



Smart Classrooms, Smarter Learning Reviewing Iot and Ai in Educational Environments

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Abstract

The idea of "smart classrooms" emerged from the dramatic shift in educational settings brought about by the fast development of AI and the Internet of Things (IoT). Smart classrooms track student activity, behavior in the classroom, and environmental factors in real time through the use of interconnected gadgets, sensors, and intelligent systems. Adaptive and personalized learning routes tailored to individual student needs are made possible when this data is examined using AI and machine learning techniques. Efficiency and effectiveness in learning are both improved by smart classrooms' support for dynamic material delivery, immersive digital learning experiences, and context-aware teaching practices. The optimization of classroom resources, safety, and management are all enhanced by the constant monitoring and automation made possible by IoT-enabled equipment. This study delves into the current literature on the topic of instructional AI and IoT integration, including studies, pilot programs, and theoretical frameworks. Significant advancements in intelligent decision-making for teachers, intelligent student engagement, and real-time learning customisation have been highlighted by the results. In addition to outlining potential future possibilities for inclusive and scalable smart learning environments, the research delves into concerns like data privacy and security as well as infrastructure needs. All things considered, the Internet of Things (IoT) and artificial intelligence (AI) provide a game-changing strategy for education, leading to more effective, student-centered learning environments and smarter classrooms.

Keywords: Smart classrooms, learning IOT, AI, educational, environments

1. Introduction

The area of education has been continuously evolving due to new technological developments and improved ways of instruction and student learning. Modern classrooms often make use of many types of information and communication technology, including tablets, interactive whiteboards, robotics, and programmable boards. These technological advancements augment more traditional forms of education. Elementary and secondary school curriculum now use online learning tools, which have become even more important due to the COVID-19 pandemic. Students may now follow entirely personalized learning paths in online learning environments, and teachers can choose from a wide variety of resources to create engaging and effective lesson plans. (Qazi et al. 2024) published the following. Collecting and analyzing data in real-time is enhancing various scenarios, such as smart cities and ambient-assisted living environments. There is some speculation that schools and classrooms can benefit from integrating data collected through IoT devices and evaluating it using AI and machine learning. The smart classroom utilizes digitized, contextualized, and adaptive technology and software to improve and speed up learning, among other benefits (Alam et al. 2021). In these contexts, technology gathers and processes data from students, teachers, and the surrounding environment to improve the standard of teaching and learning, with the end objective of making decisions easier.

1.1 A attitude for Developing an IoT-Enabled Smart Classroom

The potential of this sector is nearly limitless, having won in areas as varied as medical, engineering, computer science, space and technology, autos, and many more. Using technologies based on the Internet of Things (IoT), the major objective is to automate classrooms. By detecting when humans are in the vicinity, our study presents a way for regulating and managing electrical equipment such as lights and fans. With the use of a classroom camera, it is possible to monitor the whereabouts of each student and their individual seats. This classroom is divided into two halves. Whenever they sense the presence of a human in a certain area, the light and fan will activate. One possible goal of this article is to provide a blueprint for a smart classroom that automates electrical equipment with an eye on reducing energy use..(Cauli et al. 2021)

1.2 The Implication of IoT in Revolutionizing Conventional Teaching and Learning Approaches

The Internet of Things (IoT) has the potential to significantly alter current approaches to education. One of the many possible educational uses for the Internet of Things is the real-time collection and analysis of data on student behavior and performance. According to Agbo et al. (2021), this data-driven method allows teachers to monitor their students' development and modify their teachings appropriately. Teachers will be able to identify which

students are having difficulty in specific courses and work with them to improve by analyzing data collected from the Internet of Things.

Personalized and adaptable learning environments are also within reach, thanks to the Internet of Things. Hole and Mason (2018) state that children can have access to individualized learning materials through the use of IoT devices and platforms. Because they are more likely to take an active role in their own education, students' motivation and engagement are both increased by this individualized approach to teaching. Additionally, the IoT facilitates group communication and education. Internet of Things (IoT) platforms and devices facilitate collaboration among students, instructors, and parents/guardians (Wang et al., 2020). Through the use of Internet of Things (IoT) technology, students are able to work together on assigned tasks, exchange resources, and complete assignments. In this group project, students learn to work together, develop their interpersonal skills, and hone their communication abilities.

1.3 Internet of Things Platforms, Devices, and Technologies in Educational Environments

In order for schools to make better use of the Internet of Things (IoT), IoT platforms are crucial. These platforms allow individuals to connect and manage devices that are part of the Internet of Things (IoT), gather and analyze data, and communicate and engage with other people in the IoT ecosystem. (Liu and colleagues, 2021). One use of IoT platforms in education is the approach taken by the IoT Technology Department to integrate IoT technology into an intelligent decision-support education platform. An application service layer that interacts with the education resources layer enables users, including teachers and students, to request services on this platform. "(Li et al. 2023)" claim The program analyzes course materials and generates unique study regimens using data clustering methods. The wisdom education platform is another IoT-based educational platform; it employs state-of-the-art classroom design and IoT technologies. This platform allows for the design and execution of many architectural layers that connect to standard network infrastructure through an Internet of Things gateway. Improving multimedia teaching tools and creating a better learning environment are the main goals of the platform.

