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# Improving Online Education in Educational Institutions through the Integration of Internet of Things (IoT)

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***Abstract*—A key facilitating infrastructure for building intelligent structures that enable efficient in-person and virtual learning environments is the Internet of Things (IoT). The shift to smart learning, that includes IoT and Artificial Intelligence (AI) into the educational system, is enticing since it directly affects the motivation of learners, enrolment, participation, and in-depth understanding. Teaching and learning, management, examination, and class monitoring are only a few of the numerous issues that afflict conventional education. Many ingenious approaches to many facets of our lives are being made possible by modern advancements in information and communication technology (ICT); nonetheless, these imaginative concepts aren't adequately incorporated into the framework of education. The COVID-19 pandemic scenario, in specific, has brought out the need for innovative, creative approaches in the field of teaching. The present research examines previous investigations in the field and discusses the following topics: (i) issues with the current educational system and potential fixes; (ii) the shift to smart learning; and (iii) scientific hurdles (such as technological and cultural barriers) in making the move to smart learning. In accordance with these outcomes, creative approaches to the issues with the conventional system—such as smart teaching, smart evaluation, smart school environment, and smart management—are presented. The business and academic community may now include IoT, AI, and ICT into smart learning owing to the aforementioned experimental research's novel developments.**

***Keywords—Online education, Internet of Things (IoT), Smart teaching, Smart classroom.***

## I. INTRODUCTION

With its diverse array of learning environments and contexts, the education industry constitutes one of the main drivers of development of nation. The introduction of technological advances has created a profound effect on the effectiveness and practicality of educational organizations. A primary goal associated with global technological advancement is increasing student involvement [1]. This additionally focuses at gathering information from an extensive variety of resources and bringing together into various learning remedies, that is crucial to the supply of assessments which depend on the everyday actions of students depending on the viewpoint of education. Evaluations of students remain performed by hand, even though the field of teaching has seen significant technology improvements. This is susceptible to mistakes by humans because while calculating performance among students, important details might have been overlooked.

IoT, which is becoming more and more popular, is an internet of connected objects. Creating smart surroundings and things with self-awareness is the main goal. Apart from the various sectors that encompass various sensors, the rise of the IoT caused a change in the worldwide computer landscape [2]. Significant fresh developments have emerged in the last few years, especially in the field of fusing technical components with sensor and device networks. When combined with the relationships among technological structures and other devices, this assists in the resolution of the majority of instrument- and protocol-related issues. It is anticipated that the convergence of electronic systems such as communication between machines and contextualize analysis of data will facilitate the evolution of various sectors.

Additionally, given the growing popularity of smart things, it was anticipated that cloud computing's introduction and application in the haze model would further IoT development. Such advances drive passion for this research, igniting a desire to review existing literature, create novel approaches, and discover fresh IoT possibilities [3]. The ongoing technical development in the field of wireless networks for communication, that has drawn the attention of experts in the field and is currently being employed in maritime industries worldwide, has aided in the expansion of e-learning.

During the beginning of time, students, scholars, and intellectuals have enjoyed math, science, and the study of engineering. Such topics have influenced how civilization as a whole has developed. Since carvings on clay and rock to etching on reed and paper, mankind is trying to establish methods of learning [4]. The rise of industry drastically altered every element of human life. Science advanced remarkably. Thus, a great deal of advancement is being made in the ICT industry. The fields of science and technology came together to create e-learning, a cutting-edge approach to teaching. The word e-learning describes online or electronically educational

settings. The conventional system of learning is typically supported by this mode of instruction.

However, it is a stand-alone system that has the potential to offer an extensive virtual learning environment. During the past, academics such as instructors, teachers, as well as educators served as sources and disseminators of expertise. In recent times, an instructor job description evolved to include mentorship, facilitation, as well as coaching. A new and intriguing approach to teaching is e-learning [5]. E-learning has garnered greater interest now due to its advantageous attributes. It encourages autonomous study and continuous advancement. This has no limitations by where they are or ethnicity of the students. Furthermore, students had the ability to use learning resources around-the-clock, anyplace. Later in 2020, the COVID-19 pandemic presented a significant threat to everyone on the planet. Around the globe, the majority of institutions of learning remained shuttered. Numerous locations around the world abruptly switched to face-to-face conventional instructional methods to online instruction amid the global epidemic outbreak. The spread and quick adoption of the e-learning system in education were influenced by the COVID-19 pandemic issue.

