An evaluation of machine learning approaches in educational environments: a systematic literature review

Uma avaliação de abordagens de aprendizado de máquina em ambientes educacionais: uma revisão sistemática da literatura

Lucio Agostinho Rocha *[1]

[1] *Universidade Tecnológica Federal do Paraná, Engenharia de Computação, Apucarana, PR, Brasil.*

Abstract

The goal of this article is to investigate how methodologies based on machine learning are being applied in educational environments to enhance the quality of learning in graduation courses. The method is presented through a systematic review of literature on the main methodologies of systems based on artificial intelligence applied in smart classrooms. The results indicate that in the popularization of machine learning, the widespread use of these technologies presents new challenges for educators as learning agents who investigate learning strategies alongside their learners. The learning with these recent technologies faces challenges regarding the veracity, soundness, and quality of information. In the classroom, it is important to take into account the legal aspects and ethics principles involved in these recent machine learning advances. Besides, these issues involve how popular platforms combine data from multiple sources to generate useful information with reduced human intervention. Nowadays, society lives connected to a myriad of interconnected computational devices. In this sense, the classrooms are evolving into learning spaces where students learn together in a collaborative way and shape soft-skills abilities, such as communication, relationship, and collaboration.

Keywords: Educational research. Smart classroom. Machine learning. Learning processes. Artificial Intelligence.

Resumo

O objetivo deste artigo é investigar como metodologias baseadas em aprendizado de máquina estão sendo aplicadas em ambientes educacionais para melhorar a qualidade do aprendizado em cursos de graduação. O método é apresentado através de uma revisão sistemática da literatura das principais metodologias de sistemas baseados em inteligência artificial aplicados em salas de aula inteligentes. Os resultados indicam que na popularização do aprendizado de máquina, a disseminação do uso dessas tecnologias apresenta novos desafios para educadores como agentes de aprendizagem que investigam estratégias de aprendizagem ao lado de seus aprendizes. A aprendizagem com essas recentes tecnologias enfrenta desafios em relação à veracidade, solidez e qualidade da informação. Na sala de aula, é importante levar em consideração os aspectos legais e os princípios éticos envolvidos nesses recentes avanços com aprendizado de máquina. Além disso, essas questões envolvem como plataformas populares combinam dados de múltiplas fontes para gerar conteúdo útil com reduzida intervenção humana. Nos dias atuais, a sociedade vive conectada a uma miríade de dispositivos computacionais interconectados. Nesse sentido, as salas de aula estão evoluindo para espaços de aprendizagem onde estudantes aprendem juntos de maneira colaborativa, e modelam habilidades de *soft-skills*, tais como comunicação, relacionamento e colaboração.

Palavras-chave: Pesquisa educacional. Sala de aula inteligente. Aprendizado de máquina. Processos de aprendizagem. Inteligência Artificial.

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1 Introduction

The sustainability of education should foster ethical aspects reflected in a healthy partnership between educators and their students. In traditional education, the focus is on the average performance of students (Luan; Tsai, 2021), but this concept neglects personal learning behaviors. It is a common issue that to follow individual learning demands effort and time from both learners and educators.

*Email: luciorocha@utfpr.edu.br

So, many educators use information and communication technologies (ICT) to improve the quality of their classes by automating many educational tasks, such as tests and exams, to follow the continuous progress of their students. The standardization of learning with automatic tools may imply a reduction of creativity and diversity of teaching methodologies, and auxiliary digital technologies could increase the costs of effective learning. In a taylorist perspective, a "shelf teacher" appears to play a role in increasing productivity, but in the constructivist theory, the importance of learning is revealed as an active process based on personal experience and self-reflection supported by experienced educators. In this sense, to effectively improve the quality of education, it is essential to investigate the incorporation of new digital technologies in classrooms.

In fact, smart campuses improve the quality of education with the convergence of new digital technologies in the context of smart cities to satisfy social needs (Chamorro-Atalaya; Morales-Romero; Quispe-Andía, 2023). Besides, systems based on Artificial Intelligence (AI) have been applied in education since the 1970s, and they are used as virtual pedagogical agents to promote personalized learning, such as assessment and feedback. Automated learning-based systems have gained importance mainly due to their ability to solve non-trivial tasks, including solving math formulas, producing texts and images, programming codes, and others.

