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AdaDeep: Adaboost and Deep Learning to Discover Student 5.0 AI Capabilities in the Fifth Industrial Revolution (Industry 5.0)

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Abstract: While industry 5.0 is a human-centered shift that focuses on the integration of cutting-edge technology with human skills and talent, Education 5.0 is a result of the substantial influence of the Industry 5.0 and Society 5.0 on education. In this study, we coin the term Student 5.0, a generation that learns skills that are becoming more and more crucial in the modern workplace as a consequence of merging the features of Industry 5.0 and Education 5.0. This study proposes combining two powerful prediction models: Adaboost and deep learning to form AdaDeep. AdaDeep prediction analysis was used on a student data set to discover the AI capabilities that students should acquire to thrive in the Industry 5.0 era. The goal is to gain insight into how the human centralization feature of industry 5.0 could assist in making improvements to the educational process. The findings of this study suggests that the reinforcement of the use of AI and individualized learning is what characterizes this new era of personalized and efficient education. In addition, Education 5.0 has increased the focus on Industry 5.0 soft skills like critical thinking, cooperation, and the ability to communicate effectively with both humans and machines (robots). To better prepare students for the job market, educational institutions should incorporate these abilities into the curriculum.

Keywords: *Education 5.0, Emerging technologies in education, Industry 5.0, Society 5.0*.

1. Introduction

Industry 4.0 and Industry 5.0 are two Industrial Revolutions, with Industry 4.0 focusing on technology and Industry 5.0 focusing on value [1]. Industry 5.0 has advanced the research horizon of Industry 4.0 toward a smart and cooperative socioeconomic shift powered by both mankind and technologies [2]. Industry 5.0 is a new industrial paradigm that encourages people's involvement and collaboration with the manufacturing procedure, and it was highlighted throughout the COVID-19 epidemic [3]. Actually, the fifth industrial revolution (Industry 5.0), or the age of collaborating robots is now in effect. The coexistence of intelligent robots and people is at the centre of the Industry 5.0, which also emphasizes resilience and sustainability. In contrast to Industry 4.0, which concentrated on automation and digitalization, Industry 5.0 is built on collaboration between humans and machines as a fundamental concept that assures attention on the safety of people and society. For example, the study in [4] explores both automated procedures and the strategy of reintegrating human employees into the supply chain. The following points highlight the crucial aspects of the Industry 5.0:

1. Integration of AI, robots, IoT, Metaverse and other emerging technologies. These technologies enable new types of human-machine cooperation and communication while also enhancing productivity and efficiency.
2. The relevance of data and analytics, which are utilized to support decision-making and enhance business results
3. Humans and robots are designed to coexist, not to replace one another. Robots in Industry 5.0 behave as partners rather than rivals as they are connected with human minds [5].
4. More solutions will be available to the market than with Industry 4.0.
5. Industry 5.0 will result in more employment creation than job loss since the human participation is essential in Industry 5.0.
6. Personalization, not mass production, will take the lead.
7. Psychology will control the development of technology to ensure the safety of cooperation between humans and robots.

2. Motivation

Although not many studies have been conducted on the relationship between Industry 5.0 and student performance, it is possible that integrating Industry 5.0 technology into the curriculum may improve the educational process and student outcomes. By using modern technologies that are in high demand in the jobs market, students will gain practical experience in related fields, they become more prepared for careers, and they understand the concept of cooperation with robots and Industrial 5.0 technologies. In

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addition, integrating Industry 5.0 technology into the classroom may increase student engagement, enthusiasm, and engagement, leading to better performance and learning outcomes. Therefore, this study is essential to understand the relationship between Industry 5.0 and academic success.

The structure of the study is as follows. A thorough literature assessment is presented on the concept of industry 5.0. As a result, a modernized version of the society named Society 5.0 emerged as illustrated by Fig. 1. Then, we emphasize how Industry 5.0 has influenced the idea of Education 5.0. The emergence of what we named Student 5.0, the fundamental contribution of this study, is one of the key gains of those approaches. Finally, we applied a prediction analysis to a student data set in order to ascertain the level of students' AI proficiency required for using AI in the classroom. The objective is to investigate how to apply the human-centric advantage from industry 5.0 to offer suggestions for ways to enhance the educational experience.