1.4 IoT Applications in education and knowledge

Data analytics driven by the Internet of Things are essential for flexible and personalized learning environments. Online sensors and gadgets can provide instructors with real-time data that can help them understand their students' learning preferences, methods, and progress. It is possible that we may use this information to design individualized study plans and interventions for each student. For example, analytics derived from the Internet of Things (IoT) might monitor pupils' development and pinpoint areas of weakness. A study conducted by (Wei et al., 2022) Instructional decisions are informed by trends and patterns identified via data analysis of student participation, performance, and behavior. This data-driven method allows teachers to personalize their teachings for each student, which might lead to improved academic achievement. The real-time customization of educational resources and activities according to each student's requirements and progress is made feasible through the application of IoT data analytics, enabling adaptive learning. Adaptive learning systems customize students' educational experiences by continuously tracking and analyzing data on their performance and engagement. These systems then provide students with individualized suggestions, feedback, and materials. (Pabba et al. 2021)

1.5 Impact of AI on the Field of Education and Its Possible Use in Tailored Curriculum Development

Research into artificial intelligence (AI) is expanding at a rapid pace, with the ultimate goal of giving machines human-level intelligence. These robots have a wide range of potential uses, including in healthcare diagnostics, autonomous transportation, and classroom instruction. One sector feeling the effects of the AI revolution is the educational sector. Benefits to both students and educators are increasing as a result of technological advancements. (Esteveza et al., 2021) A revolutionary shift is occurring in the field of education due to the impact that artificial intelligence is having on student learning and engagement with course content. Students' engagement, individual learning plans, and final grades could all benefit from the use of AI in the classroom. Personalization of courses based on student strengths, limitations, and learning styles is a potential outcome of adaptive learning systems driven by artificial intelligence (AI). By analyzing data on student performance and adjusting the difficulty level of instructional content using machine learning algorithms, the systems provide real-time feedback and development suggestions. Students are able to succeed academically and make up for lost time when they learn at their own speed. Thanks to AI, we were able to implement a student-centered learning model. According to Xiaoling et al. (2021)

Utilizing apps and technology driven by artificial intelligence has the potential to radically alter the ways in which schools do assessment, evaluation, and testing. Teachers may gain useful information into their students' performance, learning objectives, and teaching effectiveness with the aid of these tools.

Evaluation systems driven by artificial intelligence may analyze students' assignment responses and deliver them personalized feedback, helping them to gain insight into their strengths and areas for improvement. Another use of AI in education is smart teaching systems (ITS), which pair students with virtual assistants or chatbots powered by AI to tackle difficult assignments in real-time. Integrating ITS with more conventional forms of instruction helps pique students' interest and facilitate their grasp of difficult ideas. (Li et al., 2016) Thanks to natural language processing (NLP), which allows robots to understand human speech, AI-enabled chatbots can speak with students in a natural and smooth way. In addition, with the use of natural language processing, AI-driven grading systems can accurately evaluate student replies, enabling teachers to obtain feedback quickly and with no effort. In the realm of education, artificial intelligence technologies such as Bing and ChatGPT are referred to as "objects people can think with" (Vasconcelos & dos Santos, 2023). This is especially true when trying to help kids improve their

critical and reflective thinking skills, while also fostering their creativity, problem-solving talents, and ability to grasp complex ideas. (Kazemi et al. 2014);

Another area where AI is creating waves in the field of education is predictive analytics. We can possibly identify struggling kids and intervene before they fall farther behind by using predictive analytics to go through massive amounts of student performance data. This method may help schools save money while also improving student outcomes, reallocating resources more effectively, and adjusting allocation priorities. Another use of AI in the classroom is the facilitation of game-based learning. A more attractive, collaborative, and engaging future for individualized learning may be possible with the help of AI-driven games. "Soft skills" like problem-solving and critical thinking are encouraged, and students' grasp of more abstract ideas in math and physics might be improved by playing these games.

Students are able to monitor their progress and pinpoint problem areas with the use of AI-driven evaluation tools that provide them quick feedback. Teachers might use these materials to gauge their students' current level of understanding and then modify their lectures appropriately. Another possible advantage of AI-powered feedback systems for students is the development of abilities for self-assessment. This is because these systems can promote metacognition and self-directed learning. By tailoring instruction to each student's specific requirements, personalized learning fosters a welcoming and fruitful classroom setting. Future advancements in AI may substantially improve individualized education through the use of data analytics, adaptive methods, and smart tutoring systems. As a result, this has the potential to provide each student with an exceptional educational experience. (Williamson et al. 2023)

Before AI can reach its full potential in the classroom, there are several obstacles that must be overcome. For example, data security must be considered paramount while handling students' personal information. Additionally, in order to ensure that all students are treated fairly, biases in AI systems must be eliminated. However, artificial intelligence has a plethora of possibilities for education, such as more accessibility, better student outcomes, and classroom efficiency. Educators should strive to assist students in developing ethically good AI practices, according to AI supporters, and AI will remain an integral part of society for the near future. One area where AI might significantly change the face of education is in the development of personalized lesson plans that take into consideration the strengths and weaknesses of each student. (Yanev and colleagues in 2024) By implementing AI-powered adaptive learning systems, intelligent tutoring systems, natural language processing (NLP), predictive analytics, game-based learning, assessment, and feedback tools, educational institutions have the potential to enhance student outcomes, faculty efficiency, and the promotion of lifelong learning. An essential part of the IoT is artificial intelligence (AI). There is a difference between artificial intelligence and the Internet of Things, despite the fact that both are critical to creating smart systems and gadgets that can communicate in the real world. Among the numerous applications of AI in the IoT, here are a few:

- Sensors, cameras, and other Internet of Things (IoT) devices provide massive quantities of data, which AI algorithms sift through.
- It may figure out how to manage the heating, lighting, and security systems depending on the data that's been studied.
- It's possible that AI may make human engagement in IoT systems less necessary by automating jobs and procedures.
- Predictive care driven by AI has the potential to reduce downtime and boost productivity by seeing problems before they escalate.
- Based on their actions, it may suggest products or services to users, creating a personalized experience.

