AI-Powered e-Learning: Innovations, Challenges, and the Future of Education

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Manuscript received November 5, 2024; revised December 10, 2024; accepted January 8, 2025; published May 13, 2025

***Abstract*—The present study explores the transformative impact of Artificial Intelligence (AI) on e-learning and its implications for the future of education. It explores recent revolutions in AI-powered educational technologies, such as adaptive learning systems, intelligent tutoring systems, and personalized learning platforms. The study discourses how these advancements increase student engagement, improve learning outcomes, and provide tailored educational experiences. Additionally, it addresses the challenges associated with implementing AI in education, including data privacy concerns, the digital divide, and the need for educator training. Systematic secondary research approach was implemented to gather the data related to the topic of present study. The potential of AI to revolutionize assessment methods, curriculum design, and administrative tasks in educational institutions is also considered. Finally, the study anticipates the future trajectory of AI in education, sightseeing its potential to create more comprehensive, well-organized, and effective learning environments while admitting the importance of sustaining a balance between technological revolution and human-centered pedagogics.**

***Keywords*—Artificial Intelligence (AI), Natural Language Processing (NLP), machine learning, e-learning, education**

I. Introduction

E-learning is prevailing in education and it plays a pivotal role in the development of various aspect of learning [1, 2]. The integration of Artificial Intelligence (AI) and Machine Learning (ML) in e-learning has revolutionized the way students learn and enhance their knowledge. By using AI-Powered algorithms, e-learning platforms improved personalizing learning experiences to a substantial level [3]. The integration of AI and ML in e-learning has not only revolutionized how educational content is delivered but has also created new opportunities for improved engagement and retention rates. AI-driven recommendation systems personalize educational materials, fostering engagement [4]. Educators improve instruction using learner data to identify patterns and areas for enhancement. With advancing technology, AI and ML in e-learning have limitless potential. Using learner data and AI models, platforms can continuously enhance algorithms for effective learning. These developments have transformed education, integrating technology to adapt to individual needs and be future proof [5]. The integration of AI and ML into e-learning enhances educational systems by addressing individual needs, preferences, and learning styles. This promotes lifelong learning and academic improvement. The combination of AI and ML in e-learning has revolutionized education. Personalized learning, feedback, and technological advancements have enhanced the e-learning sector [6]. As AI and ML shape the future of education, more innovative tools and methods will improve e-learning's effectiveness, optimize student results, and empower lifelong learners. The integration of AI technology in e-learning has brought about numerous innovations, but also poses significant challenges for the future of education. With the ever-increasing demand for personalized and adaptive learning experiences, AI has emerged as a potential solution. By harnessing the power of AI algorithms, eLearning platforms can analyze student data, track progress, and provide tailored recommendations to individuals. This not only enhances the overall learning experience but also allows educators to identify areas where students may be struggling and offer targeted support. However, the implementation of AI in eLearning comes with its own set of challenges, such as ensuring data privacy, dealing with algorithm biases, and fostering human-machine collaboration. Nevertheless, by addressing these challenges and leveraging the capabilities of AI, eLearning can be transformed into a dynamic and efficient educational ecosystem that caters to the diverse needs of learners worldwide.

II. Foundations of AI in e-Learning

AI in e-learning uses powerful technologies like machine learning and Natural Language Processing (NLP) to create personalized experiences [7]. This customization is achieved through adaptive algorithms that detect patterns and tailor content for each learner. AI systems with natural language processing enable human-like understanding and manipulation of human language [8]. This allows for the development of intelligent chatbots and advanced content analysis techniques. AI with NLP can automate grading and generate feedback for written assessments in e-learning, increasing learner satisfaction. Recent research in this field has shown strong evidence that as the level of personalization in AI systems increases, learner satisfaction also consistently increases. This highlights the significance of customizing the learning experience to meet the specific needs and preferences of each learner, which AI can achieve through its use of ML and NLP. Fig. 1 shows the AI and e-learning platforms.

AI in e-learning relies on quality datasets for training and

evaluating models. More high-quality data leads to improved outcomes in machine learning. AI-powered e-learning follows a five-step process: gathering data, preprocessing it, selecting models, training them, and deploying the AI model [9]. Data analytics and dashboards help enhance insights from AI models. Python is widely used in e-learning for its adaptability. AI in e-learning creates personalized and efficient learning experiences through machine learning and natural language processing techniques [10]. Extensive datasets, advanced AI models, and open-source technologies are transforming knowledge acquisition in e-learning.