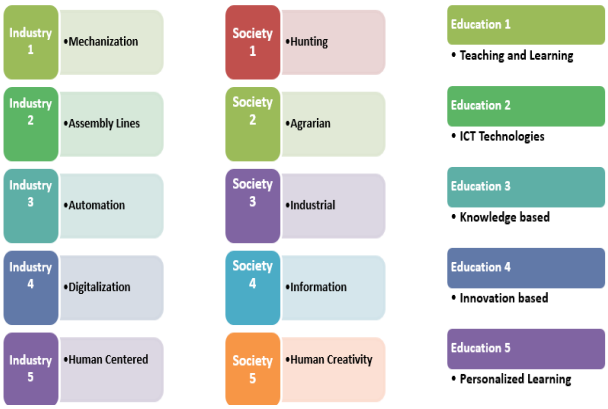

Fig. 1. Industry 5.0, Society 5.0 and Education 5.0 evolution stages

3. Literature Review

Several studies reported developing predictive models for students' performance prediction such as Data mining techniques [6], machine learning algorithms [7], Using decision trees [8], Ensemble Model [9] and Random Forest [10]. However, no comprehensive investigation has been conducted to study the integration between Industry 5.0 and academic curricula. Therefore, this section prepares the reader with the relevant works required to understand the relationship between Industry 5.0 and Society 5.0 leading to the formation of education 5.0 that will teach the student 5.0.

3.1. Industry 5.0

Industry 5.0 is an innovative idea for the European industry that prioritizes stakeholder value, sustainability, and human centricity [11]. Hence, strategies for industrial growth concentrate on three distinct sectors: human-centric, sustainable, and resilient development [12]. To secure a sustainable and equitable future for all, it is critical to achieve an appropriate balance between economic growth and human-centered development. The notion of Industry 5.0's industrial humanization, sustainability, and resilience were discussed by [13]. The Industry 4.0 revolution is driving efficiency and business models but has recently shifted towards machine-oriented technology, paving the way for Industry 5.0 [14]. The Industry 4.0 framework, which stresses the digitization of industry and the incorporation of cutting-edge technologies like AI, robots, and the IoT, serves as a foundation for this paradigm. Industry 5.0, however, goes above and beyond by emphasizing the significance of social objectives, such as environmental preservation and worker welfare, as major forces behind industrial progress. Building on the innovations of Industry 4.0, Industry 5.0 emphasizes social restrictions and human-centric concepts. With a focus on sustainability, moral behavior, and employee wellbeing, Industry 5.0 seeks to achieve a balance between technology innovation and societal requirements. Industry 5.0 is the next industrial evolution, leveraging human specialists and competent machines to create resource-effective and user-friendly manufacturing products [15]. The author in [16] examined industry 5.0's possible use, the definitions of industry 5.0 and the cutting-edge technologies needed for this industrial revolution. For sure, human centric aspect of Industry 5.0 is of great importance to societies.

Industry must consider societal limits to avoid leaving anyone behind. This affects a wide range of things, including maintaining a safe and healthy work environment, supporting human rights, and the criteria for employing individuals [17]. Therefore, In order to welcome sustainable growth in the age of industry 5, the authors in [17] discuss how human resources (HR) are prepared for the adaptation process. The focus on shifting from technology-driven growth to a wholly human-centric approach constitutes one of the most significant paradigmatic shifts defining Industry 5.0. The findings showed that Industry 5.0 provides sustainable advance values through 16 operations, which should be created in a particular order to optimize their interactions and contribute to the desired sustainability values [18].

3.2. Society 5.0

To improve people's standard of living, society must balance growth and problem-solving abilities with critical, inventive, and balanced thinking. The period of history that led to the numbering up to "5" was extremely different from the era of industrial revolutions. Agricultural economies are linked to the first two "Societies". The first, second, and some of the third industrial revolutions are roughly equivalent to Society 3.0, an industrial civilization. Society 4.0 has evolved from a highly digitalized form of

the Industry 3.0 to the present because "information" has grown to be so important [11]. Industry 5.0 and Society 5.0 are two futuristic industries and societies [19]. The purpose of Industry 5.0 is to put human prosperity at the heart of production processes, accomplishing societal goals other than hiring and expanding the economy [20]. Society 5.0 predicts a shift from conventional economic growth to fairer systems that prioritize social and environmental goals. The goal of Society 5.0 is to accomplish economic growth while also tackling social and environmental issues. To explain this, it must be emphasized that the IoT, robotics, AI, augmented reality, and other cutting-edge information technology innovations are being used to benefit citizens, and not just for financial gain [11]. As the focus of this study, the research findings indicate that the era of Society 5.0 corresponds to the development of comprehensive models and is important for the educational system [21].

