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AI and Machine Learning Techniques in the Development of Intelligent Tutoring System: A Review

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***Abstract*—An Intelligent Tutoring System (ITS) is critical in education because it provides one to one personalized teaching assistance to learners as they educate how to solve problems through guidance and prompt feedback. ITS is one application of Artificial Intelligence (AI) in education. It provides a smart learning environment for students without intervention from the teacher. ITS's primary goal is to support and help learners obtain domain-specific intellectual knowledge in a practical and productive manner through the use of different computing technologies. This paper presents a comprehensive survey for previous research on ITS that utilize various techniques of AI and Machine Learning (ML). It gives an overview of ITS, its architecture, and some existing ITS examples. In addition, it highlights and summarizes the current research efforts and obstacles to ITS using AI, as well as some future opportunities. This study shows the importance of AI and ML in ITS development. It is noticed that researchers focus more on Reinforcement Learning (RL), Artificial Neural Networks (ANN), clustering, Bayesian Network (BN) and Fuzzy Logic (FL) approaches.**

***Index Terms*—Artificial Intelligence, Machine Learning, Intelligent Tutoring System, ITS, Bayesian network, Reinforcement Learning, Artificial Neural Networks.**

I. Introduction

The technology of Artificial Intelligence has been integrated into the field of education since the 1960s. AI techniques have been involved at schools and colleges by developing Intelligent Tutoring Systems that support students' learning environment. Recent advancements in intelligent tutoring have explicitly demonstrated that tutoring system users may make quick improvements and significantly enhance their achievement in specific subjects and abilities.

This paper presents some related work in ITS and AI and mainly discusses the most critical issues related to improving education using Machine Learning (ML). It gives an overview of ITS, its architecture, and some developed ITS examples. In addition, it highlights and summarizes the current research efforts and obstacles to ITS using AI, as well as some future opportunities.

This study's primary contribution is a review of several machine learning approaches in intelligent tutoring system in the educational sector. The rest of the paper is organized as follows: Section 1 represents an overview of the intelligent tutoring system, as well as its history, its components, and the relationship between ITS and artificial intelligence. Section 2 shows the related work in ITS using machine learning. The main challenges and limitations behind the application of Machine Learning in the education sector are represented in Section 3. Next, Section 4 illustrates some future opportunities in ITS, especially on the work needed for improving the use of machine learning models in education. Finally, Section 5 contains final thoughts.

II. An Overview of Intelligent Tutoring systems

An Intelligent Tutoring System (ITS) is important in education because it gives intelligent, one-on-one, computer-based support to educators to handle problems by providing instruction and immediate feedback. ITS can be one application of Artificial Intelligence (AI) in education. It provides a smart learning environment for students without intervention from the teacher. ITS's primary goal is to support and help learners obtain domain-specific intellectual knowledge in a practical and productive manner through the use of different computing. ITS has been developed in different subjects. For example, mathematics, science, linguistics, physics, and the medical sector. The idea of ITS is to obtain knowledge about the learners, then provide instructions, feedback, and hints to each student individually according to his responses.

The development of Intelligent Computer-Assisted Learning (ICAI) in the 1960s and 1970s marked the beginning of ITS. The phrase "Intelligent Tutoring Systems" was first introduced in 1982. Six years later, in 1988, the idea was consolidated widely in the first ITS conference [1]. Since then, there has been an improvement in research and studies relating to development of such system.

The traditional architecture of ITS composed of three main components: student model, tutor model, and domain model. Later, a fourth component was added which is called user interface, which communicates between the learner and the system as shown in Fig 1. More details about each component as follows:

1. A student or learner model that contains the states and characteristics of each learner. For instance, what student knows, done and how learns. The main goal of the learner model is to ensure that the system has all the necessary information about each learner as it can respond properly.

2. A tutor or pedagogical model consists of the teaching strategies that will most effectively assist the learner's progress. For example, how to teach, the steps of learning, questions a learner might ask. It is responsible for managing the reaction of the student with the system.