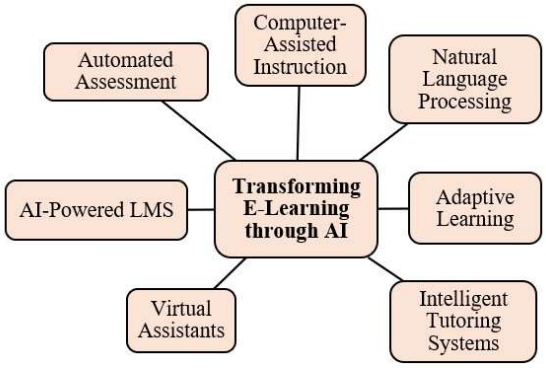

Fig. 1. AI and e-learning platforms.

A. Machine Learning in e-Learning

Learning Management Systems (LMS) collect learner activity data to update learner models. LMS need to go beyond basic tasks and analyze user behavior, knowledge levels, and preferences [11, 12]. This enables customized educational experiences for more effective learning results [13]. Advanced machine learning algorithms are suitable tools for analyzing and modeling learner activities and are used to create item-based recommendations of different aggregation. For example, they define content usage to group content and create general recommendation models depending on the type, such as recommended learning paths or personalized quizzes, that can guide the user according to the problems identified by the related knowledge model. The need for intelligent and scalable applications has led to Personalized Adaptive Learning Pathway application data recording services [14]. With smart tools and technology, users can learn in their own way rather than following the teacher's path. There are many smart services that support personalized learning and help students learn based on reviews and tasks [14]. Collaboration between learners through forums, individual dialogues, and group assignments provides an exchange of ideas and experiences that help both of them to learn [15]. Analyzing learner performance and actions to predict error determination, addressing stressful exam follow-up, maintaining next steps, and providing positive feedback are essential.

The interaction of academic life and social life provides clues to more comprehensive user information. Adaptive learning, in which the pace and presentation of recommendations are determined by the user, has greater potential for success since it is a more flexible approach [16]. Model optimization and refinements should be done continuously as more data is collected from the user. The host of big data must be carried out through learning adaptive rules and careful data mining. Experimentation is notable in a first learning management system, and outstanding benefits are drawn from decisions made on the described algorithms, including the recommender system [17, 18]. Furthermore, the adaptive engine analyzes the learner's progress, identifies areas of improvement, and offers targeted recommendations to address their specific needs. Through this adaptive approach, learners are empowered to take ownership of their learning journey and progress at their own pace [19]. Additionally, the adaptive engine fosters collaboration and interaction among learners, creating a dynamic learning environment where learners can exchange ideas, perspectives, and experiences [20, 21]. This collaborative approach not only enhances the learning process but also promotes social interaction and the development of interpersonal skills. This asserts that adaptive engine plays a crucial role in personalized learning and enables learners to maximize their learning potential. By leveraging advanced machine learning algorithms and continually refining the model based on user data, the adaptive engine ensures that learners receive tailored recommendations and support that meet their unique needs [22]. This results in a more engaging and effective learning experience, empowering learners to achieve their goals and succeed academically.

B. Natural Language Processing (NLP) in e-Learning

NLP a subfield of AI and computer science, deals with the interactions between computers and human language [23]. More specifically, the task of NLP is to enable computers to understand, think, and generate natural language [24]. In an academic context and e-learning in particular, NLP has the following tasks: human-computer communication with natural language, computer-assisted language learning, and the evaluation of human natural language use, whether written, spoken, or gestural [25]. In this attempt, our focus mainly on the use of NLP technologies in e-learning for shaping learner experience, providing intelligent and expert assistance, developing adaptive learning systems, personalized and group-oriented, and designing learning environments, e-materials, and resources that help learners in the generation of their knowledge, in addition to other issues. Next, we discuss NLP systems dealing with the technologies and tools in which NLP is extensively used in e-learning to transact with learners through e-tutors and learning systems.

NLP is commonly used to develop conversational agents for e-learning purposes. Language learners are one of the primary groups targeted with NLP tools, given that languages are primarily acquired by being taught by knowledgeable speakers. Therefore, various software applications enable learners to learn aspects of foreign languages, such as vocabulary and grammar, simulating one aspect of the learning and teaching process. Several NLP tools are used to evaluate learner text, such as writing exercises [26]. One of the most well-known applications of this use of NLP is essay-scoring software. NLP is increasingly making AI a more viable option for in-class instruction. Besides research, teachers and principals in other classrooms are already using AI-based services right now in a variety of ways, including in some cases their core curriculum [27]. Given this opportunity

to expand and deepen the educational conversation, this paper has a clear e-learning focus. In the light of e-learning, ML and NLP the present study aims to determine the AI powered e-learning challenges and future of education in this pursuit.