3.3. Education 5.0

The education sector is crucial to economic progress as it act as a talent pool for other industries. Thus, future educational policy makers will concentrate on professional learning and technological integration. Currently, the most recent iteration of the educational system, known as Education 5.0, emphasizes student's character development through a student-centered approach. As a result, four strategies are introduced, such as lifelong learning, sustainability, resilience, and human-centric design modules [22]. Because of that, a sustainable, caring educational paradigm integrating ethics, humanism, and technology is addressed by the study in [23]. Education 5.0 places an emphasis on utilizing digital tools, platforms, and infrastructure to improve learning and gives students the chance to take part in curriculum creation. Critical thinking, problem solving, and creativity are important in education 5.0 in order to better prepare students for the challenges of the coming Industry 5.0 based labor market. The key components of Education 5.0 include cooperation, content, learning environment, delivery models, assessment and recognition, and quality assurance [24]. Industry 4.0 requires shared vision and methodical approach while Industry 5.0 requires updated education.

Students need to be equipped with the ability to interact, be innovative, think critically, and cooperate [25]. Although the concept of Education 5.0 is great, some would oppose that not all students could benefit from it. The truth is that not all students have access to the tools and technology needed to take full advantage of Education 5.0. Accordingly, investing in developing appropriate infrastructure, digitally preparing teachers, and developing curriculum is also essential for the success of Education 5.0. In addition, although Education 5.0 may be effective for some students, its implementation must be carefully considered and take into account each student's unique requirements and circumstances.

3.4. Student 5.0

Education prepares student 5.0 generation for Society 5.0 by "teaching leadership, digital literacy, communication, emotional intelligence, entrepreneurship, and global citizenship, while balancing critical thinking and emotional intelligence" [26]. Technology will make it simpler for instructors and students to collaborate and boost their enthusiasm in their education [27]. Consequently, digital transformation brings up new opportunities for universities and has the potential to be perhaps the primary driver of reform [28] as the findings revealed that university students' digital transitions were beneficial [29]. The most recent paradigm in education, known as Education 5.0, emphasizes the importance of individualized and student-centred instruction. Still, to successfully shift to this new paradigm, instructors, students, and educational institutions must work together to address the issues and provide answers for students in the era of Education 5.0.

Education 5.0 is about people rather than technologies, and it may be addressed by developing ideas that recognize human beings' creative potential [30]. Students may encounter difficulties with every new educational paradigm. To support student 5.0, changing educators' attitudes, textbooks, curricula, educational technology, pedagogies, innovation, research, reforms, and policies are the primary educational challenges and restriction that should be addressed for the age of Student 5.0. To meet this challenge, higher education institutions must reformulate their teaching processes. For example, soft skills, as depicted in Fig. 2, are critical for both career and private success. In Addition, digital literacy, sustainability and inter-culturally are also essential for success [31]. Furthermore, a future educational model should combines location and time flexibility, personalization, collaboration, adaptation of innovative teaching techniques and equipment, and the proactive duty of the instructor as a mentor and trainer [32].

4. Methodology

Today's student 5.0 generation is interested in using cutting-edge technology in their schooling to access information, work with others, and complete tasks using computers, tablets, and other devices. Additionally, they need having access to online tools and resources that might improve their learning. Many students like to use emerging technology such as AI for an educational experience and customized programs that help them advance at a speed appropriate to their abilities in their educational stages and thus can increase their level of participation, productivity, and academic performance.

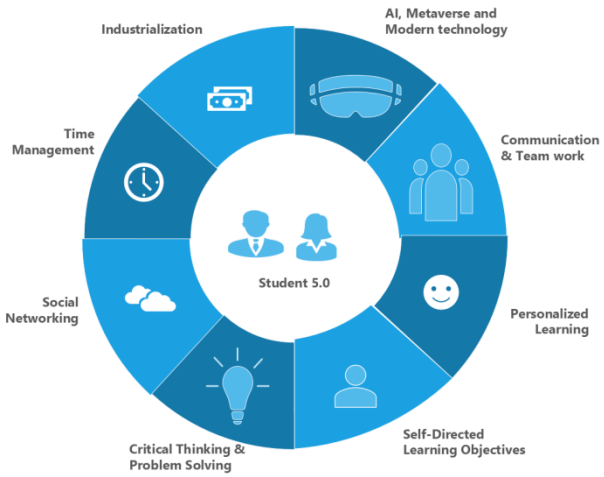

Fig. 2. Student 5.0 skills

Students have different expectations when it comes to the usage of AI and metaverse technologies in the educational process. Some individuals might have expected that new technology will provide chances for customized learning, such as adaptive tutoring that change to meet the needs and learning preferences of each learner. Others could like using AI to automate grading and assessment, enabling instructors to spend more time instructing and offering feedback [33]. Students may also prefer to have engaging, immersive, and interactive lectures that mimic real-world scenarios or allow them to study difficult concepts in more visually attractive ways like the usage of metaverse technology. However, not all students may be comfortable utilizing new technologies or be familiar with them. Hence, this study aims at investigating student 5.0 generation perspectives of using AI in education environment settings. The following subsections will discuss the used dataset, prediction model and the experimental results.