In this article, the objective is to investigate how Machine Learning (ML) and related methodologies for smart classrooms are being applied in educational environments to improve the quality of learning in graduation courses. In order to give a contextualization of this theme, a systematic review of literature is presented in the following sections. The relevance is to obtain insights into methodologies and best practices that may be applied as guides to improve the quality of education supported by recent digital technologies. This paper summarizes some of the most relevant features of smart classrooms.

This article is structured as follows. The next section presents a background of AI technologies applied in smart classrooms; Section 3 presents a methodology of systematic review to select relevant articles for this theme; Section 4 discusses these latter results; finally, Section 5 does final considerations.

2 Background

According to Shapiro (2003), Artificial Intelligence (AI) is a field of computer science devoted to deal with computational aspects of intelligent behavior. Russel and Norvig (2021, p. 37) define AI as a system that performs correct actions based on rationality, and a system is considered rational when it does the correct action based on its available data. Zhang, Lu, and Jin (2021) indicate that the main areas of AI are the perception, the communication, the planning, the reasoning, and the knowledge engineering. The term AI is defined as follows:

The term "Artificial Intelligence" (AI) was first mentioned by John McCarthy in 1956 and refers to the ability of computer systems to undertake human tasks (like learning and thinking) that frequently can only be attained through human intelligence (Dimitriadou; Lanitis, 2023, p. 2).

Machine Learning (ML) is a knowledge area of AI that concentrates on designing systems through algorithms that learn or improve their performance based on the data they consume (Oracle Corporation, 2024; Eglite; Birzniece, 2022). ML and AI are frequently presented together, but they are not the same concept. In general, the two primary ML algorithms that are frequently used are supervised and unsupervised learning. The algorithms of supervised learning are trained with labeled data sets and have a predefined output. The algorithm could use a dictionary of fruit names to group labeled images, for instance. The most common algorithms of supervised learning are linear regression and logistic, multiclass classification, and support vector machines; but the algorithms for unsupervised learning utilize a different approach. The system learns to identify processes and complex patterns with minimal human intervention. This ML process involves training based on unlabeled data sets or a predefined output. For instance, the algorithm could group unlabeled images by their similarities with images of fruits, and place them in specific groups, setting a new label for each new group (e.g., a group of similar images of maces, a group of similar images of strawberries, and so on). The common algorithms of unsupervised learning include k-means, association rules, principal and independent component analysis.

ML is being applied in smart classrooms, and this concept is evolving over the years. Yang and Su (2021) give to "smart learning environment" a definition of an effective learning place that provides appropriate resources and convenient interaction tools with automatic record and evaluation of results. Additionally, Dimitriadou and Lanitis (2022) also define this concept as an integrated learning space that combines emerging technologies. The personalized learning through computational devices is meaningful to engage students in self-learning according to their profile, needs, and interests. A recent approach (Luan; Tsai, 2021) is to collect learning patterns to intervene properly with teaching materials, considering the differences between learners.

It is important to consider the reliability, safety, and implications of incorporating emergent digital technologies in classrooms. The reliability in a sense of soundness of digital contents; the safety in the sense of quality of information in the era of fast widespread of unreliable information on digital media; and the implications due to the effort to improve the abilities of thinking and critical skills with these new technologies during classes.

Chen, Zou, and Xie (2021) declare that AI applied in education has been extensively used in online platforms, web-based chatbots, humanoid robots, and computer programs. These authors also indicate that these technologies may be applied to special education, performance prediction, emotional detection, personalized learning, discourse analysis, teaching evaluation, natural language processing, and educational robots. In this sense, ethical issues need to be considered about personnel data (Pelletier; Brown; Brooks, 2021). For instance, the use of these data, its access roles, security restrictions, storage, and the duration of their availability.

The application of new emerging digital technologies in classrooms is characterized by different definitions and terminology. According to Wang and Yu (2023), education systems based on AI are related with emergent technologies. Chamorro-Atalaya, Morales-Romero, and Quispe-Andía (2023) consider the term Education 4.0 to describe educational practices based on competences and supported by AI with exchange of knowledge in cloud environments. In Education 4.0, intelligent educational environments shape professional skills and social responsibility.