3. A domain or Knowledge or expert model contains topics and all materials that students intended to learn. It represents the content, the skills, and procedures that students are required to learn. The model also includes information about student mistakes or misunderstandings so that ITS can gives qualified assistance.

4. A user interface is a form of communication between users and a machine. It can be graphics communications, emotional and social connections, natural language communication, and component interface.

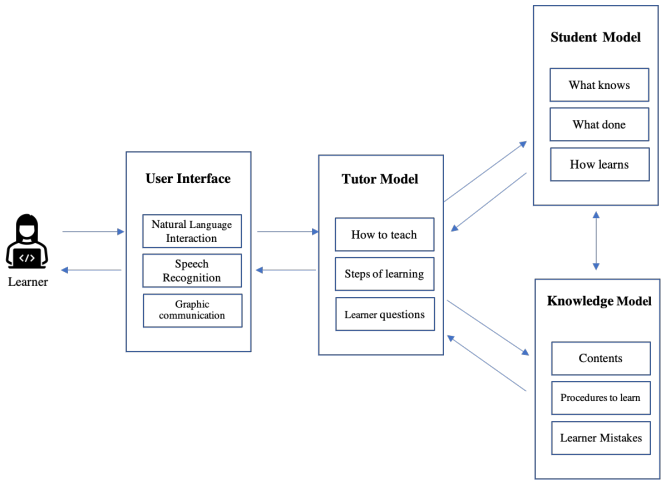

Fig. 1. The architecture of ITS.

A. Intelligent Tutoring Systems and Machine Learning

The integration of artificial intelligence technology with education leads in a wide range of intelligent educational software solutions for a wide range of activities and topics. Machine learning techniques may be used to create a new generation of ITS and intelligent tools. Machine learning provides a diverse set of methodologies and ideas for reasoning, inference, and learning. It can adapt ITS lesson to the students according to their level of education, knowledge, abilities, limitations. It might also be able to engage in natural language conversation. Additionally, the automatic creation of workouts and assessments is a critical component of ITS. Some of AI and machine learning techniques used for building ITS are:

- Reinforcement Learning (RL) is a machine learning technique that helps an agent to learn in an immersive environment by trial and error based on input from its own behaviors and experiences [2]. After each act, the agent examines a current circumstance called a state, takes action, and receives feedback from the environment called reward. RL can be used in the pedagogical model in ITS so the system can automatically determine the best teaching policy for learners [3]. At first, a random student state is considered, and a reward for the RL agent is created. The RL agent acts in accordance with the state and reward. The RL agent's action is to choose a relevant question or suggestion for the learner. Each question has a specific goal in mind. The learner is examined with this question. Following that, a reward for the RL is calculated according on the student's response. The learner is then taught a similar question, and his or her state is assessed based on the training output [2]. Furthermore, RL may also be utilized in student modeling by changing the state variable for the RL agent [3][4].
- Artificial Neural Networks (ANNs) [5] are computational algorithms based on the human brain's idea, consisting of millions of neurons. Each neuron is connected with other ones in a particular structure. The concept of ANNs is to process information as the human brain does. The structure of neural networks is composed of three layers: input, hidden, and output. Each layer has a specific purpose. The use of ANN in ITS is highly effective mainly to its ability to connect the features of the learner to the topics and its capacity to update the information on the screen and the educators' record while using the system. The pedagogical model may be created using the ANN mechanism, which is made up of processing units called neurons that are arranged into groups that represent relevant concepts. For such a purpose, the ITS will use the learner and Knowledge modules to give information concerning the student performance and the content utilized through the learning exercise [6].
- Clustering [7] is an unsupervised data analysis technique to find pattern in an input data and divide them into several groups that have similar characteristics. Most clustering techniques can be applied to student model in ITS by dividing student into groups based on their learning behavior data and performance [8].
- Bayesian Network (BN) (also referred to as a decision network) is a probabilistic graphical model that describes a set of variables and their conditional relationships. It's ideal for making decisions even if the information is incomplete or uncertain. BN may be used in ITS student modeling to suggest teaching strategies by integrating the content structure with the student profile and learning style [9]. The procedure is carried out by defining a set of variables related to the user's learning style and others related to the status of knowledge [10]. The Bayesian network is being used to analyze the student's current state of knowledge so that the system would modify and provide updated knowledge to improve student achievement as outcomes during the learning process [11].
- Fuzzy Logic (FL) [12] is a decision-making approach that

