Interactive and Innovative Technologies for Smart Education

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Abstract. New concepts and ideas have emerged in the process of obtaining and disseminating cognitive, ethical, and public knowledge. In the current state of education, learners, tutors, and the knowledge being transferred are all present, and smart education has made the process of acquiring knowledge more flexible. This concept is accomplished through the use of smart devices and technologies that are interconnected to access digital resources. Smart education refers to a new way of learning that has gotten a lot of attention, notably during the 2020 Covid-19 Pandemic. This article examines the technologies that have aided smart education in achieving its educational goals. With smart technological solutions, modern technologies are enhancing the teaching - learning process in today's education. It is with great hope that the use of modern technologies in smart education will improve educational quality while also making teaching and learning more convenient.

Keywords: smart education, technologies, innovation, interaction, e-learning.

1. Introduction

For the successful structuring of students' educational processes, the system of education necessitates the employment of new teaching technology. In today's digital era, smart education is a form of education which is becoming increasingly generally recognized and enthusiastically embraced adopted by younger generations. This highlights the fact that education based on current technology allows for more efficient and convenient knowledge transfer to students [22]. Smart education can be referred to the process of learning adapted by the new age of digital orientation, providing a more interactive, collaborative and visual method for the purpose of increasing learners engagements and allows tutors to understand student skills and learning preferences. Smart education is a means of learning that has been adopted by the modern era of digital orientation to provide a more dynamic, interactive, and visible way for enhancing students' engagement and allowing instructors to identify student talents and student motivation. Nonetheless, the growing diversity

of data collection is posing a substantial challenge to information systems (IS) and instructional development research. These issues inspire the creation of new ideas, which leads to new technology advancements that allow for the advancement of how improved educational activities are offered [30].

Considering rapid technology breakthroughs, anything can be implemented, networked, and integrated with intelligent and innovative design, and education is no exception. In terms of innovative methods of education, learning, and instructional practices, comprehensive and innovative technology have offered unique chances for academic institutions [29]. Regardless of the fact that key technical innovations have been overlooked in the past, events such as the 2020 pandemic demand quick adaptation of the usage of smart devices and technologies to promote smart learning and education.

Innovative and interactive technology is employed for many core skills, allowing learners to experience smart education via the use of various interactive technologies [18]. Some innovative technologies, such as augmented reality (AR), virtual reality (VR), internet of things (IoT), metaverse, immersive 3D etc., have rattled the education system with their amazing abilities. but concerns are still raised about human alteration or laziness in the adaptation of these technologies, which is related to the fear that prompted the late adaptive response of these technologies in the educational systems.

2.   New Technological Approaches For Smart Education

Education is indeed an area where one might anticipate innovations to take hold as soon as they become accessible. But in actuality, other sectors are faster to adjust to new technological ideas than the education industry [9]. However, since the discovery of mobile devices and the internet, technological advancement has gone decades beyond the conventional instructional system. AR, VR, IoT, metaverse, Immersive 3D, and other emerging approaches for smart education are further discussed.

2.1.   Augmented/Mixed/Virtual Reality

Although AR and VR are similar, they are two separate technologies. AR is an immersive experience in which computer-generated facts and features are connected to the actual world; examples of AR include Global Positioning System (GPS) and cameras [21]. In comparison to AR, VR tends to take place in a controlled environment in which users may engage with it and modify computer-generated elements in a digital world using sensory devices. Examples of VR include contemporary game consoles such as the PlayStation and the Oculus Rift [26]. It can be seen in Figure 1 that AR and VR are combined in mixed reality (MR).

According to [6], augmented reality and virtual reality offer significant possibilities for supporting students in improving their abilities and expertise. Furthermore, integrating AR/VR into education may provide engaging and effective education experiences.