The emergence of AI technologies is associated with smart classrooms as a complementary alternative to offer more creative and efficient learning. Some of the main technologies in smart classrooms are robotics, computer vision, augmented/virtual/mixed reality, active methodologies, mobile devices, sensors, and computer vision-based surveillance supported by e-learning platforms (Dimitriadou; Lanitis, 2022). The role of teachers is to enhance the skills of their students through new ubiquitous, social and mobile learning methodologies. The combination of AI jointly of these emergent technologies shows that smart classrooms are still evolving to be used during the learning process. In smart classrooms, the students are encouraged to learn by themselves and also bring their own devices to classes. Some authors consider that big data and cloud computing, supported by additional tools of speech recognition and deep learning, are the basis for the effectivity of many smart classrooms. For instance, Gui (2020) does the building of English teaching aided by neural networks to guide the reform of foreign language education. This methodology can receive various network resources and carry out characteristic data through deep learning. Li and Yao (2023) also utilize big data sets to predict the grades of English learners.

In addition to this, the advent of SARS-CoV-2 (COVID-19) impacted the acceptance of online courses and provided opportunities to evaluate new technologies in the graduate courses, especially in university settings, when all teaching became virtual, testing the sustainability of education systems. Another aspect is that inclusion, jointly with equitative activities, should be offered in higher education to promote sustainable possibilities (Chai; Ye, 2024). Although investments in higher education brought interest in leverage AI science, learners were impacted by restrictions in technological issues, connectivity, and solitary learning. It is an empirical issue that many online courses were shown by themselves to be inefficient to carry out the effective personalized learning without the interaction with the human educator. However, learning with ML systems was possible due to the explosion in the volume of data during the second half of the 2000s and the popularization of data capture through cheap devices.

For smart classrooms, it is possible to use ML algorithms with structured data as databases and unstructured data as images, audio and video to build decision-making systems to predict and classify data from huge datasets. In these systems based on ML, pre-trained models are used to find solutions that are not explicitly defined in the dataset (Shaik, 2022). More specifically, the most common are those that use ML to analyse, learn and apply classifying and prediction from datasets. Deep learning holds multi-layer neural networks with processing layers to train new concepts and link to previous. Recurrent neural networks (RNNs) and gated recurrent units (GRUs) are examples of techniques that apply deep learning to text classification. Other examples are long short-term memory (LSTM) and convolutional neural networks (CNNs) (Shaik, 2022).

In summary, most smart classrooms in higher education use blended learning (Chen; Zou; Xie, 2021) supported by a myriad of digital technologies. In this sense, it is important to investigate how smart environments are useful to improve learning in classrooms.

It is observed that the application of ML systems has shown its efficacy and can potentially be applied jointly with active methodologies. However, the use of these methodologies based on automated systems may also be insufficient when learners demonstrate passive behavior during the learning process. Besides, the environment of classrooms should be a place of constant human interaction.

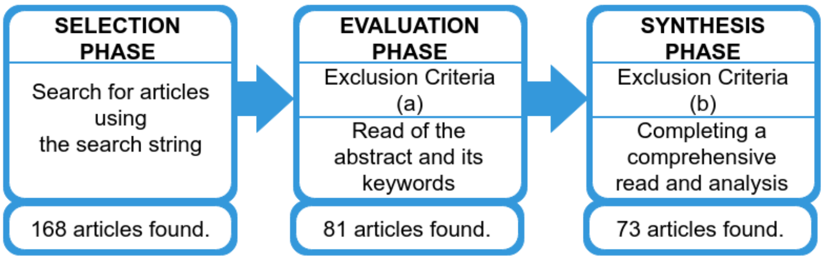

Figure 1. Flowchart of the Systematic Review.
Source: Created by the author.