Another applicable fields that necessitates a practical lab and expertise in design is the study of engineering. However, students may be able to access simulated labs, modeling, and experiential seminars through e-learning [6]. Professional and unstructured training in engineering might be made available through e-learning to a variety of students, regardless of age or expertise. The STEM area where emphasis has traditionally been placed on modeling and training, laboratory instruction, practical experience, and material for instruction is the teaching of engineering. In the past, the emphasis of education in engineering has concentrated on fostering imaginative thinking, analytical thinking, and problem-solving abilities. Investigators, academics, and designers are constantly looking for and creating new instructional approaches and strategies. Their primary goal is to enhance the engineering education procedure, which includes project-based learning (PBL), classroom instruction, and collaborative learning.

The web has developed from practically inaccessible to the biggest and easiest-to-access repository of knowledge generated in the previous 20 years. It has altered how individuals perceive information and education as well as how they interact, purchase goods, socialize, and conduct commerce. Learning via the internet is significantly more than merely a modern take on remote learning; it is revolutionizing regular classrooms and expanding opportunities for education. Learners who receive classes, utilize their own laptops to access the web [7]. Online degrees and programs have grown in popularity over the course of the last ten years amid numerous alternative learners, especially people who choose to maintain full-time careers or establishing family.

Online educational portals of the originating universities have a tendency to offer graduation and academic programs, certain of them are done digitally. Learners may utilize virtual learning to transform any place having power and web access to a learning environment [8]. This may involve real-time interactions involving academics, simulation settings, written content, graphics, music, and film. Compared to a regular school setting this is a considerably more flexible and dynamic setting for learning. This is being demonstrated that if fully utilized, virtual education can be more successful than conventional classroom training.

Online courses for learners worldwide have become necessary due to the increased digitization of schools and universities. The courses in this category provide numerous benefits of online learning, including the ability of attending session from anywhere, low costs, and a high level of ease and adaptability that saves learners money as well as time [9].

Achieving sustainability in online education requires a focus on long-term viability, resource efficiency, and accessibility, all while maintaining educational quality. The key strategies to ensure sustainability in online education include Adopting Environmentally Friendly Practices, Leverage Open Educational Resources, Support Faculty and Continuous Improvement, Measure and Track Sustainability Efforts and etc. Improving privacy in online education involves safeguarding student data, ensuring secure access to learning platforms, and adhering to privacy regulations. Achieving reliability in online education involves ensuring consistent, high-quality learning experiences through stable technology, accessible resources, and robust support systems. Improving efficiency in online education involves streamlining processes, optimizing the use of technology, and enhancing the overall learning experience for students and educators.

There is no denying the enormous advantages of online learning. With online education, students are able to benefit through convenience and adaptability they are unlikely to receive in regular educational environments. The benefits of online learning and the way it may assist students are discussed here. The purpose of this paper on online education is to offer a thorough overview of its current state, emerging trends, challenges, and advancements. It seeks to synthesize and evaluate existing research, pinpoint gaps, and provide insights into potential future developments. Table 1 discusses the difference among E-learning and Classroom learning.

Table 1. E-learning vs Classroom learning

| E-Learning | Classroom Learning |
|---|---|
| One significant benefit of online learning is accessibility. Learners can study in their personal environment thanks to it. Instructors are able to pay attention again and again. | Regular schooling is less adaptable than e-learning. Attendance at class is required of students. |
| Space and time are not factors in e-learning. Wherever and during any moment, learners are able to view classes. | On comparing e-learning, conventional schooling follows rigid guidelines and is reliant on place and time. |