In recent years, technological advancements have simplified the usage of VR and AR, making it more accessible. According to a [19] report, many people already own VR/AR compatible smart gadgets like the ARCore and Oculus Quest 2 (VR headset). Thus, there's no need for a huge and pricey headgear to carry around. In addition, one of the most recent practical applications of this technology is for showing instructions or
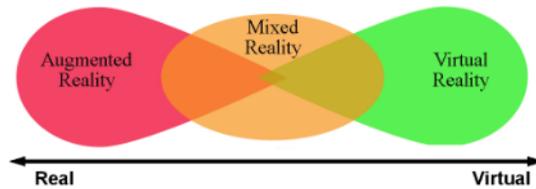
Fig. 1. A representation of AR, MR, VR classification [6]

information in big indoor spaces such as shopping malls and airports. Furthermore, it has been employed in education and other fields like healthcare, remote support, shopping convenience, automotive manufacturing, and so on

2.2. Internet of Things

The internet of things (IoT) is a technological evolution in which items connected to sensing devices, controllers, and processors connect with one another to accomplish a specific goal [16]. Using the internet of things concept in any educational setting would improve the quality of the educational system since learners develop faster and teachers will do their jobs better. As a result, a smart educational system is developed. It includes various communication technologies to stimulate the learning experience and adapt to the demands of various learners [1].

2.3. Metaverse

Metaverse is a three-dimensional virtual reality world in which any user with access to a terminal, from anywhere on the planet, may engage in everything from trading to entertainment. Much of human day-to-day communication has been transferred to the virtual world as a result of the metaverse's advent, which has had a significant impact on human societies and culture in the physical world [12]. It is now being marketed as the technology of the future since it has been incorporated into a variety of industries. The potential of the metaverse as a new educational environment is considered to be a place to build interpersonal contact, greater flexibility to create and distribute, and the introduction of better perceptions and rising participation through virtual machines. As seen in Fig 2, a classroom session conducted in the metaverse.

The current evolution of the metaverse in the educational system enables students to conduct experiments such as examining the anatomy lab on the interior of the body seen in fig 3. As face-to-face interaction becomes more difficult as a result of the Covid-19 pandemic, events that were previously considered to be only feasible outdoors are being transformed to virtual worlds and are fast growing into industries like as medical services, education, and entertainment [17].

2.4. Big Data Technology

Mostly associated with smart education, big data technology has grown at an enormous speed, and incorporates information retrieved from students' interactions with technology

Fig. 2. Classroom map in Zepeto [17]

Fig. 3. Metaverse avatars watching a surgical scene in the smart operating room [15]

as well as their personal and academic profiles. One of the most perplexing features of big data in academia is the lack of standardization [11], as it is in other industries, is how to draw meaning from the data gathered. Researchers and practitioners are steadily publishing and disclosing additional evidence of the advantages of big data technologies.

In smart education, the phrase "big data" is not yet universally defined. All behavioural data obtained from human beings' everyday educational actions, which contains hierarchy, sequence, and contextual properties, is referred to as big data technology in smart education. Furthermore, it relates to data collected from student activations, which is mostly generated through student monitoring systems, interactive learning systems, and curriculum management systems, among other sources [28].

2.5.   Blockchain Technology

Due to its distinguishing properties such as decentralization, trustworthiness, security, and integrity of data, blockchain technology has received considerable attention lately. Many industries are investigating the prospect of incorporating blockchain technology into their respective fields in order to fully use blockchain's potential. Despite its fast expansion, there is little information available about blockchain's current cutting-edge technology in the education system [25]. Beyond credential administration and success evaluation; blockchain technology can be used in education in a variety of innovative ways. Blockchain technology offers a lot of possibilities for both teachers and students in terms of formative assessments, teaching session design and execution, and tracking the progress of the entire learning experience [10].

2.6. Cloud Computing

In the education sector, cloud technology has gotten a huge interest as a method to offer more stable and secure quality education. [14] introduced a cloud-based smart system of education for e-learning digital experiences with the purpose of distributing and sharing advanced forms of educational material such as text, pictures, images, videos, and three-dimensional (3D) objects, among other things. Digital learning has always been a part of smart education, dating back to instructive TV programmes. Electronic-learning, mobile-learning, and now smart-learning have all grown from it. With the use of cutting-edge technology such as IoT and cloud computing, academies are getting smarter. It improves the typical classroom setting to help students learn more effectively [5].

2.7. Artificial intelligence Technologies

Artificial intelligence plays a variety of functions in education today, making it smarter. Artificial intelligence advancements have opened a new era of computer-assisted education. Computer systems with cognitive capacities can not only operate as intelligent teachers, resources, or students, but they can also help with strategic planning in the context of education. The combination of artificial intelligence with education opens up new avenues for considerably improving educational and learning quality. Intelligent systems assist instructors in testing, data collection, academic performance improvement, and the development of new strategies. Asynchronous learning and smart educators assist students enhance their academic performance [13]. Furthermore, the implementation of artificial intelligence with education is a revolution not just in smart education but also in human understanding, cognitive, and civilizations.