III. Methodology

Systematic secondary research approach was implemented to gather the data related to the topic of present study. Systematic reviews are a rigorous and thoroughly planned, multi-stage research methodology that focuses on gathering, evaluating, interpreting, and synthesizing evidence on a specific topic. Systematic reviews differ from traditional reviews in their ability to answer specific research questions and contribute to reproducible research [28]. Although systematic reviews began in the health fields, they are now used in a wide variety of fields, including education, social sciences, engineering, and environmental sciences, as well as in big data analytics and machine learning. Systematic reviews are designed in such a meticulous manner in order to guarantee that they are transparent, reproducible, and free from bias [29]. In this light, it is absolutely indispensable for researchers to follow a clear procedure when conducting systematic reviews. For each phase, it is imperative that the researcher is as accurate and comprehensive as possible.

The present study involved various steps to collect the information related to AI and eLearning. The first step was the formation of the research imperative on the related topic. Then we have identified the inclusion and exclusion criteria of the research article gathering. This is followed by the literature selection and data extraction from the exciting research studied. After that data relevance was employed. Finally, data interpretation was done on the basis of selected articles.

In the perspective of present study, the subsequent databases were scrutinized for the most appropriate available research paper: Google scholar, Talyor & Francis, Springer Link, Saudi Digital Library (SDL), Science Direct, IEEE, Sage Open, Academia, Eric, Emerald, MDPI journals, and Scopus. The search on for the targeted research article was restricted to published paper in English between 2019 to 2024. The search for the papers included the combination of AI and e-learning, AI and ML, NLP, adaptive learning, AI-powered LMS, virtual assistants, personalized e-learning, adaptive assessment and feedback, challenges and ethical consideration in AI, challenges in AI, privacy and security in AI, bias in AI and future of AI in education. After the strategies of the search the identified papers were downloaded. A total of 224 published papers between the years 2019 and 2024 were obtained. For the eligibility of the papers for discussion on the topic abstract and introduction of the downloaded were analyzed.

As the emphasis of the present study was on the AI Powered e-learning innovation and challenges, the criteria for inclusion of the published studies were: AI in e-learning, AI in Education, ML, NLP, Augmented Reality (AR), Virtual Reality (VR) and NLP which were applied to Education and e-learning context. In addition, the inclusion criteria were precise to AI implement in school and universities. Data that associated with the inclusion criteria were rooted out from the selected articles. The articles with 100% association to the inclusion criteria was considered appropriate for making a point on the topic.

In order to exclude the studies, form the discussion for the present study the criteria were: studies conducted other than English language; published before 2019; letter to editors: book reviews: books: book chapters: brief reports: commentaries: and expert opinion. Moreover, all non-scientific work that is not related to education were excluded from the present study.

After employing inclusion and exclusion criteria based on the title and abstract (n = 96) studies were excluded from the discussion. 128 articles were assessed for the eligibility of the discussion of the study. Then the articles with unclear information were excluded from the study (n = 57). Finally incongruous area topic (n = 34) was excluded for discussion. The study included a total of 23 studies were included in discussion to make an assertion o AI-innovation, challenges and future of education.

IV. Innovations in AI-Powered e-Learning

The history of e-learning has long been intertwined with both technological and pedagogical development [30–32]. To date, there are key innovations that AI has brought to e-learning, enriching the learner's experience by implementing new technologies and methodologies, the profound features of which will be discussed next. First, it shall be noted that among the benefits for the learner in AI-powered e-learning are personalized learning experiences, which incorporate content and activities that reflect and respond to the needs, characteristics, circumstances, abilities, and interests of the individual who is learning. Personalization engines can assist in tracking preferential trends based on user interactions, and user guidelines can also assist learners in assimilating appropriate personalization.

Adaptive assessment and feedback systems in e-learning are AI-based features that help platforms assess learners either before the start of the course or during traversal to adapt instructional materials and attempts to best fit learners, as well as to provide them with the appropriate feedback on their current state or progress [33]. These systems adapt in real time according to the data and feedback received, changing the intra-lesson testing pattern to address the individual needs of each learner. Moreover, the implementation of AI within them managed to eliminate human bias, making the assessment more objective. In higher education, vast implementation of this innovative feature can be seen in different universities across the UK. Finally, AI-powered e-learning is immersed in the prospect of ending a one-size-fits-all content generation trend. With AI, learning materials can now be built to interact and engage with the learner to spur intrinsic motivation, ensuring immersive and engaging learning experiences [34, 35].