1.6 Challenges in IoT Integration

- **Technical Issues and Infrastructure:** The infrastructure is not stable and solid, which is a big concern.
- This includes things like sluggish Wi-Fi, not enough network bandwidth, and students and teachers don't have enough equipment.
- The initial investment needed to outfit an entire campus or school with Internet of Things (IoT) devices, equipment, and infrastructure is too high for many schools and universities to afford.
- According to Koukaras et al. (2021)
- Students' privacy and security are jeopardized because linked IoT devices collect massive amounts of personally identifiable information without strong cybersecurity protections.
- It is imperative that both classroom teachers and school administrators have the skills to understand, manage, and effectively utilize IoT devices in the workplace and classroom. (Qin et al. 2022)

1.7 Implications of IoT Integration

- **Better Learning Experiences:** By providing personalized, adaptive content and real-time data on student progress, the Internet of Things (IoT) may radically alter the way schools operate.
- **Greater Operational Efficient:** Automating tasks such as tracking student Improving operational efficiency in educational institutions may be achieved through better attendance tracking and inventory management.
- The Internet of Things (IoT) enables teachers, students, and institutions to communicate in real-time, which makes classes more dynamic and engaging.
- **Data-Driven Decision-Making:** The insights produced by data collected by IoT devices have the potential to improve educational strategies and pedagogical approaches.

2. OBJECTIVES OF THE STUDY

1. To research IoT devices, platforms, and technologies in learning environments
2. To research the difficulties and implications of IOT in the classroom

3. Materials And Methods

The current state of smart systems and the widespread availability of smart devices make it imperative to reconsider the current state of smart technology integration into educational practices. Smart cities and smart health are growing in significance, but education is still left out. A survey of the literature on the topic reveals a dearth of studies devoted to smart schooling. These limitations motivated us to undertake a comprehensive literature analysis in search of issues plaguing traditional education, possible innovative solutions, and roadblocks to putting these answers into action. Smart systems and the Internet of Things are relatively new phenomena, despite the fact that education has been present since the beginning of time. We combed through the literature to have a clearer sense of pure education overall, but we only included papers about smart education implementation that were published between 2015 and 2020. Also included were projects with the overarching goal of making education smarter in some way, shape, or form. Science Direct, IEEE Explore, Scopus, and Google Scholar were the databases that were searched for this purpose. Google Scholar gives users access to every journal article, but academic libraries restrict users to a subset of high-quality publications published by connected publishers and journals. Searching the digital world requires a searching string, and the quality of the searching string determines the search's success. The query consists of the words that include the target audience, methodology, and results. This research paper follows a three-stage methodology that includes planning, conducting, and reporting. The parts that follow this section explore these phases in detail. The development of the review process requires significant and vital effort. It is critical to adhere to the proper process in order to carry out an effective evaluation. The authors run the risk of veering off course and missing their target if the technique is flawed. Thus, we have identified and discussed emerging research questions, search strategies, and selection criteria at this level.

Table 1. A comparison of how well IoT devices communicate to each other

Board	Network	Bandwidth	Date Rate	Range	Standardization	Reference
Bluetooth	PAN	1 MHz	1- 3 Mbit/s	100m	IEEE 802.15.1	Bluetooth Technology Alliance 2020,
Wi-Fi	PAN	20 or 40 MHz	10 mbps	100m	IEEE 802.11	Wi-Fi Technology Alliance. 2020
ZigBee	WAN	2 MHz	250 kbps	Less than 1 km	ZigBee alliance	ZigBee Technology Alliance. 2020
NB-IoT	WAN	200 KHz	200 kbps	More than 1 KM	3GPP	NB-IoT Technology. 2020

Table 2. The string used to look up relevant publications

Area	Keywords	Synonyms in literature
Population	Education	Education OR Campus OR University OR Class
Methodology	Smart Devices	Internet of <input type="checkbox"/> things OR IoT
Outcomes	Smart Education	Smart Education OR Smart Campus OR University

Quality Assessment

The study's quality is determined by the number of parameters. To ensure that the publications included in this study are of good quality, we have followed these guidelines.

Inclusion criteria:

- Papers addressing the integration of smart technology (IoT, AI, 5G, AR, VR, etc.) into education cover a wide range of issues, including smart pedagogy, smart classrooms, smart assessment, and smart administration.
- Data linked to smart educational technology and equipment, broken down into its component parts.
- Giving a credible account of the methodology and results
- We have included all the papers from last year that received even a single citation, because smart schooling was underrated.

Exclusion criteria:

- Smart education would be more effective if it integrated technology with teaching, but the research articles only address one of these areas.
- The goals, procedures, and results of a study should be clearly described in a research article.
- Not a single citation from a published study appeared in the previous year.