3. Application Of Artificial Intelligence Techniques In Smart Education

As the base technology used in the evolution of smart education, Artificial Intelligence (AI) techniques are important mechanism because it creates and mimic people's decision-making processes. Additional explanation of some artificial intelligence model such as Fuzzy Logic, Decision Trees, Neural Networks, Bayesian Networks, Genetic Algorithms, and Hidden Markov Models are used in smart educational reforms etc., to develop a suitable AI integration in education [7].

Fuzzy Logic Fuzzy logic is an artificial intelligence strategy for processors to use the "degrees of fact" instead of the traditional "true or false" (1s or 0s) Binary logic that underlies current computers.

Decision Tree For classification and regression in AI machine learning, Decision Tree (DT) is a nonlinear supervised training technique for developing algorithms for defining target classes by learning fundamental decision rules from data characteristics.

Neural Network The neural network technique is a collection of algorithms that attempt to find hidden patterns in a data stack by employing approaches that mirror how the brain operates. Neural networks in this sense are made up of a collection of naturally or artificially neurons.

Bayesian Network The Bayesian network (BN) is a completely comprehensive model for describing data about an uncertain domain, with each node representing a random price and each chord showing the transition options for those unknown parameters.

Genetic Algorithm A genetic algorithm (GA) is an artificial intelligence (AI) approach for addressing both limited and uncontrolled classification problem that uses a natural selection process similar to evolutionary biology.

Hidden Markov Model The Hidden Markov model (HMM) is a statistical Intelligence technique commonly used to represent biological events. In reality, a pattern is represented as the outcome of a continuous random process that progresses through a set of "secret" levels from the viewer.

Some performance indicators (e.g., specificity, accuracy, area under the curve, sensitivity, and so on) are used in measuring the approaches employed in the implementation of machine learning and artificial intelligence in the educational system and other domains [8].

Accuracy Accuracy matrices specify the amount of accurate classification model across all types of assumptions made. *Accuracy* is an excellent measure to utilize whenever the target factor categories in the data are nearly equal, but it is not the ideal measure as well when the point factor categories in the data are a bulk of one category. Accuracy = (TP + N) / (TP + FP + FN + TN)

Sensitivity For a given model and prediction issue, sensitivity analysis provides a method for assessing the link between model performance and dataset size. Sensitivity is not so much about accurately obtaining instances as it is about obtaining all cases that match. So there is 100 per cent *sensitivity* if there is always matching data in a dataset. Sensitivity = (TP) / (TP+FN).

Specificity The fraction of true negatives properly predicted by the model is known as *specificity*. Specificity = (TN) / (TN+FP). Specificity is the polar opposite of Sensitivity.

Note in the above, TP (True Positive), TN (True Negative), FP (False POSITIVE) and FN (False Negative). As further explained by [31], these indicators or metrics are used after developing a model to determine the model's effectiveness. The measures used to evaluate the AI model are significant. The measurements are used determine how machine learning techniques' performance is assessed and evaluated.

From the standpoint of instructional methods shown in figure 4, AI in education can serve as an intelligent tutor, tutee, learning tool/partner, or policy-making adviser [13].
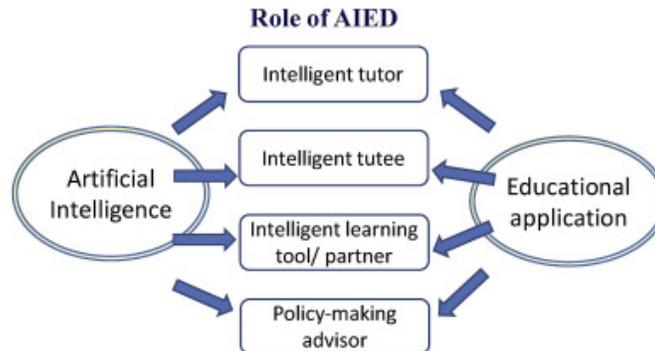
Role of AIED

Intelligent tutor

Artificial Intelligence

Intelligent tutee

Educational application

Intelligent learning tool/ partner

Policy-making advisor

Fig. 4. Structure for AI's roles in educational systems [13]

4.   Smart Education Environment

The integration of innovative technology is often limited when there are two main components, competition and skill level of technology. The smart educational environment represents a step forward in the application of innovative and interactive technologies to the traditional library, transforming it into a completely different system that can be called smart education. With the incorporation of new technologies, an environment can be considered a smart environment for smart education in which the educational approach uses technologies such as IoT as part of new innovation with which it can collaborate to enhance the quality of services by offering a customized smart educational environment [20].