Numerous AI-powered e-learning technologies are transformative because they innovate our understanding of educational technology to act as an independent teacher who truly understands the learning approaches of the individual. With AI capabilities and frameworks anticipated to further develop and integrate with e-learning systems based on data, the possible future development of the entire educational interface is limitless [36]. Many highly skilled technical professionals, the development of AI applications within the edtech domain, AI has been in embryonic exploratory use in

the form of smart chat agents assisting in customer service [37]. Small and non-traditional universities are leveraging AI-fueled course-sharing platforms to grow internationally by providing online education in excessive demand. AI and big data provide learner insights by gathering information from online training metrics, which appears to support teachers in adopting new technologies for their own use [38]. A strong discourse around AI and its e-learning application mostly seems to be immersed in developing new e-learning technologies to help educators. Thus, the applications of and discourse about AI in e-learning are dominated by improving educators' experiences with AI technology.

A. Personalized Learning Experiences

The advent of AI has led to the premise of personalized and individualized learning experiences. A learner's performance, including metacognitive states, is analyzed by diagnosing activities and large-scale learner behavior data [39]. This is expected to prompt individualism in pace, material, approach, and other theoretical continuum subdivisions of the learner. AI-based predict-and-test algorithms predict student understanding based on skill assessments [40]. Once revealed, personalized measurement approaches build personalized educational roads. The resulting system increases such educational activities without modifying the student's behavior.

Cognitive-state-based measurements, such as metacognition, show the potential for studying the design of personalized learning technologies [41]. These should not only lead to reflections on a system but also can be used by the system feedback at the current stage. Feedback can be useful for refining knowledge, setting goals, pathway decisions, and other initiatives. Many learning systems are based on the potential of analyzing current data to create previous student learning types that provide personalized educational activities. Cognitive state is fundamental and impossible for AI. Furthermore, the massive open online course based on AI has been developing the personalized learning approach. The system designed hypotheses only based on grading to guide student behavior. Cognitive state is used for personalizing feedback and providing a personalized intervention [42]. It is an automated engine that uses machine learning techniques and biographical, demographic data, changing lines like giving feedback on projects in K12, with effort being a burden.

The major advantage of the personalized learning approach is that it delivers the material that the student needs, at the time he requires it, in a format that fits him perfectly, at the speed that he needs, and with the depth that is appropriate for him. Every individual is unique; personalized learning creates unique individuals that do not fit into an ordinary category. Student autonomy is reemphasized by the choice of resources to learn from, the choice to take deliberate action to grasp the material more fully [43]. Certain actions take longer, and some are a continuous process, reducing the action rate. The fact that students are not obliged to implement or execute them makes it worthwhile. Instead, they choose to follow some actions to ensure that the information is well understood and to make sure they can see their ways. They invest their energy and attention because students have committed ownership of the learning objectives.

A number of research results [44–47] demonstrate the relevance and value of personalized learning technology with increased performance. A favorable outcome is recorded with significantly improved effectiveness; data effectiveness, custom assessment, and so forth are frequently noted as good signs. In addition to performance indicators, this research employs other results-related indicators that are crucial in learning. Co-creation is significant in every interaction, conversation, and behavior between learners and teachers. It is also a vital learning approach to maximize student satisfaction and participation. Facial appearance can reveal a student's emotional condition. AI in education reduces discrimination between students. What are the problems? It is well-liked by less-abled students. It adds equality opportunities in college. Most learners are centric, but if enabled, their time may be better employed, especially in learning.

B. Adaptive Assessment and Feedback

Assessment is a cornerstone of education defined by educational and instructional sciences as a process of assessing and evaluating the cognitive skills, knowledge, and potential of learners, especially by eliciting performance in a systematic and comprehensive manner [48]. Technically, assessment refers to the process of gathering interpretational and decision-making data about a range of individual and collective performance, understanding, capability, knowledge, skill, achievement, or competence. In any education system, a significant amount of time is devoted to assessing student performance. Large-scale assessment is also increasingly used to evaluate the effectiveness of a range of initiatives aimed at improving education.

Traditional, paper-based quizzes perpetuate a one-size-fits-all, punitive style of assessment. Fixed or multiple-choice formats marginalize the needs of non-traditional learners. The academic path of quick inquiry and answer means memorizing and recalling an overwhelming quantity of material and facts about subjects, which empowers neither lifelong learning nor a love of learning. AI can be used to provide a dynamically assessed quiz [14]. For example, when an assignment is incomplete, students can be given hints to complete it. Additionally, an AI-powered quiz can be adapted based on assessment and feedback previously given to the areas that the student may not have quite understood yet. Finally, quizzes can also be more formative if they have more gamified interfaces. Lastly, any AI-based system of knowledge and skill assessment and feedback should be validated to determine its fairness as well as to build confidence among educationalists.