4.1. Data Set

We used "Students' Perceptions of AI in Education "data set [34]. The survey data in this dataset pertain to second- and third-year undergraduate students in the Faculty of Cybernetics, Statistics, and Economic Informatics. The poll was circulated through social media groups and carried out online. The survey's objective was to learn more about how students recognize artificial intelligence's significance within the educational setting. This data set's label, "passing all exams," conveys the idea of academic accomplishment.

4.2. AdaDeep: Experimental settings

We examined several prediction algorithms to help predict students' performance and success in all examinations based on how they perceive the use of AI in the academic environment. The purpose is to validate the statements provided by this study on the benefits of integrating AI into teaching and learning practices. The prediction models will find patterns and trends about students' impressions of employing AI in the academic process on the data set. Students' answers were analyzed with data analysis tools and compared to their passing of all exams as a criterion for their academic performance. Table 1 and fig. 3 illustrate the accuracy of the examined prediction models on the dataset. Accuracy indicated "the Relative number of correctly classified examples or in other words percentage of correct predictions"[35]. The table shows that deep learning and adaboost are the two best algorithms in terms of accuracy.

Table 1. Accuracy performance of various AI prediction models

AI Model	***Prediction accuracy***
deep learning	77.78
adaboost(random forest)	74.07
decision tree	66.67
Naive Bayes	55.56

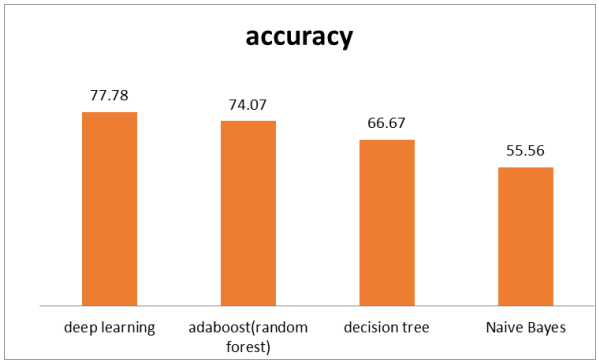

Fig. 3. Various AI techniques' accuracy performance of predicting students passing all exams based on the Students' Perceptions of AI in Education

Adaboost (shorts for Adaptive boost) is a machine learning technique that combines several weak learners to generate a powerful classifier. Random forest, on the other hand, is an ensemble approach that generates many decision trees and then combines them to get a final prediction [36]. Each tree is trained on a random portion of the data and a random subset of the features to reduce over fitting. Adaboost with random forest combines these two strategies by utilizing random forests as the Adaboost algorithm's weak learners. This can assist in increasing the classifier's accuracy and lessening the danger of over fitting. The basic idea is to train a sequence of random forest models, each one focused on the samples that the preceding models misclassified. It works by modifying the weights of each training example according to its correctness, such that the next weak learner focuses on the

instances that the previous ones misclassified [37]. The final prediction is then created by integrating all the models' predictions in the series.

4.3. AdaDeep Proposed Prediction Model

This study proposed Combining Adaboost with deep learning to form AdaDeep. AdaDeep may lead to a stronger prediction model that can handle imbalanced data with better prediction accuracy. As illustrated by the methodology in fig. 4, Adaboost with deep learning methodology splits the dataset into 70% for training and 30% for testing.