aids in dealing with uncertainty. It works as a degree of input possibilities to produce a definite output. Unlike boolean logic, which is limited to YES or NO, it includes all intermediate possibilities in between. FL is widely used to develop student model in ITS. The primary purpose is to measure and evaluate a learner's educational performance. It applies the idea of a fuzzy set theory that maps an input to a fuzzy output by identifying and updating learners' knowledge level [13].

B. Examples of ITS

There are a lot of successful ITS applications using artificial intelligence and machine learning techniques in education. This section highlights some examples of these intelligent systems. Most of the examples presented are for university-level students and primarily for learning computer science, mathematics and physics.

LISPITS [14] is an Intelligent Tutoring System for teaching the LISP programming language. The main features of LISPITS are to optimize the time spent in doing coding exercises and provides feedback to students while they were performing the exercise. Another application that simulates human tutors and converses with students in natural language is AutoTutor [15][16]. AutoTutor can answer the student's questions, summarize topics, and identify and correct misconceptions and erroneous ideas for students. Moreover, ActiveMath [16] and SmartTutor [17] developed for learning mathematics. ActiveMath provides adaptive content, presentation features, and appearance to learners, while SmartTutor provides examples to solve problems and proposes relevant test papers from past examinations as well as the next most efficient activity for the student to complete.

A GIFT (Generalized Intelligent Framework for Tutoring) [18] was created to provide tools and methods for making ITS more accessible and simpler to install Computer-Based Tutoring Systems (CBTS). GIFT enables researchers to test and analyze CBTS materials, instruments, and methods experimentally. Abu Naser proposed ITSB [19], an interesting tool for designing smart tutoring systems that was planned and built using Delphi Embarcadero. It has two system, one for teacher and the other one for student. More examples of ITS are presented in Table 1.

III. Literature Review

All of an ITS's modules have been researched from the standpoint of artificial intelligence. The objective is to reduce the amount of knowledge engineering done at the development and to make the system more adaptive to the learner. Applied artificial intelligence, specifically Machine Learning (ML) techniques to different ITS modules, has been widely studied. Examples of ML techniques used in ITS models are Reinforcement Learning, Artificial Neural Network, Fuzzy logic, Bayesian Network and clustering. More details on each technique in the following sections and in Table 2.

A. ITS and Reinforcement Learning

Several studies used reinforcement learning for a different purpose in a learning environment. Some of them applied reinforcement learning to compute effective pedagogical strategies for adaptive learning. For instance, Rafferty et al. [25] proposed strategies for determining optimal teaching behavior considering the vast state and action spaces that exist in teaching. Furthermore, Chi. et al. [26] induced two collections of pedagogical policies from pre-existing human activity evidence, the first for improving tutorial decisions that lead to learning and the second for improving those that contribute little or nothing to learning.

In 2011, Malpani. et al. [27] presented a personalized intelligent tutoring system that learns teaching rules and provides instructions to students based on their needs. They found that the more a student interacts with the system, the more improvement is observed in his learning. Another study by Matsuda. et al. [28] proposed a method called RAFINE (Reinforcement learning Application for INcremental courseware Engineering) which iteratively detects the least effective material and gives it to the courseware developers to improve it. Moreover, Moore. et al. [35] used reinforcement learning of model-based methods for generating hints by following a greedy policy under uncertainty in an adversarial game called Connect Four.