A meta-analysis and systematic review on the effect of formative assessment on academic achievement in computer-based technology showed various educational technologies that could be used for helping students improve their assessment skills, including immediate, formative, and predictive analytics. Analytics allows student-centered education to form an automated feedback loop. Various systems use analytics to, for example, identify when a student may drop out of a class so that this can be addressed by either the teacher or the institution, monitor student participation in multimedia content thereby improving their success, or assist

instructors in their teaching by telling the teacher or lecturer which lesson plans work best and for what type of student. There are a number of educational platforms and companies that have already set up such feedback loops, many using a learning analytics engine. One possible advantage of such a system is that in addition to and in parallel with having dedicated feedback or a full-performance analytics interface, the feedback can be processed and delivered with personalization. These offer an advantage in adaptive feedback techniques for overcoming the aforementioned drawbacks in feedback loops.

V. Challenges and Ethical Considerations

The greatest challenge for many AI-powered E-learning systems is ensuring trust, fairness, transparency, accountability, and especially privacy and security of sensitive data, as well as ensuring the reliability of recommendations [49]. As is often the case with many machine learning systems, they can perform well for some populations while having unintended negative consequences for others. Furthermore, recommendation models cannot always account for the constantly changing content of Massive Open Online Courses (MOOCs). Recommendations based primarily on student preferences discourage curiosity and exploration, essential qualities of effective e-learning. In general, it may be beneficial to develop and study the impacts of using diversity as a guiding principle of AI-enhanced e-learning.

Although historically there is little capacity to support large-scale online learning, AI is changing that by greatly reducing human interaction. AI can detect emotions and manage digital teaching assistants that can provide empathy and personalized feedback. While digital codecs can provide access to the benefits of AI, we should not overlook barriers for individuals who have not previously been well-supported in face-to-face programs—those who speak a minority language, those who cannot read, those with significant disabilities, and the many individuals who do not have reliable access to networked devices.

A. Data Privacy and Security

Data privacy and security are top concerns when it comes to implementing AI-powered e-learning algorithms [48]. Students have intentionally revealed sensitive biometric details while using the software, which has broad implications for data privacy and security, especially for students. Education is a unique space regarding privacy; students have rights that their data from the classroom should not be visible to people who they haven't consented to view. Educational establishments have long been held to provide special legal status with regard to the outcomes of students' work. In most cases, the services provided by the educational establishment are directly related to the students' education, and their use and handling of the data need to align with the educational fulfillment of the students. In these situations, it is easy to assume that an educational institution requires legal protection. Students' data is safeguarded under privacy legislation to protect the privacy of students enrolled at the school, ensuring that addresses, phone numbers, and other personal information are not inappropriately shared and that students are not identifiable and can therefore not be tracked. The privacy and data protection principles support the accomplishments of the special legal status of the institution identified in the educational fulfillment direction for the use of the data by both students and the educational institution [49].

There are many security challenges associated with the use of large amounts of information during the engagement of e-learning systems. The usage of computer devices and laptops for the processing of the e-learning system may bring inherent risks to consumers [50]. Any such systems may be subject to intrusion and other problems if they lack security and safety controls, which make them a vulnerable fortress. The misuse of e-learning information is perpetrated by hackers and counterfeiters who may benefit by performing various dangerous activities with the purpose of statistically using the data inside repositories intended for personal and biased use. The large number of students present makes e-learning services especially challenging, so selective attention is not paid by expert personnel in the holding of system configuration. Recent legal privacy provisions about student privacy by education enforcement agencies dictate how e-learning technology should be treated. Films and recordings display students in their exclusive locations, providing many social experiences. It should be feasible to obstruct access control as well as data communication between various stakeholders and software.

Overall security is necessary for e-learning systems for which there are no data protection hazards and confidential data or offerings, while still enabling their various teachers, learners, employees, forums, and analytical organizations. With respect to personal computers, optimal usage entails exceeding the constraints that are imposed in service of educational purposes. Attentive activities related to various protections from spies and assaults should be followed, and the progression of focused goals in connection with the configuration options for such services must be made accessible to supervise the potential experience of an e-learning solution to the full.