3 Systematic Review of the Literature

In this sense, it is fundamental to investigate how the application of ML systems and related methodologies contributes to improve learning in classrooms. The methodology employed in this article is based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA), which is a methodology commonly found in the literature (Montoya-Rodríguez; Franco; Llerena, 2023; Alfoudari; Durugbo; Aldhmour, 2021; Shazli; Che Lah; Hashim, 2023). In this systematic review, the research topics are identified, evaluated, and analyzed. The proposed review is as follows: a) the definition of research questions; b) the definition of search terms; c) the selection of bibliographic bases; d) the definition of inclusion and exclusion criteria for articles; e) the summary reading of these selected references. In this systematic review, three steps were defined to select articles: 1) Selection Phase: the search of papers according to the selected bases; 2) Evaluation Phase: the filtering by relevance of title, resume, keywords, and period starting from 2020; 3) Synthesis Phase: the evaluation of these papers in both quantitative and qualitative terms. Figure 1 shows the steps followed in this study.

The research questions (RQ) are necessary to evaluate the references, and they are presented in the following items:

RQ 1 : What are the goals for using ML in the classroom?
RQ 2 : What methodologies are used in graduation courses?
RQ 3 : What ML softwares support this type of learning?
RQ 4 : What are the contents that have been developed?

The RQ 1 defines the objective of the article, as the focus is on ML techniques for graduation courses; the RQ 2 identifies the methodology; the RQ 3 identifies the ML softwares that were used for learning; finally, the RQ 4 describes the developed contents in the classroom.

Table 1. Criteria for the Eligibility.

Items of Inclusion Criteria	Items of Exclusion Criteria
a) The studies that address the concepts of the search string: ("artificial intelligence" OR "machine learning") AND ("educational research" AND "smart classroom"). b) The articles written in English published in the last five years, starting from 2020 until the first half of 2024. c) The practical application of artificial intelligence to the improvement of learning in graduation courses.	a) The proposals and concepts not applied in the classroom; b) The papers without pedagogical analysis of artificial intelligence technologies in graduation courses.

Source: Created by the author.

These research questions were used to define the following keywords: artificial intelligence, machine learning, educational research, and smart classroom. Then, the search string is: ("artificial intelligence" OR "machine learning") AND ("educational research" AND "smart classroom"). This search string was submitted to these digital bibliography catalogues: IEEE Xplore, Elsevier Scopus, DOAJ (Directory of Open Access Journals), and reviewed articles found by Google Scholar. These databases are considered reputable in terms of research quality. The inclusion criteria (IC) are: a) the studies that address the concepts of the search string; b) the English articles published in the last five years, starting from 2020 until the first semester of 2024; c) the practical application of AI to the improvement of learning in graduation courses. The exclusion criteria (EC) are: a) the proposals and concepts not applied in the classroom; b) the papers without pedagogical analysis of AI technologies in graduation courses. These criteria are summarized in Table 1.

Figure 2 shows the obtained articles by year. Since 2020, there are many researches related to the inclusion of AI in classrooms, and this issue is shown in the figure. Table 2 summarizes the obtained articles in the Selection phase.

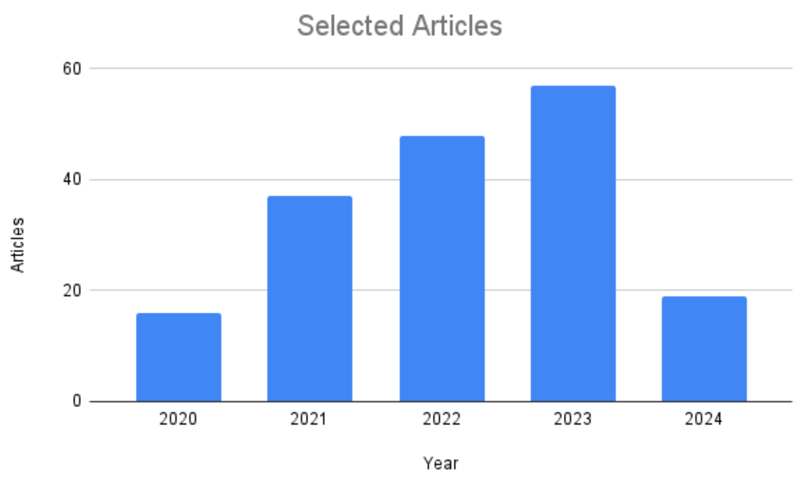

Figure 2. Selection Phase: Articles starting from 2020.
Source: Created by the author.