B. ITS and Artificial Neural Networks

There have been numerous studies that applied artificial neural networks to ITS architecture to improve the teaching process. For example, Venkatesh et.al [29] proposed a framework incorporating a knowledge base student model with pedagogical perspectives. Their thesis was used to apply ITS through the use of supervised learning neural networks to assist students in effectively constructing skills. A study by Abu Naser [30] presented a technique in the field of learner models that apply ANN and expert systems to gain skills for the learner model (LP-ITS). Moreover, Bernard et.al [31] conducted a related research to identify students learning styles. The evaluation was conducted on 75 students, and it was discovered that using this method improved the quality of learning and provided more reliable instruction to students, resulting in higher levels of learning success and less time needed to learn [31]. In addition, Carvalho et al. [36] used a neural network to strengthen the teacher's rules and identify a learning approach that is more flexible and attentive to the student's profile.

C. ITS and Clustering

On the other hand, several studies have been conducted on data-driven student cluster based on online learning behavior. In [37], they proposed strategies for providing feedback that are automatically grouped using machine learning approaches applied to groups of student results. Another study [38] employed the k-means and fuzzy c-means algorithms to cluster the data available from an ITS, and the multidimensional data analysis findings were displayed to offer the instructor

TABLE I
SOME EXAMPLES OF ITS

Name	Purpose	Feature/facility	Subject	Grade	Studies
LISPITS	Learn computer language LISP	• Identify errors and give positive guidance to students as they complete the exercise. • Reduce the amount of time spent on coding exercises.	Computer science	University	[14]
AutoTutor	Mimics human tutors and encourages learnersin natural language dialogues.	• Provides guidance to the student and encourages him to provide more information. • Asks the learner to fill in the blanks and gives hints. • Asserts to fill in incomplete data, detects and corrects mistakes and erroneous concepts. • Responds to questions from students and summarizes subjects.	Computer literacy and physics	University	[15] [16]
ActiveMath	Learn mathematics	• offers adaptive material, presentation functionality, and appearance to learners. • Creating high-quality hyper-media content takes time and money; the material should be reusable in multiple settings.	Mathematics	-	[20]
SmartTutor	developed for tutoring of mathematics.	• Explain the topic's fundamental knowledge • Provide problem-solving examples • Suggest relevant test papers from past examinations • Recommend the next most efficient activity for the learner to perform.	Mathematics	University	[17]
ITSPOKE	speech-enabled version of the Why2-Atlas	• Generate an empirically based knowledge of the consequences of utilizing spoken dialogue tutoring rather than text-based conversation tutoring. • The system engages the learner in a spoken discussion to clarify misunderstandings and elicit more thorough explanations.	Physics	university	[21]
GIFT	Build Framework for ITS	• To include tools and methods to make the development of Computer-Based Tutoring Systems more inexpensive and easier (CBTS) • To incorporate chosen tutoring concepts and techniques into CBTS. • To allow CBTS researchers to test and evaluate CBTS experimentally (components, tools, and methods)	-	-	[18]
KERMIT	Use the Entity-Relationship data model to practice conceptual database design.	• To model domain knowledge and produce student models, Constraint-Based Modeling is used.	Computer science	university	[22]
ITSB	Intelligent teaching system creation tool	• Created and built with Delphi Embarcadero XE8 • It has two system, one for teacher and second one for student	Computer science	university	[19] [23]
IMITS	help undergraduate electrical engineering students with their first circuits core subjects	• The tutor examines the student's actions in learning and comprehending important information. • Analyzes any issues that the student may be experiencing; and tutors the student as needed.	Electrical engineering	University	[24]

with pedagogically reliable feedback. Moreover, [39] utilized a clustering technique on data collected from 106 college students studying about the circulatory system to encourage self-regulated learning with MetaTutor. An ITS prototype was created to teach multi-column basic mathematics to children aged 5 to 10 years [32]. Their system [32] was designed to collect incorrect user input and analyze it using an experimental clustering method to identify common misconceptions. Another study [8] clustered students based on their online learning behavior in order to give more adaptable.

D. ITS and Bayesian networks

Several studies applying Bayesian Networks in building ITS. A study in 2001 by Gamboa and Fred [10], proposed a model for ITS using BN. A learner model, a knowledge base, an adaptation module, a pedagogical module, and a presentation module comprise the model's architecture. In 2013, Santhi et.al [9] reviewed different intelligent tutoring systems called cognitive tutors using BN, and they presented how it could be used for effective decision making. Furthermore, in 2018 Alday [11], developed a model for ITS to learn programming language using the concept of BN.

