, AI may aid educators with curriculum building and pedagogical practices. It is crucial to include AI and ML into education so that students are ready for a world where these technologies are used more and more in all kinds of businesses. To ensure a balanced and appropriate use of AI and ML in educational contexts, it is important to approach this integration with a thorough assessment of ethical considerations, data protection, and the necessity for human supervision.

D. A New Approach to Combining ChatGPT with Big Language Models

A number of advantages have resulted from the recent incorporation of ChatGPT and Large Language Models (LLMs) into the educational system. Students learn at different rates and have different preferences, but these models make it possible to adapt instruction based on each student's requirements and preferred methods of learning. They let teachers create interactive materials and provide students access to up-to-date knowledge on a wide range of topics, so they are a great addition to any curriculum. A Master of Languages (LLM) degree is a great asset in any field, but especially in language teaching, where students may improve their proficiency in reading, writing, and speaking a variety of languages. Educators may use these models to enhance the classroom experience by creating lesson plans, quizzes, and educational games; students can use them to help their research and writing. Education becomes more interesting and accessible, particularly for those with impairments or learning

challenges, when LLMs promote interactive learning settings. Using them in the classroom helps students become more digitally literate and critical thinkers by demonstrating how to evaluate the reliability of information generated by AI systems. Educators may stay current in their disciplines with the help of these models' chances for ongoing professional development. To make sure these tools supplement human instructors rather than replace them, ethical concerns, data protection, and the significance of human supervision must be front and center when these technologies are used in the classroom. Their smooth incorporation into the educational system depends on this well-rounded strategy.

E. Methods for Benefiting Students and Educators Through the Use of AI and ML By implementing a number of critical tactics, educational institutions may improve students' access to information and learning opportunities while also assisting educators in using AI and ML technology. To begin with, teaching students about AI in the classroom increases their familiarity with and competence with the technology. Teachers must have access to professional development opportunities if they are to

AI may be used to educate successfully. AI has the potential to revolutionize education by developing individualized lesson plans and enhancing assessment tools with adaptive resources and feedback. In order to combat the issue of student work created by AI, educational institutions should prioritize academic integrity by purchasing technologies that can identify this kind of material. Important next measures include working with AI and tech businesses, increasing digital literacy, and encouraging critical thinking. These steps guarantee that teachers are prepared to deal with and benefit from these innovations in technology and also make it easier to incorporate AI and ML into the classroom.

F. Considerations of Ethics in the Use of Artificial Intelligence and Machine Learning in the Classroom

This section explores the moral questions raised by the use of ML and AI in the classroom, focusing on key issues including student data protection, algorithmic biases, and data privacy. The ethical incorporation of AI technology into educational settings relies heavily on these factors, which are well recognized. We prioritize the protection of student data above anything else. One prevalent application of AI in education is the collecting and analysis of large amounts of student data, which brings up valid concerns about data security and privacy. In order to make sure that student information is safe, we stress how important it is to set up thorough data protection measures and follow strict data privacy rules.

Another important factor that we check out is the potential effects of AI systems on school safety. Protecting information against unauthorized access and breaches is what this entails. Our research highlights the need of implementing advanced security measures and regularly checking AI systems for vulnerabilities.

We look at the serious ethical issue of whether or not AI systems have inherent biases. The use of biased algorithms in the classroom might lead to unfair or biased teaching practices. We recommend using diverse datasets to train AI models in order to decrease biases, and our study emphasizes the significance of creating accountable and open AI systems.

In order to make sure that the results were legitimate and trustwor-

thy, we checked that they were consistent with one another and had proof to back them up. Our Systematic Literature Review (SLR) is based on credible and extensive study since we were able to find 22 high-quality publications that met our strict criteria. There is extensive documentation of the selection process, and Supplementary contains analyses of all chosen works. Our literature review will be based on the most credible and applicable papers about the use of AI and ML in the classroom if we follow this process.

V. CONCLUSIONS

Educators, legislators, and researchers interested in the effective use of AI and ML technologies in the classroom may find our comprehensive forecast of future trends and practical recommendations useful. Our study findings form the basis of modern methodologies that aim to steer the field towards the ethical and innovative use of these technologies.

□ Attention teachers: We suggest that they put an emphasis on using AI in a way that complements traditional teaching methods. Educators must get training to equip themselves with the knowledge and abilities to use AI technology efficiently. Students' engagement and general academic achievement will be enhanced as a result of their ability to personalize learning experiences.