| | |
|---|---|
| For both educational organizations and students, expenses related to operations are a major concern. There are numerous methods that e-learning reduces this expense. In particular, becoming electronic reduces the expense of journey, assessment, and administrative expenses. | In comparison to e-learning, conventional learning requires additional expenditures for papers, transportation, assessments, management, etc. |
| A vast array of programs are able to be delivered because smart learning enables professors to instruct students anywhere in the globe. | This pattern isn't addressed in conventional education. Professors' presence in person is required. It thus becomes unable to provide all kinds of program. |
| Numerous platforms, such as Google Meet, Zoom, Skype, and others, are utilized for interaction. | A person's presence is required in conventional schooling, and there aren't any alternative choices. A significant portion of the funding is spent on everyday and transportation costs, particularly during meetings. |
| Socialization is a fundamental shortcoming in intelligent learning. Learners' communication and social abilities are severely impacted when they stay at their residence or are preoccupied with electronics, etc. | Community education represents one of the main advantages of conventional schooling. Learners' interpersonal abilities are enhanced when they gather and engage in in-person conversations. |
| Lack of extracurricular tasks is another problem concerning e-learning. | Extracurricular programs are offered by conventional schooling as opposed to e-learning. This readies the students for additional coursework. |
| Online learning reduces operating expenses, but putting in a e-learning requires a significant upfront investment. | Conventional teaching continues to be somewhat expensive altogether. |

## II. Challenges in Traditional Teaching Method

The following are the challenges involved in traditional classroom teaching method [10].

### *A. Having accessibility to excellent educators and instructors*

In the majority of instances, the opportunity for high-quality learning is restricted in conventional educational environments because not every instructors have the same expertise or sufficiently competent to educate students. Instructors must receive upskilling in order to provide students with an opportunity for excellent instruction, and curricula must be standardized—tasks that aren't simple to do. In addition, families have their own standard expectations regarding how and when their kids ought to acquire certain things.

### *B. One-size-fix-all method*

The strategy to conventional schooling involves a single size fits all. It has not been customized. Kids can't begin learning on themselves as it's not customized. Their intellects are unable to acquire knowledge in a manner that suits or piques their curiosity. Students consequently struggle with studying. Students are missing enjoyable experiences with learning in conventional classes.

### *C. Motivated by a fear of tests*

Examination anxiety, not a passion for studying, continues to be the driving force behind the conventional educational system. For them, there can be nothing enjoyable in studying. During the course of their education, students around the globe, from daycare to elementary to intermediate school, must take many assessments.

### *D. Teacher-student ratio in classroom, especially in a country like India*

India faces significant challenges in maintaining a teacher-student proportion in classrooms because to its large population (1.3 billion) and 359 million youngsters. In India, the teacher-to-student ratio is 1:40, but the optimal ratio globally is 1:10. It makes sense that it will be harder with a population that is constantly expanding.

### *E. Necessity to switch to smart education*

After reading about the problems that conventional schooling is experiencing right now, whatever it should undertake next, is the following. Undoubtedly, there has been an evolution favoring online learning. Absolutely no rationale rather to choose e-learning because conventional schooling is focused on taking examinations, motivated by a dread of tests, impersonal, and doesn't make educational experiences enjoyable for students. Ultimately, the goal of smart education is to enable kids to appreciate and easily acquire everything in their personalized speed as well as in a format and language that they can comprehend. Every youngster will begin training on themselves as long as providing them with the appropriate educational resources.

It goes without saying that all intelligent educational systems give kids enjoyable educational experiences that inspire an enthusiasm of studying. Students are able to visit to learn on their own schedules to strengthen and improve their science and math foundations with the help of the BYJU'S education application. Teachers and students worldwide can take dynamic programming lessons from Michelle Sun's First Code Academy. The goal of Mark Luo's Huohua Siwei is to transform kids from exam takers into rational thinkers. Contemporary equipment makes classrooms appealing, which encourages kids to enjoy intellectual stimulation. Every smart teaching organization ultimately want to delight youngsters with enjoyable educational experiences.

## III. Benefits of Online Education

Initially Learners on the internet can perform investigation, participate in online seminars, communicate with other students, ask instructors concerns, and write online tests. These are a few advantages of learning via the internet [11].

### A. Work from anywhere at any time

Especially learners who have a lot of responsibilities to manage, this serves as a fantastic advantage of online education. It's extremely easy to get education resources and turn in work because all can be accessed on the internet. Students are free to choose the precise time and location of their choice as long they manage to meet the deadlines for their assignments.