E. ITS and Fuzzy Logic

A new method proposed by Crockett et al. in 2017 [12] used a fuzzy classification tree to predict and be adapted to a student's learning style throughout the tutoring conversation. This Conversational Intelligent Tutoring Device (CITS) aims to simulate a human teacher to increase the performance of the teaching process by providing a natural language lesson and modifying content to an individual's learning style. Early findings indicate that the model significantly improved the prediction accuracy of the CITS and found some excellent relations between these variables.

F. Hybrid ITSs

An interesting study [38] proposed an approach based on integrating an artificial neural network with a reinforcement learning algorithm. These techniques help to provide learners

TABLE II
SOME RESEARCH ON ITS USING MACHINE LEARNING TECHNIQUES

AI Techniques	Ref. No	Author	Year	System	Contributions	Result
Reinforcement learning (RL)	[25]	Rafferty et al.	2016	POMDPs	Finding optimal teaching actions	Can accelerate learning relative to baseline performance
	[26]	Chi. et al.	2011	-	Using RL, create two sets of educational policies based on pre-existing human activity evidence.	Assist students in learning even as tutors use ineffective pedagogical lesson techniques
	[27]	Malpani. et al.	2011	-	(RL) techniques to implicitly train the ITS with an adaptive student model that estimates the student's learning pattern	More improvement is observed in learning.
	[28]	Matsuda. et al.	2019	RAFINE	Recognize inappropriate instructional content on current online courseware.	Gives evidence-based recommendations to online courseware developers for improving courseware content
Artificial Neural Network (ANN)	[29]	Venkatesh et.al	2010	ITDS	A framework incorporating a knowledge base student model with pedagogical perspectives	Reduces development times and the technical expertise needed of employees participating in the development of an auto-regulated intelligent tutoring conversation system
	[30]	Abu Naser	2012	LP-ITS	Determine the learners' academic achievement degree	The accuracy of forecasting learner achievement is extremely good.
	[31]	Bernard et.al	2015	LSID-ANN	Identify students learning styles.	Enhance student performance and shorten learning time
Clustering	[32]	Zakrzewska	2008	-	Gathering erroneous user input and analyzing it to identify common misunderstandings.	An ITS prototype for educating multi-column basic arithmetic to schoolchildren aged 5 to 10.
	[8]	Šarić-Grgić et.al	2020	-	Students were clustered based on their online learning habits.	More adaptable scaffolding can be provided by an intelligent tutoring system or a human tutor.
Bayesian Networks	[9]	Santhi et.al	2013	-	Review if ITS using Bayesian Networks and how it can be used for efficient decision making.	Assist learners in making progress in the learning process.
	[11]	B. Alday	2018	-	Developed a model of ITS using BN to learn programming language	Improve student performance when using such system Help instructors to evaluate students
	[10]	H. Gamboa et.al	2002	-	Proposed ITS using Bayesian Networks	Implement an architecture of ITS to use it as e-learning tool
Fuzzy Logic	[12]	Crockett et.al	2017	Oscar CITS	Create a fuzzy prediction model based on the variables gathered during natural language conversation.	Improved the Oscar CITS's prediction accuracy
Hybrid BN + Fuzzy Logic	[13]	Eryılmaz et.al	2020	(FB-ITS)	To assist students in learning environments, a student model based on Bayesian networks and fuzzy logic is being developed.	Higher academic performance, quickness in completing final exams, and academic success.
ANN with RL	[33]	Fenza et.al	2017	-	Tutoring rules are taught by first analyzing the behaviors of human tutors and then monitoring how each student interacts inside a learning environment at various stages of the learning process at run-time.	Combining human tutors' knowledge with adaptation done by the same tutors while monitoring and evaluating student behavior
ANN + Fuzzy	[34]	Cabada et.al	2014	-	Determine on the following exercise to be completed by the learner, allowing for individual learning.	Assist kids in the 2^{nd} grade of primary school in improving their math skills.