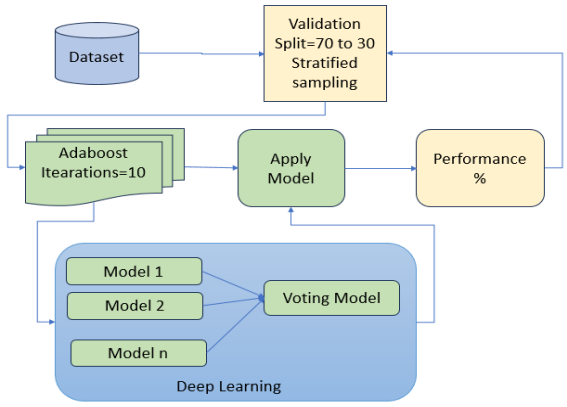

Fig. 4. AdaBoost with deep learning methodology

To validate the proposed model, the most popular performance metrics for each classification task that include precision, recall and F1 were used and measured. The following formulas describe how to calculate these performance metrics:

$$Precision = TP / (TP + FP) \quad (1)$$

$$Recall = TP / (TP + FN) \quad (2)$$

$$F1measuer = (2*Precision*Recall)/(precision+recall) \quad (3)$$

Recall and precision are combined into one metric called the F1 score. F1 utilized to assess how well our models make the trade-off between precision and recall. The accuracy and recall weighted average is called the F1 score which takes into account incorrect positives and false negatives.

Various prediction models were validated using F1, Precision, and Recall. Table 2 shows that Adaboost with deep learning has the best performance in terms of F1 measure when compared to other prediction models. In most cases, F1 score is more valuable than accuracy, particularly when dealing with an unequal class distribution. Fig. 5 shows that the deep learning improves the adaboost performance over the other two adaboost classifiers: random forest and decision trees.

AI Model	*accuracy*	*F1*	*recall*	*precision*
adaboost(deep learning)	81.48	74.85	73.57	76.19
adaboost(random forest)	74.07	42.52	50	37
adaboost (decision tree)	59.26	37.20	40	34.78

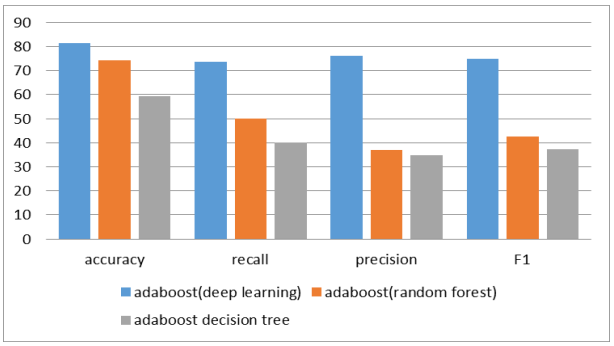

Fig. 5. Adadeep F1, Precision, recall and accuracy compared to traditional Adaboost classifiers

4.4. Adadeep: Results and Discussion

Table 3 displays, in descending order, the weight of the survey factors as by Rapidminer analytic tool for correlation. The table depicts how students feel about their anxiety that AI is dehumanizing, is responsible for job losses, and is leading to other job replacement (these worries received the least weight). Students nowadays are not terrified of AI since they have grown up in a society that is more and more dependent on technology. The absence of fear about AI among the present generation of student 5.0 can be a big benefit in their academic and professional endeavors. In fact, many young people are eager to explore the opportunities that AI will open for them in their studies and careers. Students may benefit from this lack of anxiety since they are more likely to be open to learning about AI and adapting it into their studies as a result. AI may give various benefits to students, such as individualized learning experiences, enhanced data analysis, and real-time feedback. By taking advantage of these, students can achieve greater academic achievement and acquire a competitive edge in their future employment. Additionally, students who are aware with AI and its applications may be better equipped to adapt to the changing employment market and take advantage of new possibilities as they arise.

Table 3. Questions listed in descending order by their weights based on prediction significance.

Question	*Weight*
Q6#6.Administration	1.0

Q2#4.Discussions	0.9402475430550583
Q5.Feelings	0.9141026518800522
Q8.Advantage_teaching	0.8957690649591121
Q4#1.AI_costly	0.8431756671904089
Q14.Major	0.8323885705083701
Q2#3.Social_media	0.8169739732732444
Q6#5.Marketing	0.8043445692249267
Q13.Year_of_study	0.7892675610857318
Q9.Advantage_learning	0.7691298206788635
Q4#3.Economic_growth	0.6659416141603972
Q11.Disadvantage_educational_process	0.6644534234876239
Q2#1.Internet	0.6313355992161499
Q16.GPA	0.5726426944127839
Q4#2.Economic_crisis	0.5321878197029921
Q1.AI_knowledge	0.4763509807629810 5
Q3#4.AI_rulling_society	0.3745187660518138
Q3#2.Job_replacement	0.3063320208941456 3
Q3#1.AI_dehumanization	0.1948004430934241 5
Q4#4.Job_loss	0.1599129657862575