B. Bias and Fairness in AI Algorithms

Recently, a lot of attention has been dedicated to bias and fairness in AI algorithms that have the potential to have far-reaching societal impacts [51]. There is growing concern that AI algorithms frequently display bias that can result in unfair treatment or disadvantage to certain groups or individuals [52, 53]. This is particularly pertinent in data analysis where algorithms can make decisions regarding whether or not a person receives a loan or a university admission. Social consequences of bias in AI have even led to a call for their regulation. Algorithms can introduce bias, even if the data that were used to train these algorithms are not biased themselves.

There are many different ethical and legal aspects of how bias should be measured and quantified in AI which are beyond the scope of this paper. However, we shall look at specific applications of AI in higher education and consider what aspects of AI algorithmic bias might mean in the context of higher education. Existing systems for obtaining higher education clearly have certain criteria that need to be fulfilled before a potential student is offered a place at a university. For instance, in the UK, the tariff has been rigorously tested

both ethically and legally by the government, and also by the Office for Students. The higher education professional body that represents mainly alternative providers in the UK has also argued that the system of initial teacher training has too much emphasis on candidates' academic background. Once data is generated by AI, biases can affect interpretation and learning as AI is employed in data gathering and evidence management. That can produce false claims to base further AI-developed claims upon and decisions made upon them. One clear problem is that AI clients may not want to know the results are biased if those results serve their purposes. In today's world of social media, a one-sided argument, backed by AI, can become international news within a second, dissipating false facts from true facts. In healthcare treatment, biases can put patients' lives at risk. How to deal with bias? It is imperative that AI is deployed according to necessary ethical and legal standards, founded on cases of bias or both. AI has overcome substantial technical challenges to produce overwhelming amounts of data. If any claims or decisions must be held back or recovered upon bias-versus-bias challenges, AI engineers and data managers must detect bias in AI-generated data.

C. Challenges and Strategies for Ensuring Data Validity in AI

Large amounts of potential data sources are never integrated into AI systems [54]. Still, there can be different issues before this human-AI data interaction. In AI, there are two main ways to describe sources of potential evidence used as data, both based on the representativeness of the data and, as such, the validity of the results. One part of the data is gathered with a focus on algorithm design, and as such, the experimental apparatus is independent of the data quality, cutting down the risk of certain biases due to data quality. This means more experimental studies with an AI application are designed in partnership. However, as we increasingly gather large amounts of data that are not subjected to a priori experimental design, this will also become more common, raising the question of what data is also needed for validation purposes. There can be a number of reasons that impede the representativeness of input data, such as outright missingness or measurement error. In addition, there can be intuition about the world outside of the context of the data, which means the questions might look valid; however, they really measure other things and, as such, are invalid and can cause predictive bias.

As for research implications, AI validation should occur over time rather than at a single point. Hence, techniques for the validation of AI must be developed for monitoring the health of the system and be capable of changing according to how data and the world change. Data for AI are rarely final; AI systems either learn or operate with new information [55]. If systems are not continuously valid, then this must be calculated, such as by tracking and reporting how shifts in data affect the system over time. It should also be noted that the user understanding of bias in data in AI is an area where we lack a good solution. The actual selection and comprehensive validation process can be completed using statistical, business, and technical considerations from an organization's viewpoint. Data-directed considerations can also offer tentative and more generally used border validation equivalent processes. However, these approaches are generally very computationally costly and, like all methods, are limited by the information in the data. It is also relevant for organizations to perform validation prior to deployment. Publishing the results of this final step is also important to prove to consumers of a system and to the public that evidence of machine learning systems is valid for use in the organization.

D. Ethical Considerations in AI Data Presentation

In designing 'appliable' AI, data scientists and other organizations share a responsibility not only to ask, "What is possible and profitable?" but also, "What is the right thing to do?" To decide the 'rightness' of AI data presentation—and associated ethical implications—we must consider the potential harms and benefits of data presentation recommended by AI. Misrepresentation of data-driven insights has the potential to support major harms. Firstly, the individuals and communities that inaccuracy affects may not be able to correct machine learning models that have decided they are of high and low worth. Wrongful representation of a group based on skewed data can also cause further unequal distribution of resources and be used to justify job losses. Miscommunication of uncertainty data has the potential to cause a loss of confidence in science and for governments. Each of these issues, placed in the context of society's current response, has the capacity to exacerbate the scale of the current situation.