4. Result And Discussion

4.1 Smart classroom

New approaches to education emerged in tandem with technological development. These days, teachers use technology to keep students' attention and improve their learning. Utilizing smart technology, a "smart classroom" creates an environment that is more favorable to learning. Regardless of national or religious norms, the majority of the world's populations disapprove upon coeducational classrooms. Mariam et al. (2018) investigated this issue within this social context and proposed a paradigm where male teachers deliver virtual lectures to pupils (male or female) who access the courses using mobile devices. Further investigation on online education and the role of the internet of things was carried out by Riccardo et al. (2018). As part of their virtual learning, they used fog and cloud computing layers to handle enormous amounts of data produced by different devices. While writing, the authors proposed an interactive digital pedagogy. Similar to how the instructor's tablet acts as her agency, the students' computers and tablets do the same. One of the main problems with virtual classrooms is that teachers can't closely monitor their pupils' progress. Moreover, children learn best when given several options; however, this is not possible in a virtual classroom. Another challenge that schools have is the organization of classroom seating. The authors of this piece propose a system for managing students' time in the classroom. After delving more into the topic, Wang et al. (2019) proposed a smart framework that schools may use to intelligently control things like class size and seating arrangements. Adaptability in the classroom fosters learning, but an unsuitable environment, especially in terms of temperature, might have the reverse impact. In their suggestion of a "flexible classroom," Aaron et al. (2019) delved more into this matter. If students want to have deeper discussions in this class, they may just turn their heads or walk around. This instructor taught Introduction to Electronics Circuits (IEC) for a year in a traditional classroom before moving to a more adaptable model the following year.

The data demonstrated that the second option yielded better results. Manchanok et al. pursued a similar goal with regard to the vacant lecture halls on college campuses that result from a mismatch between enrollment and actual attendance. By utilizing IoT sensors, they made optimal use of classrooms in real-time. By utilizing AI to predict which classrooms would be in session and assigning students accordingly, they were able to cut down on wasted space. In the actual world, AI faces a number of challenges. To find available seats in this situation, a reliable approach is needed. There is room for error in reading and allocation as well. In learning-focused classrooms, students employ critical and creative thinking skills while they study. As Piotr et al. (2018) pointed out, the best way to teach is with the student in mind. Factors that he examined were students' lack of motivation to engage, instructors' resistance to learner-centered approaches, the extra time required for e-learning materials, and the significance that students placed on these issues. Further research on the use of cellphones to increase student engagement was conducted by Xiangyangm et al. that year (2018) Similarly, the writers of Martinez-Maldonado et al. developed MTFedback to offer immediate comments. Whenever a smart group works together, the teacher is notified instantly with this function. Open education is seen as a form of instruction that is always evolving. The current massive open online course (MOOC) movement in open education includes courses provided by well-known universities all around the globe. Augmented and virtual reality-enhanced massive open online courses (MOOCs) are also fascinating. Examining the effectiveness of MOOC courses, Ip et al. (2019) draw conclusions. Based on the results, it not only makes class more enjoyable and less stressful, but it also improves students' comprehension. One typical complaint about having an overabundance of students in a single classroom is their lack of confidence and ability to participate actively. We all know that students who are too frightened to speak up will suffer greatly as a result. The authors of devised a system whereby students complete and debate assignments in groups to tackle this issue and promote greater student collaboration. Consequently, children are more inclined to collaborate.

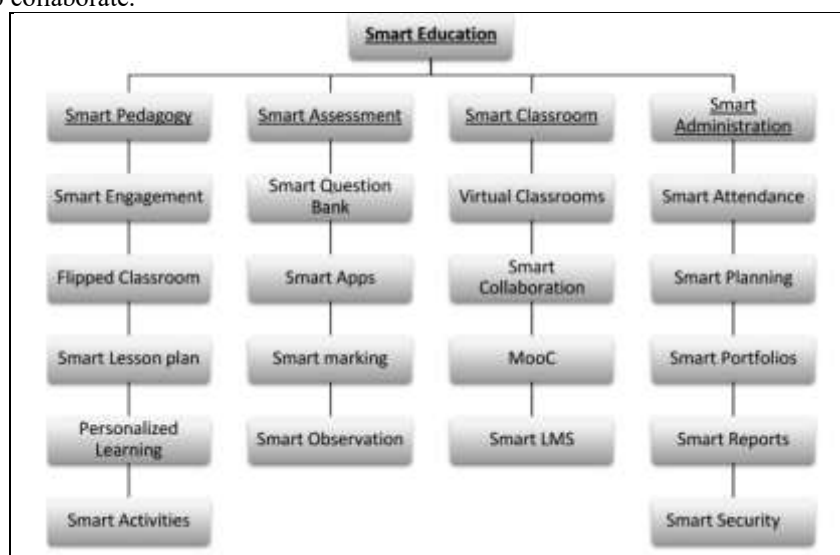


Fig. 1. Intelligent education categorisation

4.2 Smart assessment

Assessment is a crucial part of every educational program since it shows how far along the students, teachers, and curriculum are. The smart assessment uses information and communication technology to automate and clarify this process. The table provides a thorough synopsis of the pertinent literature on smart evaluation. The assessment for open reports conducted by Salsabeel et al. (2016) was examined using a mobile device. They built an app that could be utilized by educators and their pupils alike. Students are given evaluations by their teachers and are expected to complete them independently utilizing portable electronic devices. The automated marking of papers saves both time and money. Teachers can save time and effort by using an app developed by Zhou et al. (2016) to construct assessment assignments that promote higher-order thinking. Similarly, an evaluation tool for chatbot development was developed by Benotti et al. (2018). The goal of this application was to increase the rate of student engagement and assignment completion. Out of all the learners in the case study, chatbot users had the highest level of engagement. A further study by Roldán-Álvarez et al. (2018) proposes an app that teachers may use to create different types of tasks that students can do on their phones. Without human intervention, the program may assess the learner's level of proficiency in any subject. In an alternative example study, Llamas-Nistal et al. (2019) combined the flapping classroom with continuous assessment. The findings show a clear trend. Academic and practical component pass rates were higher, while attrition was lower. The distinctive feature of this paradigm is the student's willingness to employ this blend for both learning and evaluation. In order to help students improve their pronunciation and track their progress towards class completion, Tejedor-García et al. (2020) developed an app.