In the proposed intelligence library system framework by [4], The framework, according to the authors, provides libraries with an integrated database that combines three basic components: the electronic book shelf (EBS), which provides complete access to price levels; the virtual white space (VWS), which allows users to discuss data library resource; and the Innovation and Social Networking Database (ISNB), which allows users to share and store innovative concepts.

The benefits of a smart educational environment come from leveraging the knowledge that exists in the library and the way advanced wireless technologies are used and applied in the library. Students can directly benefit from participating in research and development using a smart educational environment. Smart education environment will provide an academic environment with intelligent educational services through the framework proposed by [4].

The interaction of humans and computers in the educational environment should be taken into account during the implementation of a smart education environment. Computer systems, when used appropriately, can be a useful tool for enhancing and assisting learning and teaching. They make students absorb information more easily during the learning process. Combining computer-based systems with practice programs, learning tutorials, and Internet-based learning can help achieve this. When students are enthusiastically immersed in the use of technology, they learn more quickly. Both students and teachers should be responsible for ensuring that continuous progress in learning and technology adoption is maintained. As a result, for the successful implementation of human-
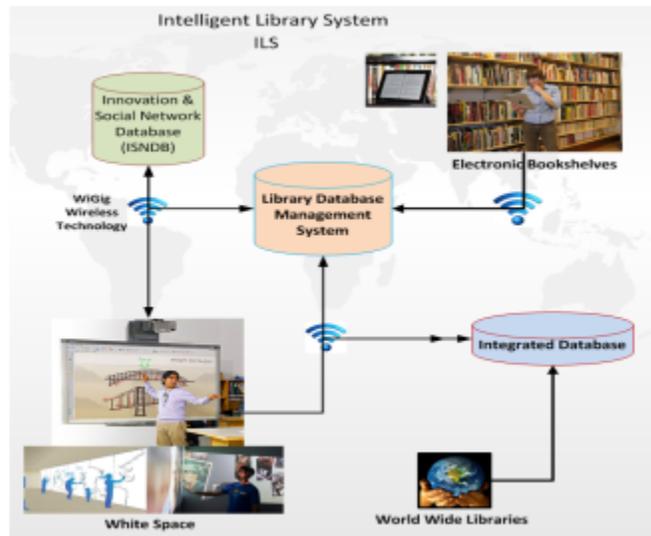
Fig. 5. Intelligence library system framework [4]

computer interaction in schools, every entity participating in the educational system must be devoted and supportive. Both students and instructors must accept and embrace technological advancements. Everyone needs to learn about information systems, and it's inescapable as the world transforms into the internet of things. New things are discerned by creativity, and new things are performed by inventing [23].

5.   Smart Education Technology Features And Challenges

Undoubtedly, smart education technology has its features and challenges. In Table 1, the technologies and their challenges and features are compared in terms of complexity, increase, reduction, moderate, and support.

Innovative technologies in smart education can be seen in Table 1 combine with technological features and challenges like [24]:

5.1.   Agility

The flexibility of smart education technologies to operate rapidly and effortlessly varies between the complexity of traditional education, the growing capabilities of artificial intelligence, augmented reality , virtual reality, blockchain and the best of 5G performance, learning management systems and applications.

5.2.   Adaptability

Traditional education is complicated in its capacity to adapt to changing situations, which is modestly controlled for augmented reality, artificial intelligence, and virtual reality.