In addition, the decision to design or use AI that has the capacity to generate 'good enough' inaccurate insights can have long-term effects on societal trust. What do we, as a society, think about social media's continually developing potential to skew public opinion? This, in turn, impacts privacy and data ethics initiatives because it becomes even harder for data scientists to determine the likelihood of a community feeling unseen and unheard due to the innovations their AI contributes to. In many cases, there is no direct trade-off between innovation and ethical concerns. Although data protection laws require that companies can show that their data collection and actions align with a purpose in their social charter, these rules are rarely enforced. The danger of unethical exploitation of AI is considered real for working groups whose documents illustrate the risk of technology's potential rapid development. Regulation and self-regulation of AI have so far involved taking a top-down approach in establishing principles that data science and AI experts believe core AI users should follow. Compliance is sought through the publication of weighed and tested precedents in AI output handling against which a company or institution's actions are then assessed. In contrast, ethical AI has a clear emphasis on stakeholder engagement and aims to encourage bottom-up ethical decision-making. This means getting professionals enabling AI in industry to consider the potential ethical risks behind their AI innovation and effectively work to find alternative AI approaches that are less discriminatory or that are less likely to violate a country's laws.

VI. The Future of AI in Education

The future of AI in education is closely tied to progress in other domains of human activity. One field that will influence

the further development of AI in education is user experience design in games and AR/VR applications [56, 57]. The more engaging and immersive the learning environment that AI in education is capable of creating through these tools, the faster its application in other educational settings will be. We anticipate that as AI becomes 'smarter', teachers will be expected to take on more creative roles; traditional teaching will be replaced by a mentor-mentee relationship, which is in line with the expectations articulated in personalized learning frameworks. More ideas regarding the application of AI in the development of educational tools are around the implementation of mixed reality and spatial learning, the utility of intelligent algorithms in e-learning chatbots, and digital teaching assistants. Another future AI application involves using machine learning for better content curation. As learning content becomes more personalized and learners finish their educational cycles with different skills, the current passive job search becomes an active seeker matchmaking role. AI will be needed to accompany the learner through this learning life journey. To cater to this new phenomenon, the future role of institutional learning centers will need revision.

A. Potential Impact on Teaching and Learning

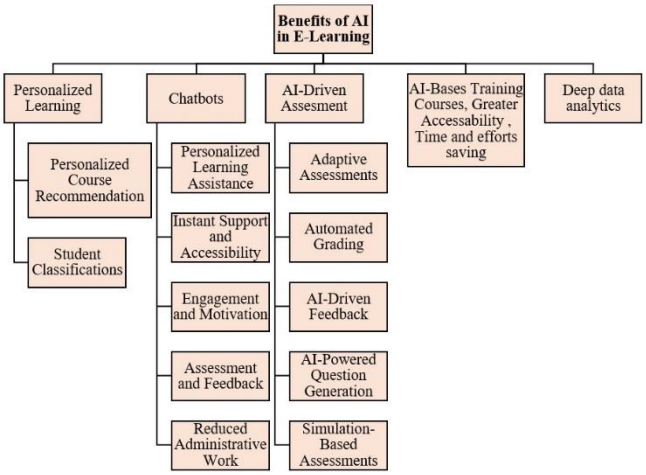

Fig. 2. AI integration in e-learning.

Artificial intelligence-based support of e-learning and tutoring systems has become a very important field of AI research [56]. AI e-learning tutoring systems can be centered around courses, subjects, curricula, or personal learning targets. They can be used to improve knowledge or to provide decision or management support, depending on the domain and the application context. AI tutoring systems aim to provide students with learning experiences that are equivalent to those of one-to-one human tutors. Emphasis should be placed on the student's ability to interact with the system, thus requiring more than simple exposure to content. Typically, AI tutoring systems collect and exploit data about the students and their improvement during the tutoring process. Intelligent tutoring systems try to model the knowledge state of each student and then attend to the students' needs, providing interactive content presentation and feedback that is optimized based on the student's response. Compared to human tutoring, the efforts and costs of a tutoring system can be distributed over a high number of students. Fig. 2 shows the potential benefits of AI integration in e-learning.

By providing multiple layers in their architectures and fostering high-level data abstractions up to knowledge discovery, AI tutoring systems interpret the student's past actions and performance in order to offer appropriate instructions and support their knowledge growth, responsive to the current context [58]. In this context, machine learning techniques observe students' interaction data, analyze resource and student models, and consider characteristics of educational content. In addition, they allow mapping learning processes and observing the impact that resource types as well as the demographic composition of the different users have. With big data and business intelligence analyses, aggregate models can be derived and used to capture user, course, and content profiles for targeted course evaluation, adaptation, and course improvement. The positive insights provided from both sides—the individual needs of the students and the community as a whole—indicate that AI tutoring systems can have a great impact on the pedagogical performance of teaching environments.