4.3 Smart administration

It is crucial that institutions closely track the progress of both teachers and students. For any school to function well, it is essential to be able to track and evaluate teachers' progress. Evaluating schools and teachers with more precision can potentially yield even better results. Transparently, the intelligent system can manage all of these issues. On top of that, administrative responsibilities have added more work for teachers. There may be intelligent solutions that might lighten this burden so that teachers can devote their whole attention to the classroom experience. According to Figure 1, the smart administration structure

- **Smart attendance** Using fingerprint attendance or doing it manually is a time-consuming process. Attendance is taken before each session, which is a pain. Not even with eight 40-minute classes in primary school is it possible. Where each classroom has sixty or more pupils. Smart cards with radio frequency identification might automate the school's attendance system. Whenever a teacher or student enters the classroom, this is utilized to record their attendance. The smart technology will notify the teacher and administration when a specific amount of pupils have arrived at class. The use of smart cards in the classroom also allows for the monitoring of teachers' punctuality and presence. Modern technology blends in seamlessly with its surroundings. Smart attendance notifies parents when their children arrive or leave school, keeping them updated on their whereabouts. Additionally, this enhances a student's learning record whenever they visit or leave a building, such as a library, café, lab, etc. The authors of the study are Ghani and colleagues, (2020) whereas (Wakchoure and colleague. et al. , 2020)

- **Smart portfolio:** Students' attendance, disciplinary history, and test scores are all recorded in the database. Notifying parents of new complaints is done through applications and SMS. Teachers and parents can access students' summaries. Teachers and parents may be able to use this data to pinpoint exactly where their child is having difficulty. The institution's administrator receives a feed in real-time. They get access to all of your student information, including lesson plans, assignments, courses taken, and grades. Online access to student work and teacher syllabi is a feature of flipped classrooms. With the use of video as a sensor, it is possible to conduct thorough classroom observations.

- **Smart reports:** For decision-making, reports are provided to the offices of the administration. Handwritten reports are far more susceptible to manipulation, which in turn raises the probability of drawing inaccurate conclusions. There is less corruption and illegal report manipulation as a result of using the smart system.

- **Smart security:** Students and faculty members cram into schools and universities. Because of their lax security procedures, they might be readily targeted by terrorists. The intelligent system greatly aids in security by means of a number of cameras and sensors. This gear is becoming ever more useful as AI continues to proliferate.

Smart pedagogy

Possessing the skills that are together called pedagogy is essential for every educator who aspires to be competent. It dives into the psychological talents needed to read and understand pupils and covers the fundamentals of teaching as well. The graphic depicts the structure of smart pedagogy.

- **Smart engagement:** Teaching is fulfilling because I get to witness firsthand the passion and engagement of my pupils. Students' critical thinking skills are improved when they actively participate in the learning process. Traditional classrooms have a low degree of student involvement. Maximizing educational quality requires increasing student participation. For quite some time, a lot has been depended upon by both writers and educators to captivate pupils and ensure that they remember specific subjects.

- **Flipped classrooms:** Because of the fog layer, "flipped classrooms" are more effective. Educators in "flipped classrooms" record themselves teaching their pupils, a novel strategy in the field. After watching the videos at home, students collaborate with their professors on class projects that are related to what they learned. The fog server can save videos for assignments and classes and even distribute them to parents' phones. Students can participate in "flipped" classes thanks to the BYOD policy.

- **Personalized learning:** One of the major issues with the traditional classroom format is that all students are expected to learn the same content. Learning takes time and may happen to anyone. As a result of developments

in information and communication technology, tailored lesson plans can now be developed for every student. They can learn on their own. Students' level of investment and engagement with their education therefore increases.