Since generation 5.0 students are defined by the combination of technology and individualized learning, many aspects may affect student performance. For example, integrating AI into many academic courses can help students achieve better academic performance. As a result, a deep understanding of AI can lead to increased job opportunities due to its importance in many companies. Furthermore, it is important to remember that this correlation does not necessarily indicate cause and effect, and that other factors can also contribute to a student's good academic achievement. For example, the ability to access the modern resources and technology is one of the most important elements. Students who have access to the latest technology and first-class resources may have an advantage. In addition, the level of training and educational design is another element. Students can succeed more if teachers use effective teaching techniques that adapt to each student's learning preferences. Moreover, students 5.0 need to develop good interpersonal and communication skills so that their performance improves steadily in their ability to work within a team and collaborate. Finally, the importance of self-directed learning is increasing. Therefore, 5.0 students will perform better because they are motivated to create their own goals and take charge of their education.

Fig. 6 shows how the Random Forest Prediction Model generates small trees to highlight the many routes that might lead to test success based on certain rules. For instance, problem-solving skills, Advantages of AI-based learning, AI knowledge, discussions, and social media use as a source for AI appear to be significant determinants of students' academic achievement. The findings also supports to encourage the theory that digital competencies are critical for educators at universities to equip their own with the technical expertise they need to help students to articulate ideas, solve problems, and engage with AI-driven applications, and preparing students for employment in AI-driven circumstances [38].

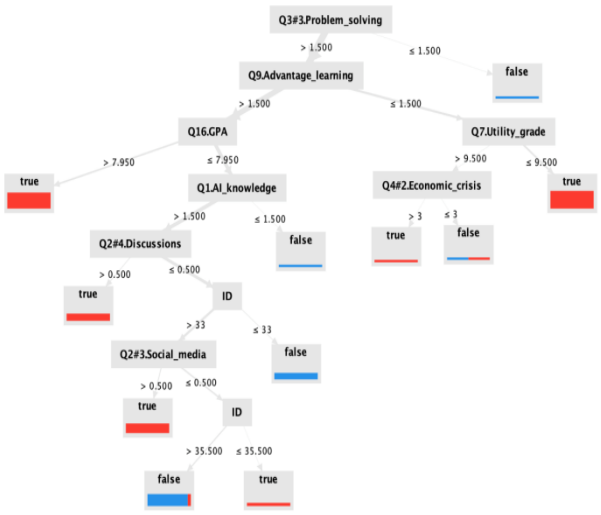

Fig. 6. Random forest for predicting academic performance

Student 5.0 should strengthen their human capability of critical thinking to beat the robots in the work environment. They are expected to be receptive to lifelong learning, creative, adaptable in a rapidly evolving labor market environment, and work towards job readiness. However, applying AI in academic contexts may have some challenges as shown in Table 4 that educational institutions must consider and address. Therefore,

instructors, students, and institutions must work together to provide solutions.

Table 4. Challenges face educational institutions in implementing AI

#	*Challenge*	*Proposed Solution*
1	Overwhelming amount of information	For the students to comprehend and assess the vast amount of information at their pace, teachers should help students to improve their critical thinking and evaluation skills.
2	Lack of engagement	Teachers may use a variety of instructional strategies, such as metaverse-based learning, interactive technologies, and group discussions to make learning more engaging and relevant.
3	Lack of personalized teaching	A unique learning experience can be created using machine learning algorithms that can analyse a range of indicators such as academic evaluations, engagement, and extracurricular activities to create comprehensive student profiles. This will enable machine learning to predict student performance, identify problems, and suggest early improvement measures, especially when identifying early warning indicators for troubled students.

5. Conclusion

Recent years have witnessed a significant change in education methodology, especially with the use of modern technology. Education is expected to continue to develop and adopt new tools and practices as technology advances. However, teachers and educational institutions must consider students' needs first and ensure that technology is used in a way that improves human interaction and individual learning in the classroom. Generation Z students require access to a wide range of digital materials and technologies that can enhance their educational experiences and help enhance their chances of success and academic excellence. This study investigates the use of AI and personalized learning platforms that are tailored to each student's abilities to meet their requirements. Hence, this study coins the term "Student 5.0" the focus of this study, and describes a new group of students who were born in the digital age and grew up and learned to use advanced technologies in their daily and educational tasks. This study concludes that student 5.0 behavior involves being critical thinker, adaptive to emerging technologies, creative in the digital world, and ready to cooperate with the AI-driven and robots-integrated jobs. Future work of this study could investigate the ethical issues of adopting Industry 5.0 in educational settings.

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