From the pedagogical point of view, AI tutoring systems have the potential to enhance and improve the learning experience of students, thus possibly impacting final cognitive and motivational achievements [59]. For example, with a personalized knowledge model approach, individual differences and previous knowledge can be captured, allowing the natural learning ability to be sustained and thus stimulating the best individual learning process. This in turn helps students to pace the learning experience according to their abilities. The cognitive load and motivation of the students are consequently relieved, and from this, reduced feelings of overload and failure should emerge. At the same time, AI tutoring systems present a viable framework to revolutionize the standard education system. Students are progressively educated to be proficient in a knowledge-based society environment, which demands them to master new learning skills. AI tutoring systems reward and continually encourage students to develop autonomous learning styles, thus promoting the ability to manage information and good intellectual skills, and to think and solve problems [60]. In addition, some research revealed that students who completed an intelligent tutoring system course performed better than students who completed the same course in face-to-face mode. Personalization and adaptivity provided by AI systems in both contexts may be of help [61].

B. Emerging Trends and Technologies

The emerging trends in e-learning are influenced by technological advances and demand-side factors like user preferences, pedagogical requirements, skill requirements, and regulatory frameworks. Some of these emerging trends in e-learning include mass personalization, massive open online courses for the masses, virtual labs, virtual experts, intelligent tutoring systems, mobile learning, formalization through overtures using big data and analytics, massive and complex digital production processes, quality assurance through peer-to-peer review and recommendations, the use of social media to enable collaborative learning with student alumni or experts, virtual learning communities, and open access intellectual property as a standard resource for course content. Several of these new emerging trends can be achieved through advances in AI and machine learning tools [62]. There are two classes of tools that could be used in

combination with AI and machine learning related to the content and the pedagogical and assessment components of e-learning [10]. The choice of specific tools needs to be aligned with the specific pedagogical or operational requirements.

AI-powered e-learning uses advances in machine learning and computational power to engage the learner in new ways by offering personalized, implicit, and instant hand-holding support for the self-regulated processes involved in reflecting, diagnosing, planning, establishing domain, and self-regulating their domain, task, and strategic knowledge acquisition processes in both generic and domain-specific systems [63]. The learner is provided with tools that are adaptive at varying levels of representational sophistication to articulation refinement and to support for knowledge reflection, diagnostic explanation space browsing behavior, and training tip generation. AI-powered e-learning is based on constructivist learning theory and supports a multimodal learning process consisting of content delivery, simulation, and reflective conversation. Its content is treated both at the propositional and procedural levels.

VII. Conclusion and Future Directions

In this paper, we have sought to highlight the historical and potential future of AI in e-learning, offering key considerations for educators, technologists, and policymakers looking to integrate AI into education. AI has the potential to transform how we learn and teach, offering personalized experiences and economic benefits while pushing us towards more equity and inclusivity. Challenges of integrating AI into education include a lack of empirical evidence of effectiveness, fostering appropriate teacher and learner trust, and ethical considerations. We underscore the importance of research and policy to safeguard data privacy, avoid bias, and ensure the fairness of AI applications, utilizing multidisciplinary research methods including ethics, learning sciences, and educational data mining, while prioritizing learner data protection. First, we must do the groundwork and continue research and dialogue with educators via rigorous evaluations of neuromorphic computing. There are also many other potential enablers of a future where AI can be used ubiquitously in e-learning and in broader society. Future research directions must focus on methods that allow white-box access to AI datasets. We must enhance facial and gestural recognition technology to ensure that AIs can only be built to be used discriminately for good. Furthermore, existing research methods or entirely new methods could be developed to ensure learners build mental models of AI. A future direction could envision fuller collaboration between educators and technologists through the development of the approaches presented here, focusing on the co-production of e-learning AI needs and the functions and underpinning methodologies. From the policy perspective, the future of AI in e-learning would be one where learners are equipped with the skills required to thrive amidst the increasing integration of AI beyond e-learning.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Ashraf Ali contributed key ideas and conceptualized the research direction, ensuring a clear focus on addressing the core objectives. Raja Muhammad Ishtiaq Khan played a vital role in drafting and refining the introduction, providing a comprehensive overview of the study's significance and discussion section. Danish Manzoor and Mohammad Abdul Mateen collaborated on the methodology, ensuring its accuracy and alignment with the research goals. Mohammad Ayaz Khan reviewed the final manuscript, offering valuable insights to enhance the overall quality and coherence of the work. All authors had approved of the final version.

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