Technology/ Features & Challenges	Agility	Adaptability	Integration	Interoperability	Reuse	Reliability	Quality	Learning Expe.	Cost	Safety	Proof Of Work	Op. Efficiency
Traditional Education	C	C	C	C	C	C	C	C	C	C	C	C
AI	I	M	I	M	M	M	I	I	R	-	N	R
AR and VR	I	M	I	M	M	M	I	I	R	-	-	-
Big Data	-	I	I	I	I	I	I	I	R	R	-	-
Blockchain	I	I	I	I	I	I	I	I	R	I	B	B
Cloud Computing	-	I	I	-	I	I	I	I	R	I	-	I
Data Science	-	-	I	-	-	M	I	I	R	-	-	M
IoT	-	I	I	C	R	I	I	B	R	R	-	S
ML and DL	-	I	-	-	I	-	I	I	R	I	-	-
5G	B	B	B	-	-	B	-	-	R	-	-	-
LMS &App.	B	B	B	B	B	B	I	I	R	-	B	I
STEM	Experiment, Discover, Thinking, Collaboration, etc.											
C-Complexity, I-Increased, R-Reduced, B-Better, M-Moderate, S-Support												

Table 1. A comparison of smart education innovative technologies [24]

In terms of adapting to new developments, big data, blockchain, cloud computing technologies, the internet of things, machine learning, and deep learning are all gaining in popularity, while 5G performance, learning management systems, and apps are improving.

5.3.   Integration

Traditional education's ability to integrate with existing or emerging technologies is still a slow process, while augmented reality, virtual reality, artificial intelligence, big data, cloud computing, blockchain technologies, the internet of things, and data science are all being moderately integrated. The performance of 5G networks, learning management systems, and applications are getting better as they integrate with current and future technology.

5.4.   Interoperability

Interoperability is a feature of smart education technology that allows them to communicate with other systems. The capacity of conventional education and the internet of things to interact with other systems or networks outside of their respective sectors is difficult. Artificial intelligence, augmented reality, and virtual reality have limited capacity to integrate with other systems. Big data and blockchains are increasingly being used in conjunction with other platforms, while learning management systems and apps, work better with other educational systems.

5.5. Reuse

For artificial intelligence, augmented reality, and virtual reality, the reusability of smart educational technology is modest. Big data, machine learning, deep learning, cloud computing, and then blockchain are all being utilized more and more often. Learning management systems and apps are better utilised than the internet of things.

5.6. Reliability

Artificial intelligence, data science, augmented reality and virtual reality are efficient technologies. Cloud computing, the internet of things, big data and blockchain are becoming increasingly trustworthy. 5G networks, as well as learning management systems and apps, are more dependable.

5.7. Quality

The quality of smart education technology is improving generally. Every time there is a new technology, it is normal for it to be tried in every possible applicable area. This has prompt for a steady quality assurance in improvement of smart education technology.

5.8. Learning Experience

Learning experience is a procedure that allows a student to accomplish a desired academic achievement in a human-centred manner, most often through technological advances. According to table 1, the learning opportunity of smart technology in education is typically growing, with the exception of the internet of things, which has a greater learning experience.

5.9. Cost

In education and other areas, the cost of innovative and interactive technology for smart education is decreasing and becoming more affordable. Cost has always been a major factor to be considered in any sector and technological invention and innovation. If a certain technical product is overpriced or too expensive, it can become a problem for both the inventor and the users because if customers are unable to afford the product, the inventor or producer will be unable to make required amount for advancement or further researches

5.10. Safety

The security of artificial intelligence, augmented reality, data science, and virtual reality, as well as 5G networks, learning management systems, and apps, has yet to be determined. But it is low in huge data and the internet of things, as well as strong performance in blockchain technology, cloud computing, machine learning, and deep learning.

5.11. Proof of Work

Proof of work is a type of encryption proof whereby one group demonstrates to another that a specified amount of processing effort may be invested. In this situation, most smart education technology has no evidence of work, according to table 1, excluding blockchain technology and learning management systems and applications, which have greater proof of work in educational settings.

5.12. Operation Efficiency

Performance measures the intelligent allocation of educational resources between the increased efficiency of cloud technology, learning management systems, and applications. Artificial intelligence is reduced to a minimum; the blockchain is more efficient; data science is modest, and the internet of things is highly favourable.

5.13. Comparison of Modern and Traditional Educations

The enormous contrast between conventional education and current smart education is clearly shown in Table 1. In terms of holistic growth, connection and response, cognition, attention, delivery techniques, persistence, comprehensibility, and accomplishment of the students. Table 2 shows a feature-by-feature comparison of modern and traditional educations. Leveraging the power and advantages, effective technology adoption creates a scalable and cost-efficient smart education system. Educational administrators and end-users should be aware of how new technologies are being used in the classroom today, as well as instances of how these technologies are being used in entrepreneurial solutions [3].