with an intelligent assistant who can choose the next challenge complexity level for them. Moreover, a study by Cabada et.al [34] used ITS for mathematics learning for the second grade by using a feed-forward neural network to identify the student's affective state and a fuzzy expert system that combines cognitive student data with affective data to determine the student's emotional state. This method allows the system to determine the difficulty of the following exercise, which would be solved by the student. Recently in 2020, an experimental study by Eryilmaz et.al [13] to build ITS using combination of BN and fuzzy logic and called FB-ITS to enhance student learning has been presented. The research included 120 university level students. The study revealed that students who experimented with FB-ITS performed better academically on overall than students who studied with other methods.

IV. Challenges in the Area of ITS

The innovations caused by Machine Learning and Intelligent Tutoring Systems in education are impressive. It supports the learning process and provides learners with a high-quality education. Although these technologies are relatively new, there are some limitations and challenges that require to consider. This section represents the main obstacles behind the application of Machine Learning for students that need to resolve.

One of the most common challenges in developing ITS is assessing and representing the student's knowledge state and specific needs in the problem domain based on uncertain data. As a result, dealing with the student model's uncertainty is challenging. Several Artificial Intelligence techniques, such as rule-based systems, Fuzzy logic, Neural networks, and Bayesian networks, have been designed for uncertainty reasoning. However, these machine learning technologies need certain developments to deal with this problem successfully [40].

The concern of data privacy remains a significant challenge in the digitized world. The non-protected data which is collected from thousands of students and teachers by Artificial Intelligence systems need to be secure. As a result, regardless of how useful and exciting this technology is, we must utilize it with prudence in order to protect our privacy and make learning transparent. This becomes even more challenging in the context of young students who cannot yet permit their data. More investigation should be done on this issue [40].

Teaching in classrooms is a complex process, and even more, it needs a human element that cannot replace by systems. A study by Steigler and Hibert [41] summarizes the best ideas for improving education in the classroom. They explain how the teaching methods should be in schools, and intelligent systems can help in the education process, but they cannot replace humans as it is a cultural process. Moreover, even the most advanced computer program provides vital knowledge and a high learning level to learners, but instructors can understand each student and ensure that each one gets the instructions and feedback required to progress. On the other hand, teaching about molarity and bias is very important in education and exists in the human world, which these systems cannot understand.

In terms of collecting data for intelligent systems, the process is challenging, specifically if we need to implement a real case scenario. When data are collected, it needs to structure, store, and validate the quantity if suitable for the use case. In addition, the training data used must be representative so the used model can predict results accurately. Furthermore, data quality is essential; thus, data need to preprocessing to filter the missing values and arrange them according to the models. Also, good feature selection and extraction to train the model are relevant to the success of a machine learning application [42].

One of the biggest challenges is the deployment of machine learning models. The lack of skills and practices for ML engineering. Also, low understanding of models, bringing applications to production a problematic issue.

Teachers should decide when and how to use these intelligent technologies in classrooms. So, all ITS must be designed and developed to support educators' needs and make teaching methods easy for students. On the other hand, a critical aspect of improving pedagogy is training teachers to use these systems in classrooms and have a clear understanding and management skills of how these systems can help integrate with the education [43].

In 2015, a study by Nye [44], summaries the main obstacles that affected developing AI technology in the education sector. For example, the lack of ICT hardware, unreliable electrical and internet infrastructure, cost of data, and lack of student's ICT basic skills. All these factors may significantly impact evolving ITS technology at schools.

Developing ITS using machine learning technology could be a high cost, precisely capturing data in some countries. While various governments can provide massive amounts of education data to inform decision-making, numerous countries are still inadequate to do so [45]. In addition, schools with limited funding may find it hard to implement this software, including the maintenance cost. However, a study by Chi and Vanlehn [46] tried to reduce the cost of developing ITS by produced an ITS approach by reusing the components of an existing ITS.