The visualization by category including the article surveys is given in Figure 3. In this figure the obtained articles may be included in more than one category. The next section discusses these latter results.

Table 2. Systematic Review of the Literature.

Catalogue Sources	Step 1 Selection Phase: Inclusion criteria	Step 2 Evaluation Phase: Exclusion criteria (a)	Step 3 Synthesis Phase: Exclusion criteria (b)
IEEE	72	32	26
Elsevier	9	2	2
DOAJ	9	5	5
Google Scholar	78	42	40
Total	168	81	73

Source: Created by the author. This dataset is available at: https://osf.io/5kxzs.

4 Discussion of the Results

The previous section results allow answers to the research questions. In the evaluation of the RQ1, the selected articles indicate the possibility of improving classrooms with AI-based systems and their related technologies. However, a further discussion is conducted in the following to clarify the reproducibility of these innovations and avoid the higher costs of non-sustainable approaches.

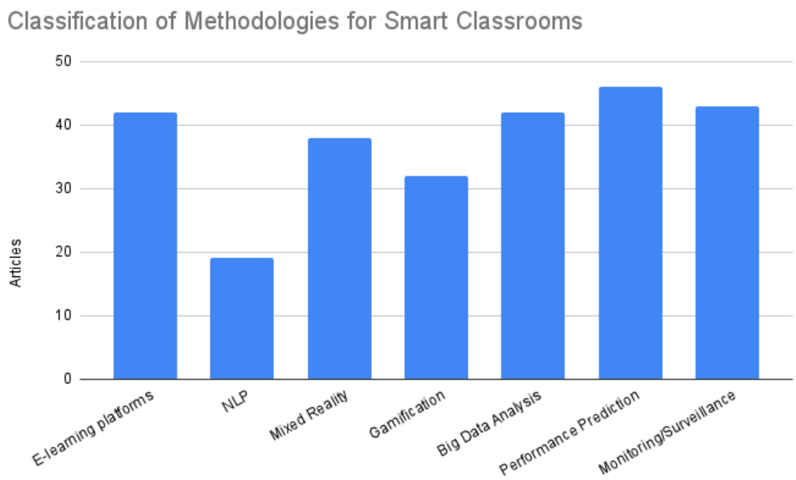

Figure 3. Classification of Methodologies for Smart Classrooms.
Source: Created by the author.

Related to the RQ2 and RQ3, Table 3 summarizes the main methodologies and software tools for application in smart classrooms. Some similarities are observed that permit to categorize them as follows: E-learning platforms; NLP; mixed/virtual/augmented reality; gamification; big data analysis; performance prediction; and monitoring/surveillance with computer vision. These categories are basic and frequently interrelated, and aim to identify how research will contribute to the creation of a smart classroom. As shown in Figure 3, these categories frequently appear together as keywords, with the exception of NLP and gamification categories, which appear in minor occurrences.

This review of the literature revealed contributions to the learning in classrooms supported by AI-based systems and newer digital technologies. Table 3 emphasizes the main methodologies used in the implementations of smart classrooms excluding surveys, as the latter describes multiple methodologies.

Table 3. Methodologies and Software Tools of Smart Classrooms.