### B. Instantaneously watch lectures

During a presentation, it's common for thoughts to wander. According to Jonathan Schooler, a psychologist, during a 45-minute class period, students tend to lose focus roughly five times. But one of the main benefits of online learning is the fact that numerous applications allow learners to rapidly examine course material by simply pausing the video or audio recording or reviewing the text that goes along with it.

### C. Minimal frightening

In schools, a lot of kids find it difficult to express in front of others. One advantage of taking classes online is that it might be a lot simpler to exchange ideas among fellow learners. Since 74% of individuals struggle with anxiety when speaking, e-learning generally promotes improved classroom engagement, reported by the National Institute of Mental Health.

### D. More time to think before sharing

Advantages of online learning and online schooling still has a discussion element to it, often in a forum or discussion board. On-campus students have to choose a stance or formulate a thought in class quickly and sometimes speak before they've fully examined everything. In an online environment, students can spend as much time as they want thinking about and honing their own ideas. This can lead to greater confidence and more elegant discussions.

### E. Concentrate on concepts

Since informal interaction accounts for 93% of communication, e-learners aren't concerned regarding their posture detracting from their point of view. Although gestures might prove useful in certain situations, educators tend to be more interested in thoughts, and e-learning removes the potential influence of physical bias on reasoned discourse.

### F. Establish interaction in public

These days, collaborative tasks and coordination are common in numerous university courses. Collaborating with peers within a nearby or college setting entails scheduling particular times and days to ensure attendance from them. On the contrary, learners enrolled in online courses can collaborate with peers virtually using online forums, electronic mail, and various other user-friendly platforms.

### G. Adjustable timetable to teach

Learners enrolled on school could be required to sit through lengthy lectures in person. Although not every e-learning programs are created equal, a lot of them make use of slide shows along with additional content. Stated differently, a learner can participate in a lesson's initial portion on one occasion and the subsequent portion the following day. For individuals that find it difficult to stay still for extended periods of time, it can be extremely beneficial.

### H. Economical

While the price of a course taken online may equal or surpass that of a regular course, learners remain able to save funds through eschewing several expenditures associated with on-campus learning, such as laboratory charges, transportation expenses, places to park, dorm accommodations, etc.

### I. Variety

Conventional students are frequently restricted to local instructors and programs. Despite being to depart their residence, the e-learner can enroll in a trip blogging program taught by an expert in travel writing and a French lesson taught by an instructor in France.

### J. Availability of lecturers

Sometimes might be difficult to speak with an instructor following lecture at conventional higher education institutions. Teachers do have time for themselves, however they are sometimes limited to a few hours per weeks' time, and there are just a lot of students awaiting to get help. Internet-based tools makes it easier to communicate with many learners simultaneously, even though instructors whom educate via the internet might additionally have particular times for students to attend. The best part of a virtual class is that instructors are able to respond queries, provide feedback, and lots more by logging on during night or while on breaks.

## IV. Problems and difficulties in online learning

Several of the challenges which engineering online learning faces prohibit its widespread adoption [12]. Among them are: (i) A few government libraries, colleges and universities, and other entities possess weak computer networks, particularly in rural locations. (ii) A shortage of institutional guidelines governing the e-learning environment. (iii) Like Egyptian as well as other underdeveloped nations, certain learners are denied utilization of computers as well as online access. (iv) A dearth of qualified personnel with solid online teaching expertise. (v) Difficult to use appropriate online education methods and equipment. (vi) The development of online education instructional content takes a lot of time and effort. (vii) The educational, commercial, and cultural sectors reject education that takes place off site and have little faith in online degrees in engineering.

## V. IoT in education

Improving the learning process continuously constitutes one of the primary responsibilities of the learning system. The American school system's antiquated and ineffective strategies for raising standards of learning are at the root underlying the issue. Employing additional instructors helps educational organizations make learning easier to obtain, however boosting staff rarely translates into higher-quality instruction.

Through educational resources, the identical process takes place. Finances are allocated by institutions of learning to physical textbooks, however these materials rapidly turn

antiquated and fails to adapt to contemporary methods of instruction. In addition, institutions of learning require ideas that are responsive to the evolving facts of the present because the system of education is a complicated machinery for enacting fresh laws.