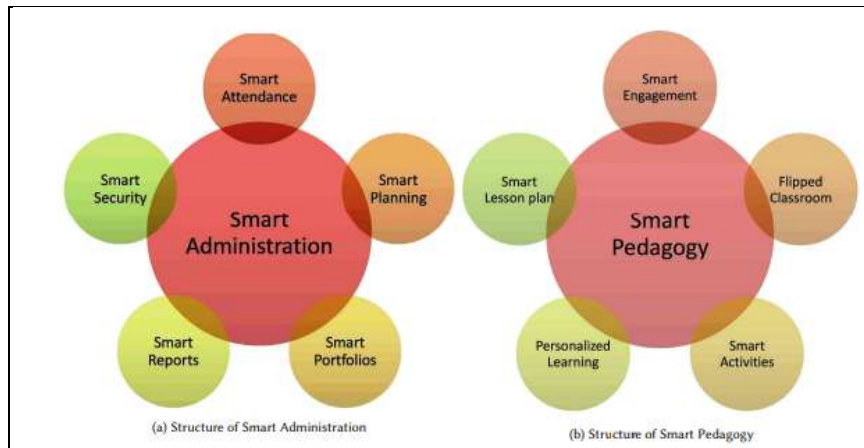


Fig. 2. Framework of Intelligent Governance and Intelligent Education

Table 3. Comprehensive overview of intelligent governance

Paper	Idea	Findings	Device / Technology Used	Limitations
Mahesh et al. [2016]	Smart attendance	Irregular attendance is the primary issue of educational institutions. This article proposes an intelligent attendance and notification system for learners to effectively manage attendance.	MCU, RFID, PDAs, Mobile phones	□ The primary issue with smart attendance is its ineffectiveness in rural places plagued by internet connectivity difficulties.
Afzal et al. [2019a]	Smart security	Authors presented an intelligent security architecture for educational institutions to ensure the protection of students and educators. They utilised cloud computing, fog computing, the Internet of Things, and numerous sensors. The findings of this investigation were encouraging.	MCU, cameras, sensors, fog and cloud computing.	□ This project was simulated and not evaluated in a genuine physical context. Consequently, it may lack reliability in practical settings.
Mohamed et al. [2018]	Smart administration	The authors presented a paradigm for informed decision-making in educational institutions. They utilised IoT and other technologies to effectively facilitate decision-making in teaching and learning.	Cameras, mobile, tablets, fog and cloud	Intelligent administrations are frequently opposed by employees. The authors failed to address strategies for overcoming these issues..
Benedict du [2016]	Smart learning	They established a framework utilising artificial intelligence and cognitive science to comprehend the essence of learning and instruction; based on this understanding, educators use novel pedagogical techniques.	Cameras, mobile, tablets, fog and cloud	□ The primary problem lies in the use of AI, as its current maturity level renders its results untrustworthy..
Govaerts et al. [2018]	Smart collaboration	Established a structure for collaboration among learners to accomplish and deliberate on a task. This enhances teamwork among pupils.	Social media, mobile phones, laptops etc	Online collaboration encounters challenges, including network failures, among others.
Cat, ̃a [2015]	Smart university	Authors presented an IoT framework to autonomously run the institution, including smart lighting, smart parking, smart tracking, and smart inventory, among others.	AI, sensors and cameras	□ The implementation of AI encounters several problems in achieving proper configuration..

Yeon and Changsun et al. (2015) delved more into engineering flipped classrooms, which encouraged student engagement and innovation. In their study, Gregory et al. compared conventional and flipped approaches to teaching electrical engineering. We divided the students into two groups of twenty. Video lectures were the main form of education in the flipped classroom model. Results from the comparison show that, on average, students' performance in the flipped classroom was higher than in the more conventional model.

4.4 Using VR for pedagogy

Several subjects have benefited from the usage of virtual reality in the classroom. The interactive school desk and the Cave automated virtual environment (CAVE) with head-mounted displays (HMDs) are the two primary ways that smart classrooms may offer virtual reality experiences, either completely or partially immersive, according to Sobota et al. (2017). The optimum technology for delivering a virtual reality (VR) experience to a single user at a time is a head-mounted display (HMD), but a VR room with numerous projection walls lets users wander freely and immerse themselves in a virtual setting. When combined with head-mounted displays (HMDs) and controlled environments (CAVEs), a number of virtual reality (VR) add-ons, such as gloves, suits, and controllers, can further improve the experience.

Table 4 Virtual reality teaching tools that have been implemented

Year	Author	Topic	Equipment used
2001	Mintz et al. (2001)	Physics/Astronomy	Computer
2002	Knudsen and Naeve (2002)	Mathematics	Head Mounted Displays (HMD)
2008	Adams and Hotrop (2008)	Computer Science	Computer, HMD
2010	Sampaio et al. (2010)	Civil Engineering	Computer
2015	Valdez et al. (2015)	Electrical Engineering	Computer, 3D Max Studio, Vray
2016	Parmar et al. (2016)	STEM	Oculus Rift HMD
2018	Ip et al. (2018)	Autism students	Projection Screens, Camera
2018	Blyth et al. (2018)	Geography	Computer
2019	Alfalah et al. (2019)	Medicine	Projector, Computer, 3D Glasses

Some long-held educational assumptions have become outmoded with the inclusion of virtual reality into the classroom (Chen & Tsai, 2012; Gu, 2017). Virtual reality technologies are more likely to favorably affect students' motivation and academic performance, as stated in several studies (Ibáñez et al., 2014; Martín-Gutiérrez et al., 2017). According to Hampel and Dancsházy (2014), students also gain a lot from creating a virtual learning environment as they can learn on their own time. Moreover, research conducted by Kaufmann & Schmalstieg (2002), Martín-Gutiérrez et al. (2017), and Zhou et al. (2008), among others, has demonstrated that students' cognitive, psychomotor, collaborative, and communication abilities, as well as their emotional capacity, are enhanced by VR technology. Virtual reality technology also has uses in the classroom. (Stavroulia et al., 2016).

4.5 Use of AR in the classroom

Several augmented display devices, such as smartboards, smartphones, and tablets, can be used by students in a smart classroom in conjunction with various programs, such as Aurasma, Layar, Augment, and Aumentaty (Chamba-Eras & Aguilar, 2017). Some examples of augmented reality headsets and glasses include Microsoft's HoloLens and Oculus Quest, as well as Windows Mixed Reality. As per Torres et al. (2011), smart classrooms can incorporate augmented reality (AR) in various ways. These include interactive books, virtual models of complex structures, educational games, sound-making AR models, augmented spectacles, AR mirrors, AR doors and windows, AR navigation resources, and AR collaborative spaces. If students can't finish complicated or dangerous experiments, if the equipment is too expensive, or if there isn't enough room in the smart classroom, then augmented reality can fix all of those problems (Chamba-Eras and Aguilar, 2017). Not only that, but students who utilize AR to study retain more information and are better able to solve problems (Queiroz et al., 2022). The table below lists only a few of the numerous courses that have profited from utilising AR in the classroom:

Table 5 Usage of augmented reality apps

Year	Author	Topic	Equipment used
2002	Kaufmann and Schmalstieg (2002)	Mathematics	Head Mounted Displays (HMDs), projector, computer
2007	Dünser and Hornecker (2007)	AR books for language education	Camera, Computers, AR markers
2012	Yoon et al. (2012)	STEM and museums	Camera, projector, computer
2014	Ibáñez et al. (2014)	Physics	Tablet

2015	Lu and Liu (2015)	Marine Education	Webcam, AR markers, computer, projector
2017	Alakärppä et al. (2017)	Environment	Android tablets, AR markers
2019	Cai et al. (2019)	Mathematics	Tablet
2020	Kerr and Lawson (2020)	Landscape Architecture	Google Assistant
2020	Demitriadou et al. (2020)	Mathematics	Tablet/mobile, AR markers
2021	Reeves et al. (2021)	Biochemistry	Tablet, AR markers
2022	Kim and Shim (2022)	Computer Science and Engineering	Camera, AR markers

Some long-held educational assumptions have become outmoded with the inclusion of virtual reality into the classroom (Chen & Tsai, 2012; Gu, 2017). Virtual reality technologies are more likely to favorably affect students' motivation and academic performance, as stated in several studies (Ibáñez et al., 2014; Martín-Gutiérrez et al., 2017). According to Hampel and Dancsházy (2014), students also gain a lot from creating a virtual learning environment as they can learn on their own time. Moreover, research conducted by Kaufmann & Schmalstieg (2002), Martín-Gutiérrez et al. (2017), and Zhou et al. (2008), among others, has demonstrated that students' cognitive, psychomotor, collaborative, and communication abilities, as well as their emotional capacity, are enhanced by VR technology. Virtual reality technology also has uses in the classroom. (Stavroulia et al., 2016).

4.5.1 Assessment of performance

An integral aspect of any educational process is providing feedback and evaluating the work of both teachers and students. The once laborious and intricate process of assessing and predicting performance has been substantially simplified by automated evaluation in a smart classroom. (Balfour, 2013).

4.5.2 Intelligent evaluation and prediction of student performance

The results of student performance assessments can help educators gauge their students' level of understanding and identify areas for improvement in the classroom. Grading students and providing them with feedback on their learning performance is another objective (Saini & Goel, 2019). Oral or written assessments of performance were the norm in the past. Aside from being tedious and time-consuming, the previously described method also results in a surplus of wasted paper and ink (Vimal & Kumbharana, 2016). The application of certain technology in a smart classroom facilitates automated assessment and prediction of performance. The most basic kind of assessment in a digital classroom is the use of multiple-choice questions. By comparing student responses to the predetermined correct answer via an online web server, these questions make it possible to automatically evaluate and provide feedback (Balfour, 2013). As part of the assessment process, many teachers utilize Turnitin, an AI-assisted plagiarism checker (Ahmed, 2015). Bhatia and Kaur (2021) present a new method for evaluating and predicting performance that makes use of quantum game theory (QGT) decision making. This application gathers data and information about students using the Internet of Things (IoT) in order to evaluate their academic progress and find places where they may make improvements. Afterwards, this data is assessed using a computer system. constant assessment may be done by teachers using the methods indicated above, saving them a lot of effort. On the other hand, students can receive feedback on a constant basis.

4.5.3 Evaluation of teacher effectiveness

Experts watching classroom instruction is a common but inefficient part of traditional modes of evaluation. Teachers also typically get comments based on their performance rather than ideas on how to improve their own teaching (Archer et al., 2016). In response to this pressing obstacle to teachers' professional development, a new technology has arisen that may supply them with consistent, high-quality, and applicable feedback.

Using Internet of Things (IoT) technology, Bhatia and Kaur (2021) monitored student and instructor growth in the classroom. To do this, they use data collected from a fog-cloud computing device to conduct long-term evaluations of teacher and student performance using a Bayesian model. In order to facilitate the easy recording of lecture notes and class discussions, Jensen et al. (2020) created a system. Using voice recognition and ML techniques, they were able to provide comprehensive estimations of essential characteristics of instructor speech. So, they deduce that it's feasible to capture and evaluate live instructor discussions for the purpose of offering automated feedback. Jensen et al. (2021) address the challenge of developing a system for automated teacher feedback. Several considerations must be made in this regard, such as data gathering techniques, automated assessment procedures, and feedback presentation formats. To achieve this goal, we employ machine learning techniques such as Random Forest classifiers and transfer learning methodologies from the BERT algorithm for NLP.

4.6 Smart classroom's influence

Based on evidence gathered from the literature and critical assessment, we will analyze the impacts of artificial intelligence and the benefits and drawbacks of using smart classroom technology in this portion.

4.6.1 Smart environment

By analyzing data collected by sensors and the Internet of Things (IoT), artificial intelligence (AI) systems can monitor students and notify teachers of any inappropriate behavior or potential accidents; this can make classrooms safer and more eco-friendly environments for learning. Artificial intelligence systems may one day fine-tune the lighting and temperature of a classroom based on factors like occupancy and ambient weather. With all these tools and technology at our disposal, we can create a classroom environment that is more comfortable and safe for students. León et al. (2016) found that students' engagement with course contents using smart classroom devices improved their learning, retention, and efficiency. Students in smart classrooms are not passive observers; rather, they are actively involved in the lesson's delivery through the enhanced interactives provided. An unintended consequence of utilizing technology in the classroom is the possibility of disconnection, which is defined as an individual's disconnection from their own learning, their curriculum, their peers, their teachers, and their own learning tools. Less student agency, less student ownership, and overall disengagement can have a negative impact on students' ability to learn. That is why it is so important for smart educators to discover ways to pique their pupils' interest in and enthusiasm for learning. (Blessinger & Wankel, 2013).