Methodology	Software Tools	Smart Classrooms
1. Massive Open Online Courses (MOOCs) and Online platforms for e-learning.	a) Google Classroom; b) Canvas; c) Blackboard; d) Moodle; e) BigBlueButton; f) chat online meeting like videoconference (For example: Zoom, WebEx, Google Meeting, Skype, Microsoft Teams); g) online quizzes; h) YouTube; i) Facebook; j) 2U; k) Loud Cloud; l) Adaptcourseware; m) Anewspring; n) customized e-learning platforms based on Fog/Cloud Computing and others.	Zhang *et al*. (2022), Bhatnagar; Sharma (2022), Shaik *et al*., 2022; Wu *et al*. (2021); Syzdykbayeva; Baikulova; Kerimbayeva (2021).
2. Natural Language Processing (NLP)	a) Chatbots; b) chatGPT, and others.	Shaik *et al*., (2022); Tang; Li (2023).
3. Virtual/Augmented Mixed Reality	a) Neural networks; b) Markov chains; c) deep learning frameworks (e.g. Caffe); d) trained based models from public datasets; e) OpenPose; f) Tensorflow, and others.	Zhang *et al*. (2020), Haghighi *et al*. (2021).
4. Gamification	a) Learning management systems (LMS); b) immersive reality; c) simulations with serious game; d) interactive media; e) HelloTalk; f) Lingualeo; g) Hello English; h) Memrise; i) Duolingo; j) browser games and others.	Dahalan; Alias; Shaharom (2023), Syzdykbayeva; Baikulova; Kerimbayeva (2021), Zhu; Guo; Yang (2023).
5. Big Data Analysis	a) Citespace; b) VOSviewer; c) Bibliometrix; d) Pytorch; e) word clouds; f) Spssau; g) Ucinet; h) Netdraw; i) datasets from questionnaires; j) public facial expression datasets; k) ML algorithms, and others.	Bhatnagar; Sharma (2023), Chai; Ye (2024), Bansal; Ahmed (2023), Madhani; Shah; Swarnalatha *et al*. (2022), Li; Yao (2023).
6. Performance Prediction	a) Random Forest (RF); b) K-nearest neighbors (KNN); c) artificial neural networks (ANN); d) support vector machine (SVM); e) Gradient Boosted Regression Trees (GBRT); f) Long Short-Term Memory (LSTM); and others.	He; Hu (2022), Luan; Tsai (2021), Zhao *et al*. (2020), Zhao *et al*. (2022), Wu *et al*. (2021).

7. Monitoring and Surveillance with Computer Vision	a) Computer vision algorithms such as YOLO, R-CNN series, etc.; b) recording softwares, and others.	Pang; Lai; Zhang *et al.* (2023), Song; Zhao; Xiong *et al.* (2022), Shanshan; Hui; Liqiao (2024).

Related to the RQ4 that describes the contents developed in the classroom, it is observed that there are few evaluations by ethical committees of research regarding how changes will be implemented in classrooms. Besides, most of the articles obtained do not consider feedback from their students regarding how AI-based systems effectively contribute or not to their performance. In this sense, qualitative feedback from these students would be important to complement the statistical results concerning the effort to perform lessons, the duration to deliver tasks, the motivation of using automated learning systems, and others. In order to complement the answer of these research questions, a discussion is done as follows.

1. Massive Open Online Courses (MOOCs) and Online platforms for e-learning: many online platforms for e-learning are publically available (Zhang; Liao, *et al.*, 2022; Shaik, 2022; Wu; Yang; Liao, 2021; Bhatnagar; Sharma, 2023; Syzdykbayeva; Baikulova; Kerimbayeva, 2021), and they have been the most utilized alternative to decrease weakness of teaching after the COVID-19 pandemic. In addition to this, the transition from in-person to online compelled educators to adopt systems that they were not prepared for (Pokhrel; Chhetri, 2021). One of the major challenges of online classes was the absence of fundamental requirements for quality learning, such as soft-skills gained by interpersonal relationship, communication abilities, expertise with information and communications technology, with the lack of adequate physical space for classes compelling emotional distress, for instance. The widespread dissemination of self-learning through large Internet resources has shown the need for an educator to properly guide problem-solving activities. For smart classrooms, Zhang, Liao, *et al.* (2022) also indicate the possibility of performing empirical analysis as an educational research method to capture teaching situations. This method has the potential to offer effective personalized feedback.
2. Natural Language Processing (NLP): this category is cited less frequently in the results, and one of the reasons is probably its relative new adoption in e-learning platforms, associated with its inherent difficulty in creating educational content. NLP is widely used for opinion mining. Shaik (2022) reveal that NLP is useful to evaluate feedback from students without human intervention. Besides, AI in education can collect data non-explicitly given by the student and adjust the teaching approach through adaptive learning platforms. These systems come to give an adaptive learning system based on students' background by continuous monitoring and tracking of students' textual feedback. Additionally, online applications like Turnitin aim to check plagiarism, typographical and grammatical errors (Shaik, 2022). Tang and Li (2023) use ChatGPT to adjust teaching contents with personalized learning. Chatbots use NLP and Deep Neural Networks (DNN) to give predictions, recognize speech and respond properly. Chatbots have become a recent option for personal assistance and tutoring in classes, which can be used to answer questions, distribute material, watch videos, and play games.
3. Virtual/Augmented/Mixed Reality: smart classrooms with immersive environments are the combination of virtual/augmented/mixed reality devices that may potentially contribute to greater knowledge retention, improve problem-solving skills, and promote more engaging experiences (Dimitriadou; Lanitis, 2022). Zhang, Lu, and Jin (2021) also highlight the possibility of investigating students' behavior, and Haghighi, Sheikhjafari, and Jolfaei (2021) the possibility of automating the face recognition for recording classes. Unfortunately, some restrictions are related to the relative weaknesses of content, the difficulties of producing virtual/augmented content, and the high costs of acquiring specific devices.
4. Gamification: this category is also cited less frequently in the results, and two of the probable reasons are the lack of acceptance by educators and the quality of educational content. Gamification has the potential of improving the educational experience by increasing motivation, engagement, and academic accomplishment (Dahalan; Alias; Shaharom, 2024). Syzdykbayeva, Baikulova, and