The term Internet of Things refers to any sort of electronic gadget that has a link to the web and is capable of exchanging information. IoT is being used by higher education institutions to monitor student enrollment, offer protection, include learners in the learning cycle, and modify instruction for individuals who need extra support.

Interactive boards, locking mechanisms, safety equipment, fire detectors, smartphone applications, educational software, and so forth are examples of IoT devices. Several responsibilities related to schooling are made easier by linked gadgets. Surveillance networks, software for administration, and intelligent learning environments give teachers the resources they need to improve student performance.

Educational methods are shifting to customized instruction through the use of technological advances, giving learners the opportunity to develop popular competencies including imagination, technological knowledge, analytical ability, and dynamic resolving issues.

The goal of IoT research has been to find out whether or not it could be applied to enhance online instruction. A strategy for simplifies making choices for educational organization officials is put forth in this research. Using such a plan, it is anticipated that educators will eventually be capable to leverage information from the IoTs in order to arrive at intelligent choices regarding the subject of teaching. Learning organizations have access to continuous streams of information that might be analyzed and fed into their instructional statistics systems in order to come up with data-driven choices.

Particularly, the accessibility of having access to learning forums via the web affects the administrative practices of college and universities. The suggested method's primary benefit lies in the fact it shows educational organizations how to use information gathered from the IoT to assist and enhance online educational experiences. Since schools and universities use the web to gather, store, and transmit data, the use of IoT in these settings is growing in popularity. Innovation has demonstrated that it plays an essential part in the discipline of learning, particularly when it comes to student interaction and instruction [13].

The IoT has impacted both the physical layout of colleges and universities and traditional ways of instruction, that has made a substantial impact on e-learning. When it comes regarding the responsibilities that IoT performs in online learning, there are two distinct sets of thought concerning the subject: first, it could potentially be learned as a course, and second, it might be utilized as a tool to improve the educational environment. Using IoT, every level of schooling may gain from the online learning transformation. Educators and kids are just two of the numerous participants at all levels who might gain greatly from this modern technology. Studies and instruction have both benefited from the application of IoT. The ease of connection among individuals and objects within the academic setting is made possible by the integration of IoT in learning.

IoT plays a transformative role in online education, enhancing learning experiences and streamlining educational processes. By connecting devices, sensors, and data, IoT creates a more interactive and efficient educational environment. With the growing demand on device connectivity and IoT, mobile connectivity remain required to be enhanced further. IoT connected device architecture of the coming years will necessitate techniques including flexible spectrum accessibility, spectrum distributing, adaptive navigation, and intelligence from signals collection. The distinctive characteristics of IT devices alongside the most ongoing widespread use of machine learning are responsible for the current increase of interest for IoT mobile networks.

Considering the enormous amount of IoT devices and the volume of transactions they generate, particularly over mobile communications networks, a scalable networking design is essential. Especially, everyday activities of individuals have become more centered around the IoTs, creating chances to have specialized data accessibility. Figure 1 illustrates the way of integrating the smart devices in education sector.

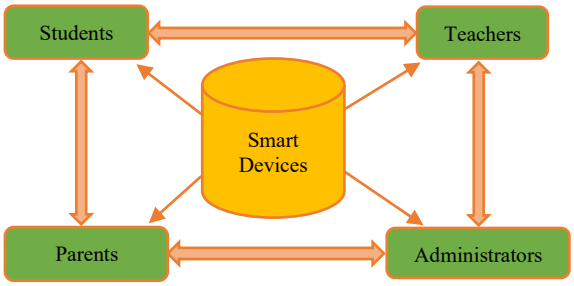


Fig 1. Smart Devices integrated in Education Sector

Furthermore, the IoTs facilitates the enhancement of online education by increasing access. Because of the initial attempts in IoT-based training, enhanced educational outcomes have recently been observed. Over wireless or connected networks, educational and instructional materials are becoming more widely available to individuals worldwide, expanding the possibilities for training to all. Learners as well as educators throughout the globe have access to both national and international data via IoT-based education, which could enhance classroom instruction and educational results. One potential replacement for IoT applications is online learning. Lately, the use of IoT devices has made it possible to incorporate educational resources within the creation of media-rich, sustainable archives.