Research on data privacy and bias in AI systems, among other ethical considerations, must continue without fail. In order to lessen the impact of biases, scientists should work towards creating AI systems that are more accountable, open, and inclusive in their data collection efforts. Furthermore, multidisciplinary research partnerships may lead to educational solutions driven by artificial intelligence.

Attention Policymakers: The establishment of regulations that encourage the safe and fair use of AI in education is of the utmost importance. Legislators should support funding for AI studies and their implementation in schools, keep student data safe, and promote equitable access to AI learning tools by drafting regulations.

Our findings support practical strategies such as investing in teacher training for AI technologies, creating guidelines for AI ethics in educational settings, and promoting partnerships between universities and tech companies to share resources and knowledge.

With these future directions in mind and these concrete recommendations in place, we can hopefully guide the ethical and effective use of AI and ML in the classroom. To maximize educational experiences while overcoming ethical, practical, and technical challenges, this technique ensures the utilization of AI and ML capabilities.

REFERENCES

in "Enhancing students' online learning experiences with artificial intelligence (AI): The MERLIN project," M. Neo, C. P. Lee, H. Y. Tan, T. K. Neo, Y. X. Tan, and N. Mahendru et al. published in the *International Journal of Technology* in 2022, volume 13, issue 5, pages 1023-1034.

[2] Armstrong Laboratory, Air Force Materiel Command, 1994, *Intelligent Tutoring Systems: Past, Present, and Future*, J. Psotka and V. J. Shute.

The 2014 article "Intelligent tutoring systems and learning outcomes: A meta-analysis" was written by M. Wenting, O. O. Adesope, J. C. Nesbit, and L. Qing. It was published in the *Journal of*

Educational Psychology and can be found on pages 901–91.

[4] "How science educators still matter: Leveraging the basic sciences for student success," published in *Med. Sci. Educ.*, volume 32, pages 747–753, by S. B. Haudek, I. Bahner, and A. N. Belovich et al. in 2022. Doi: 10.1007/s40670-022-01549-2 in the online version

"Automated grading system using natural language processing," in *Proceedings of the 2018 Second International Conference on Inventive Communication and Computational Technologies (ICICCT)*, pages 1123-1127, 2018, by A. Rokade, B. Patil, S. Rajani, S. Revandkar, and R. Shedge.

[6] "Comprehensive survey on big data privacy protection," published in 2020 in *IEEE Access*, volume 8, pages 20067-20079, with the DOI 10.1109/ACCESS.2019.2962368, was written by M. Binjubeir, A. A. Ahmed, M. A. B. Ismail, A. S. Sadiq, and M. K. Khan.

The article "Digital Democracy in Higher Education: Bridging the Digital Divide" was published in the *Innovate: Journal of Online Education* in 2005 and can be found in volume 2, issue 1.

The article "Preparing teachers for the application of AI-powered technologies in foreign language education" was published in the *Journal of Language and Cultural Instruction* in 2019. It is volume 7, issue 3, and pages 135–153. This article is cited as <https://doi.org/10.2478/jolace-2019-002>.

In their 2021 publication "The PRISMA 2020 statement: an updated guideline for reporting systematic reviews," the aforementioned authors (M. J. Page, J. E. McKenzie, P. M. Bossuyt, I. Boutron, T. C. Hoffmann, and C. D. Mulrow) were cited as the source.

[10] "Method for predicting the academic performances of college students based on education system data," *Mathematics*, vol. 10, no. 20, 3737, 2022, by C. Liu, H. Wang, and Z. A. Yuan.

According to a study published in the *Journal of Higher Education Theory and Practice* in 2022, S. V. Singh and K. K. Hiran examined the effects of artificial intelligence on the use of technology in higher education for both instruction and assessment.

12. "Recommendation system for privacy-preserving education technologies" by S. S. Xu and X. F. Yin, published in 2022 in *Computational Intelligence and Neuroscience*, volume 3502992, <https://doi.org/10.1155/2022/3502992>.

The article "Prospects and challenges of using machine learning for academic forecasting" was published in 2022 in the *Journal of Computational Intelligence and Neuroscience* and was co-authored by E. M. Onyema, K. K. Almuzaini, F. U. Onu, D. Verma, U. S. Gregory, and M. Puttaramaiah. The article can be accessed online at <https://doi.org/10.1155/2022/5624475>.

In their 2022 publication titled “Increased digital resource consumption in higher educational institutions and the artificial intelligence role in informing decisions related to student performance,” Jokhan, Chand, Singh, and Mamun discuss the rising use of digital resources in educational institutions and the function of artificial intelligence in this trend. This publication is available online at: <https://doi.org/10.3390/su21442375>.