Kerimbayeva (2021) also indicate the possibility of gamification for learning foreign languages. Teachers can provide teaching materials, AI extracts the key concepts, and the system generates questions and answers. Zhu, Guo, and Yang (2023) indicate that 21st century skills should involve high-order skills which encompass creativity and critical thinking, for example. In this sense, these authors indicate the possibility of utilizing digital game-based assessment to engage behaviors by constructing game contexts through distinct game genders. These digital games contain incentives to enhance engagement and motivation, can capture the interactions yielded during the game, and allow reproducibility of the individual process of problem-solving to support interventions.

5. Big Data Analysis: many authors combine big data sets from different sources and perform the analysis of these data sets with ML algorithms (Bhatnagar; Sharma, 2023; Chai; Ye, 2024; Bansal; Ahmed, 2023; Madhani; Shah; Swarnalatha, 2022; Li; Yao, 2023). In fact, there are many different alternatives of data analysis for smart classrooms: text mining, sentiment, social network, statistical, facial, IoT data, and others. Zhu, Guo, and Yang (2023) indicate two main categories for data analysis that are supervisioned models and statistical analysis. A possibility for supervisioned models is to include in ML modeling knowledge, skills, and affections of students as labels. Then, the relationship between the labeled data can be trained to achieve predictions on new outcomes. The most common technique of data analysis of supervisioned models is linear regression, and the most common technique of data analysis of statistical results is the correlation analysis. IoT offers a myriad of devices connected to the Internet. The most common applications are real-time monitoring, safe infrastructure, building administrative task automation, e-contents, and also online live sessions within the university campuses, although many of these devices leak in interoperability (Bhatnagar; Sharma, 2023). IoT devices may potentially acquire real data and facts to feed customized deep learning with AI, and generate a Fog-IoT portfolio designed for private clouds by universities (Bhatnagar; Sharma, 2023).
6. Performance Prediction: many ML algorithms have been used to predict academic performance and admission decision (Zhu; Guo; Yang, 2023). He and Hu (2022) affirm that the performance prediction supported by deep learning comes jointly with the advent of the fourth industrial revolution. These authors believe that deep learning should focus in comprehension, analysis, application, and evaluation, in contrast with superficial learning of memorization. In fact, smart classrooms should overcome simple mechanical memorizing in contrast with a high level of cognition. Zhu, Guo, and Yang (2023) indicate that self-reported surveys ignore the thinking process, and negligence aspects of high-order skills. The self-report aims to evaluate how well the students do tasks. A standardized test is considered highly reliable and valid where the students have to answer a pre-defined set of questions. However, in terms of methodology, tests with questionnaires leak the capture of the thinking process during learning, and make it difficult to avoid anxiety and to foster engagement, problem-solving abilities, and memory performance. Commonly, only the final score obtained is evaluated. As a consequence, if a student gives a wrong answer, the thinking process is not evaluated. In addition to this, many authors (He; Hu, 2022), Luan and Tsai (2021), Zhang, Lu, and Jin (2021), Zhang, Liao, *et al.* (2022) and Wu, Yang, and Liao (2021) propose methodologies to improve learning during the classes supported by ML and deep learning tools for data analysis.
7. Monitoring and Surveillance with Computer Vision: Dimitriadou and Lanitis (2022) indicate that computer vision-based surveillance and smart environments contribute to delivering efficient classes. Computer vision is often used to reduce the time for verifying the presence and detecting behaviors using facial identification technologies, such as high anxiety, uncomfortable situations, and concentration levels. A similar approach is proposed by Shanshan, Hui, and Liqiao (2024) to build a teaching system based on face recognition, as an alternative to observing the behavior of students in classrooms. Automated methods for behavior analysis are widely used in smart classrooms to recognize student actions, and prevent mental and physical injuries. Dimitriadou and Lanitis (2022) also indicate that students can positively interact with educational AI-based robots, which can contribute to improve the learner's knowledge.