## VI. Required Smart Devices for Online Learning

The idea of "Teach me so that I comprehend" is brought near to reality by means of contemporary teaching, such as online classes. The manner in which instructors educate and how students study in classrooms is changing as a result of these creative and purposeful utilization of technology [14]. By using this approach to instruction, learners may come out of their claws while improving their abilities to communicate. Educational professionals and administrators in schools have become aware that modern, technologically advanced tools help children educate more effectively and retain information for an extended amount of time. For the purpose to monitor students and provide guidance whenever necessary, teachers

and trainers have come up with a plethora of innovative techniques. Improving the performance of online education involves addressing various factors that affect the learning experience, engagement, and outcomes include enhancing course design and content delivery, employing adaptive learning technologies, engagement and interaction, effective communication, increasing access to technologies, promoting student motivation and sense of community.

Figure 2, 3, 4, and 5 depicts the structure of smart pedagogy, smart administration, smart classrooms and smart assessment followed in online learning.

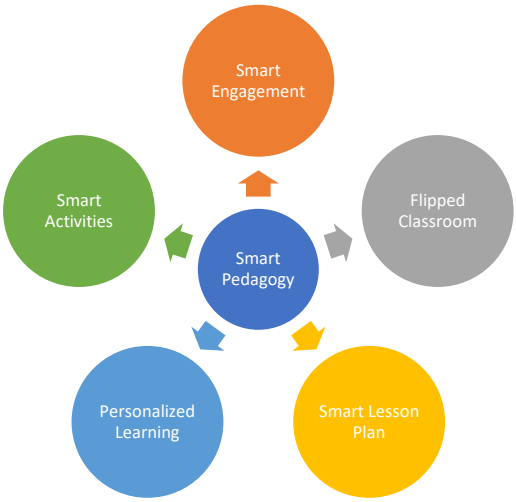


Fig 2. Smart Pedagogy

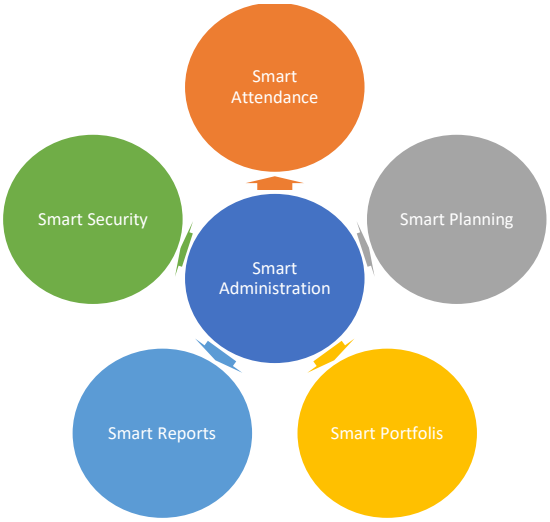


Fig 3. Smart Administration

The swift progress of technology has rendered it challenging for administrators at schools to determine which innovative educational resources would be most useful for their organizations [15-18]. Several smart instructional equipment and materials which are necessary to give children a life-changing educational experience are outlined as follows:

### A. *Whiteboards that interact*

Whiteboards that are interactive have grown into an educational necessity as a result of their extensive usage. It goes without saying that education is far more successful if it is accompanied by images, that assist learners understand difficult topics. Instructors may offer an enormous amount of additional knowledge for students by annotating or writing on files or pictures displayed on the whiteboard with a pen.