V. Future Opportunities

In the previous sections, we reviewed some recent challenges to use ITS in education. In this section, we describe potential future research prospects in ITS, focusing on the work required to improve the usage of machine learning models in the teaching process. The following are some open research issues:

- Smartphone ITS
  A survey of current ITS and educational technology approaches by Nye [44], illustrates the main future issues that exist and need new research projects. An example is using smartphone ITS in learning. The adoption of smartphones differs widely among countries. In developed countries, mobile broadband penetration is still relatively

poor (21%)[44]. As a result, future research might be done to investigate how will current ITS and other smart technology can be optimized to work with smartphone interfaces and hardware, and it is possible to automate certain aspects of localization. For the developing world, a greater emphasis on ITS and other education technologies is needed.

- Teaching Transformation
  In general, the technology of ITS could transform teaching in a better way but, of course, aren't going to replace human teachers any time soon. AI changes the way of teaching and changes the skills people need to be employed. More training for both teachers and students to prepare them to use these technologies professionally to take the benefits from them as expected.
- Automatic Grading System
  Developing an auto-grading system using machine learning at schools or colleges has numerous advantages for both teachers and students. Around 60,000 schools in China [47] are using a paper-grading system to automatically grade students' essays. The advantage of this paper-grading approach is that it can effectively examine the structure and organization of the writings. Furthermore, that helps educators to focus on teaching students rather than the effort and time spend to grade them manually.
- Personalization in the School Environment
  Incredible achievements in developing a more unique approach to children in the school have already been accomplished with the help of machine learning. Brain Power developed a Google Glass-based system that allows students with learning disabilities to stay centered in class. They developed technology that uses Machine Learning to determine student engagement levels and alert teachers when they require additional attention. Brain Power is currently conducting further studies on developing their application to introduce new functionalities to enhance learning[47]
- ITS for Distance learning
  Some research opportunities that need to be more developed and investigated are the formative automation assessment to provide students with more personalized feedback by matching data provided by students to assessment requirements specified by the teacher, which allows the generation of interactive reports and graphs [48]. Moreover, automated rule generation to resolve learners' queries and assist other students from the same course. This method often relieves the instructor to add rules manually into the system. Also, more research should be done to identify why students make a mistake so that they can be avoided rather than only corrected them.
- Taking Notes from Speech to Text
  Convert speech to text by using machine learning is overgrowing in the education sector. This technology was used successfully in note-taking for a meeting. Automatic note-taking is possible in schools and classrooms. For students, it could mean spending more time listening to a lecture rather than thinking about which notes are the most appropriate. However, it can be a simple way for teachers to arrange lesson summarization at the end of a class or catch conversation caused by students' questions. Recently it's used for kids learning by trained their speech-to-text systems to take notes, do exams, and practice terminology. Speech-to-text systems perform well for massive datasets that cater to a wide range of potential vocal inputs [49].
- Automatic conversational systems
  Automatic conversational systems are one of the best technologies used machine learning in education, and more attention moves to it. These virtual assistants help students and teachers by making information more accessible. It simulates human and human interaction. Colleges can use it to address student inquiries about work deadlines, class places, and test dates. Not only for students to get prompt responses, but college employees are often relieved of answering redundant questions. Cognii Virtual Learning Assistant is an example of a virtual assistant that is specifically developed and designed for educational conversations [49].

VI. Conclusion

The field of education is expanding, and with advanced technologies being developed, it is expected to change within the following years. Machine learning for automated learning tasks is an active research area and needs more development in the education sector. This paper presented a unique survey work related to the use of AI and ML in ITS. It includes various techniques, approaches and mechanisms used in several ITS. The study gives an outline of ITS, its history, and some instances of these systems in various topics. It has been noticed that researchers mostly use individual techniques such as RL, ANN, BN and fuzzy logic, or also a combination of them to achieve good performance. One of the future directions is to exploit this intensive survey to utilize the functions and power of each machine learning approaches to come up with a significant and efficient ITS based on a hybrid machine learning approach.

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