"Smart classrooms" take advantage of numerous technology breakthroughs to enhance teaching. Interactive whiteboards that encourage participation, ergonomic seats that promote relaxation, VR and AR tools for the instruction of three-dimensional concepts, etc. No more fiddling with the thermostat or lights—the smart technology in this classroom does it all automatically. Smart cameras also have use in reading and behavioral evaluation. The figure shows the layout of the smart classroom.

Table 6 . Intelligent system and Internet of Things solution

Proposed Solution	Description	Devices / Technologies needed
Smart attendance	Smart cards with radio frequency identification automatically track students' attendance at school. It is expected that all students and teachers sign in as they enter the classroom..	RFID, Cameras, Biometric, AI
Smart portfolios	Students' test scores, attendance records, and character assessments are all saved in the database. Notify parents through apps and SMS.	Server, mobiles phones, RFID, Cameras, Biometric, AI
Smart pedagogy	Dipped classrooms, video recording, augmented reality, and virtual reality are just a few of the innovative methods and tools that inspire student engagement and originality in the classroom.	Cameras, AR, VR, IR, and smart boards etc
Smart lesson planning	We can resolve the class issue and check that the teacher is following SOPs while planning classes if we store the lesson plan online.	Servers, Mobiles phones, PDAs, Laptops
Learner engagement	Using connected devices, artificial intelligence, augmented reality, virtual reality, and other smart technologies to captivate students	Animation, AI, AR, VR and smart glasses
Flipped classroom	Students in a flipped classroom study instructional videos on their own time before coming to class to complete homework under the watchful eye of their professors.	Cameras, AR, VR, Animation
Massive Online Open Courses	Massive open online courses (MOOCs) allow students to take classes from a variety of schools and institutions all over the world.	Cameras, Mobile phones, PDAs, Laptops
Smart assessment	Smart testing services are used to give pupils tests and then save their results on servers in the cloud.	Mobile phones, PDAs, laptops
Smart collaboration	Thanks to advancements in video conferencing, AR/VR, and AI, students may collaborate more efficiently remotely.	Mobile phones, PDAs, laptops, AR, VR, AI

5. Discussion

Major worries over data privacy and security derive from the fact that AI systems will inevitably collect vast quantities of data, some of which contains sensitive information about students and teachers. Two articles (1.4%) out of 146 retrieved for the 2019 research address the challenges, risks, and ethical issues related to AI use in the classroom. The placement of cameras on each student's desk may be both obvious and intrusive, even in made-up

classrooms. Students may feel psychologically burdened by being monitored, and classroom effectiveness may decline as a result. Some faculty, staff, and administrators may feel uneasy about the rise of chatbots, intelligent tutoring systems, and expert systems that are based on artificial intelligence. Throwing these ethical considerations out the window would be completely careless. In the future, we hope to see more research into the data privacy and ethical issues brought up by smart classrooms' usage of new sensor devices. This will help us understand how to best protect the rights and interests of both students and teachers while also making sensor technology more widely accepted. Another significant challenge is making things user-friendly. The term "usability" is used in product design to describe how well an item functions and how content the user is with the product after using it. Many people still worry that smart classrooms are too invasive and uncomfortable with all the additional sensors. For instance, certain devices are easily noticeable in the classroom, whereas wearable monitoring systems may be too heavy and inconvenient to wear all day. Learning will be more challenging in these environments because kids and instructors may experience emotional and physical rejection. Future improvements in usage may result from studies aimed at making sensor devices more aesthetically pleasing, developing methods to make them less obvious in educational settings, or developing methods to make them fit in with their environments. Reading data is a part of the sensor's user interface. Expertise in information design and human-computer interfaces is required to improve the visual display of data, a major area for usability.

6. Conclusions

Our kids' "perception" of the classroom is improving, and the foundation is being laid for more engaging, personalized teaching thanks to smart classrooms that use AI and sensor technology. Using an overview of how smart classrooms are integrating sensor technologies with AI algorithms, this paper explains how these technologies are being used. In addition, it provides a concise overview of the most important developments and concerns concerning these platforms. Intelligent classrooms have sensor systems that can multitask. It continuously monitors the physical conditions of the classroom in order to create the best possible setting for learning. Aside from picking up on nuanced body language, vocalizations, and neural activity, the sensor system might also serve as a neutral and objective judge of how well the teacher and pupils are doing in class. A wider variety of jobs may be accomplished by sensor systems that are integrated with AI technology. In a one-on-one setting, these systems may mimic intelligent teachers by learning from data, analysing student conduct, and summarising key points. On top of all that, they can also help with educational chats, provide individualized lesson plans and resources, make predictions about your grades, and provide overall intelligent support for your education. Additional research is being conducted on the issues plaguing traditional educational institutions and the potential solutions that smart technology may offer. Neither the students nor the standards are being adequately engaged during mentoring and teacher training sessions, according to the author. On top of that, administrators squander time that could be better spent instructing students. Attendance monitoring, reporting, pedagogy, lesson preparation, reporting, learner engagement, assessment, and security are just a few examples of how smart technology are enhancing traditional institutional responsibilities.

7. References

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