“Exploration of exposure to artificial intelligence in undergraduate medical education: a Canadian cross-sectional mixed-methods study,” published in *BMC Med. Educ.* in 2022, was written by A. Pucchio, R. Rathagirishnan, and N. Caton, among others. doi: 10.1088/s12909-022-03896-5

Developing multiagent E-learning system-based machine learning and feature selection strategies was published in the journal *Computational Intelligence and Neuroscience* in 2022 and authored by S. H. Hessen, H. M. Abdul-kader, A. E. Khedr, and R. K. Salem. Viewed at <https://doi.org/10.1155/2022/2941840>.”

An intelligent virtual educational system was designed to increase the efficiency of elementary education in impoverished nations (A.-S. Vidal et al., 2022).

The link to the article is <https://doi.org/10.3390/electronics11091487>.

*”Deep learning incorporated augmented reality application for engineering lab” (J. Estrada, S. Paheding, X. Yang, and Q. Niyaz, 2018).

training,” *Application Science*, volume 12, issue 10, pages 5159, 2022. This article is cited as <https://doi.org/10.3390/app12105159>.

(2019) “Artificial intelligence potential in higher education institutions enhanced learning environment in Romania and Serbia,” in *Sustainability*, volume 14, issue 10, pages 5842–5843, written by B.-M.-T. Rocsana and V. Kuleto et al., 2022.

The article “Artificial intelligence in education: Aided for personalized learning pathways” was published in the 2022 edition of *The Electronic Journal of e-Learning* and was written by T. Olga and N. Zhiyenbayeva.

The article “Artificial intelligence: A universal virtual tool to augment tutoring in higher education” was published in the 2022 volume of the journal *Computational Intelligence and Neuroscience* and was authored by K. Hemachandran et al. [21].

[22] “Exploring opportunities and challenges of artificial intelligence and machine learning in higher education institutions,” publication date: 2021, by V. Kuleto and M. Ilić et al., *Sustaina-*

bility, volume 13, issue 18, page 10424.

In their article titled “Good proctor or “big brother?” S. Coghlan, T. Miller, and J. Paterson discuss the topic. *Philos. and Technol.*, volume 34, issue 4, pages 1581–1606, 2021, examines the moral implications of virtual test proctoring tools.

[24] “Towards the grade’s prediction,” by H. A.-M. Gerlache, P. M. Ger, and L. D. L. F. Valentin. *The International Journal of Interactive Multimedia and Artificial Intelligence* published an article in 2021 titled “a study of different machine learning approaches to predict grades from student interaction data” (vol. 7, no. 4).

A study published in the *International Journal of Artificial Intelligence in Education* in 2022 by C. J. Maclellan and K. R. Koedinger titled “Domain-general tutor authoring with apprentice learner models” covers pages 1–42.

[26] In the 2020 issue of the *Universal Journal of Educational Research*, Janpla and Pallop discuss “The development of an intelligent multilevel item bank model for the national evaluation of undergraduates” (vol. 8, no. 9, pp. 4163-4172). 10.13189/ujer.2020.080942 (Decreated)

[27] “Meta-analysis of artificial intelligence works in ubiquitous learning environments and technologies,” *International Journal of Advanced Computer Science and Applications (IJACSA)*, vol. 11, no. 9, 2020, by S. Caitlin, N. Nalindren, and R. Mogiveny.

In their 2020 article titled “Improvement of an online education model with the integration of machine learning and data analysis in an LMS,” V.-C. William, R.-C. Milton, and P.-P. Xavier discuss the use of machine learning and data analysis in improving online education models. DOI: 10.3390/app10155371.

In their 2019 article titled “5G enabled technologies for smart education,” D. K. Dake and B. A. Ofosu discuss the use of 5G networks in academic settings. The DOI for this article is 10.14569/IJACSA.2019.0101228.

The article “Educating AI-thinking in science, technology, engineering, arts, and mathematics (STEAM) education” was published in 2019 in the journal *Education Science* by M.-L. How and W. L. D. Hung.

“Educsci9030184” (DOI: 10.3390/educsci9100118). [31] “Exploring the impact of artificial intelligence on teaching and learning in higher education,” article published in 2017 by S. A. D. Popenici and S. Kerr in *Research and Practice in Technology Enhanced Learning*, volume 12, issue 1, pages 1–13. Visit <https://doi.org/10.1186/s41039-017-0062-8> for more information;