5 Conclusion

Nowadays, AI poses many challenges to educators, but it is evident that this technology cannot replace human soft-skills abilities, such as communication, organization, leadership, team formation, adaptation, creativity, interpersonal relationship, and also the critical thinking abilities of judgment and decision-making. This underscores the importance of evaluating before using auto-generated answers. AI-generated content and its inherent ambiguity further emphasize the importance of critical thinking and judgment (Cao; Dede, 2023). AI tools, as chatbots for instance, may be an alternative to solve repetitive tasks of specific lessons and tests, but are insufficient to perform tasks that need immaterial abilities for learning, including improving communication, enhancing expressiveness, working with teams, brainstorming, and developing proposals, to cite a few.

Dimitriadou and Lanitis (2022) give insights into the strengths of AI to give adaptive modes of interaction, personalized feedback and advice. However, many weaknesses were also observed, such as feelings of disengagement from learning. In fact, Vygotsky (O'Donnell; King, 1999) considers learning as a cognitive process that needs human interaction to be consolidated, and not only to retain information more easily. In addition to this, according to Yang and Su (2021), the Internet connects people, but these connections are not necessarily indicative of effective learning. Many online platforms have the weakness of high costs for maintaining their infrastructure and to keep their services, which is almost impossible to be sustainable in the long term for some AI tools, mainly when big datasets are extracted from multiple sources. Dimitriadou and Lanitis (2022) also reveal threats, such as the negative impact of insert failures and/or non-confidence results during the training process of systems based on ML, reducing the quality of the teaching process. Besides, the high amount of individual data needs an effective role for security and privacy, which is almost impossible to maintain in some schools without rigorous ethical partnerships.

García-Tudela, Prendes-Espinosa and Solano-Fernández (2023) emphasize educational environments to develop competences, commonly known as soft-skills. Besides, they indicate greater prominence to the personalization of teaching automatically with integration of emerging technologies of AI, learning analytics, sensors and others. Mustafa (2022) consider the importance of putting the learner as the main actor of the learning process. In addition to this, active methodologies such as flipped classrooms promote events that traditionally are taken inside the classroom, and that now can take place outside of this environment. Some of these strategies involve virtual and remote classrooms to be on online courses and to interact with emerging technologies, such as AI. However, some authors (Dimitriadou; Lanitis, 2022) indicate that some recent digital technologies have also been proven to enforce isolation, and impede students in rural areas or with disabilities.

Finally, the emergence of many online courses supported by automated tools brings issues about how this excessive amount of information is being absorbed by students. The proposal of "learn by yourself" raises some issues about how the quality of this methodology impacts interpersonal relationship in-class and remotely. In fact, Farahani, Firouzi, Chang, *et al.* (2018) highlighted that prolonged use of the computer may cause corporal issues, such as neck strain and visual discomfort. Technology has been identified as a cause of depression due to people's increased use of technology and decreased social interaction. Besides, physical and mental health are also affected (Brohi; Mastoi; Laghari, 2023). The dependency on automated tools may lead to a decrease in critical thinking and a growing spread of misinformation.

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Conflict of Interest

The author declares that there is no conflict of interest.

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