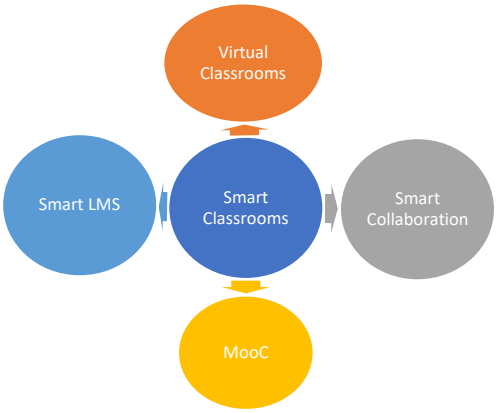


Fig 4. Smart Classrooms

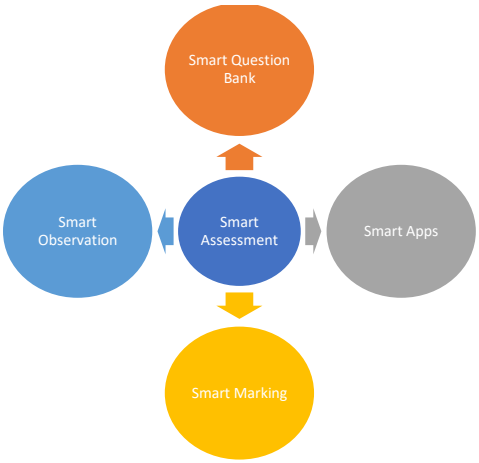


Fig 5. Smart Assessment

### B. *Intelligent Display Devices*

A more affordable but extremely intuitive technology, smart projection devices have grabbed educational institutions on surprise. With a computer and projector attached, any surface that is flat can turn fully interactive. Touch, sketch, annotate, much more—enjoy the delights of flawless writing on a fully responsive screen.

### C. *Superior Quality Document Cameras*

With the help of these creative, reasonably priced intelligent classroom tools, teachers can project homework or perhaps a virtual dissection onto a big sized monitor. It promotes active learning and teamwork in the learning environment.

### D. *Education Administration System*

A broader spectrum of daily tasks and enhanced achievement among students constitute two of the greatest advantageous outcomes of incorporating tech within the educational setting. A form of computer software utilized for monitoring, handling, and organizing instructional materials is called a learning management system.

### E. *eBooks and Tablets*

Similar to computers and cellulars, tablets and e-books are getting more and more common within learners. Learners may

delve deeper towards more skill vaults because the information may incorporate hyperlinks to supplementary resources.

### F. Verbal Typing

Several learners are reluctant to participate in online courses because of an unreliable internet connection. Voice typing transforms the spoken sentences into printed content. This attribute can be found in numerous programs.

### G. Google Lens

To find out details on a strange thing, all one has to do is take a picture of it and send it over to Google's search engine. Using the help of this innovative educational technology, kids are able to explore the subjects that pique their enthusiasm for as long as they desire.

### H. Digital Podium

This modern lecturing platform has a range of elements of media and equipment that enable constant education. The podium has adequate room for a the data visualizer, a computer keyboard compartment, and additional items alongside to an integrated UPS to maintain electrical supply and an instructional session recording mechanism.

Many of the aforementioned innovative teaching tools have the potential to greatly improve the learning possibilities provided to students in educational institutions and classrooms. Administrators can additionally make use of classroom management applications, that will control and regulate the use of applications, the web, printers, and drives in the learning environment in addition to eliminating interruptions.

## VII. Conclusion

The purpose of writing this paper on online education is to provide a comprehensive overview of the current state, trends, challenges, and advancements in the field. It aims to synthesize and analyze existing research, identify gaps, and offer insights into future directions. The entire globe is evolving quickly, and technological breakthroughs and inventions exist all around us, having an influence on every sector of society and industries. Because they happen to be young supporters or digital natives, today's students are more equipped to deal with these swift modifications. In order to remain up-to-date, colleges and universities have begun modernizing and incorporating innovations into their curricula, methods of instruction, and activities. The epidemic has accelerated the widespread use of technological advances, and family organizations have observed the importance, necessity, potential, and efficacy of gadgets for delivering comprehensive education. The incorporation of IoT and electronic devices with educational institutions was examined in this work, which also suggested an ideal structure for smart learning. This article went into additional detail about the problems with conventional methods of instruction and how electronic devices might be used to address them. The author has noticed that regulations have never been appropriately enforced as well as that students are not being effectively involved with instructor supervision and training sessions. Additionally, instructors' effort is squandered on administrative duties that may be done well. Intelligent teaching methods, preparing lessons, student involvement, smart evaluation, smart protection, flipped learning environments, smart enrollment, smart submitting, and smart gadgets transform the organization's regular operations into innovative ones. This study reviewed relevant studies, examined problems with the current educational system, and suggested potential IoT and AI-based alternatives.

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