Table 2. Feature wise comparison of modern and traditional educations [24] [3].

S/N	Parameter(s)	Traditional Education	Smart Education
1	Academic Independence	Classroom only	Through technology
2	Attainment Capability	Lower	Higher
3	Attention span	Very short	Fairly Large
4	Cognitive Ability	Limited	Enhanced
5	Evaluation	Prefixed	Continuous
6	Feedback	No provision	Evaluation with a feedback mechanism
7	Interaction	Limited	Enhanced
8	Learning Time	Fixed	Anytime & anywhere
9	Delivery	Teacher	Learner centric
10	Motivation	Teachers	self-motivated
11	Retention	Lower	Higher
12	Study type	Not promote	Promote. Group/ Collaborative
13	Understanding the ability	Limited	Much better

6.   Ethical Consideration in Technology Usage For Smart Education

Avoiding the misuse or misconduct in the learning process, ethical usage of technology should be addressed in the process of learning through technology. According to [2], humans must first talk about morality in a form that computers can comprehend before giving robots a sense of morality. This means that moral and ethical algorithms must be written in a style that allows them to be codified. Regardless of any ethical guidelines or regulations governing the use of technology in smart education, the establishment of trust is a necessary requirement for the mutual advantage of smart and intelligent education systems [27]. Students and instructors should always have mutual point of view towards the usage of technology for smart education and penalties in place for those taking unethical steps towards smart education

7.   Advantages and Disadvantages of Smart Education Technologies

As with any other innovation or advancement, there are always upsides and downsides [3]. The advantages and disadvantages of smart education are explained.

7.1.   Advantages

a. Smart technology encourages students to stay engaged in their studies. Students may use a learning management tool, for example, one may look up more information about the topic being studied, play game based learning to supplement lectures, or focus on more advanced topics.

b. It encourages instructors and parents to communicate more. Teachers may utilize applications and software to report on a student's actions in real time, alerting parents of what is happening throughout the day.

c. The cost of using smart education technology in education systems is quite low. The expense of implementing new technology throughout the municipality can be significantly high, but student computers, tablets, and class materials are inexpensive.

d. It gives today's modern student new methods to learn. Students who grow up outside of the typical educational setting can realize their full potential even if they have access to technology.

e. Smart education technology enables educational administration to provide students with data access from a single point. A learner could use technologies to get all of the resources they need for a project in one place.

f. It improves access to student behavioural data. Technology assists the education system in identifying outstanding kids and continuing to push them toward increasingly challenging tasks in order to pique their interest in the academic setting.

g. Collaboration is encouraged in the classroom through the use of these technologies. When the teacher gives a lecture from a textbook, the student retains just a little amount of information. Students will never forget anything if they can instantly put what they have learnt into practice.

h. When lecturers employ technology in the classroom, they gain credibility. Parents who are hesitant to allow their children additional screen time for learning purposes may also criticize.

7.2. Disadvantages

a. The presence of technology can cause students to get distracted. When implementing reward-based activities to boost learning in an educational setting, students may focus on what they obtain through software or applications rather than what they learn.

b. During tests, students can text themselves. It also necessitates strict restrictions for the use of technology in tests and examinations that need an accurate evaluation of the student's knowledge in order to evaluate the student's overall growth.

c. Some individuals may be unable to distinguish between trusted and unsafe websites. There are many phony and exaggerated things on the internet these days, yet they all appear true.

d. Rather than implementing modern learning technology, some institutions are unable to pay instructors' wages on a yearly basis. Prioritizing the use of technology in the classroom puts individuals at the bottom of the pay scale at a significant disadvantage.

e. Today's active learning classes are so successful that the programs may function as the instructor rather than being hands-on; technology allows the educator to take a more passive role.

f. Annually, a substantial number of people are victims of some form of identity theft. We put our pupils' identities at jeopardy every day by bringing technology into the classroom. Even if effective privacy filters are built into programs, computers, portable devices, and operating systems to lower the risk of data theft, there is no means to ensure that all dangers have been eradicated until the equipment is never connected to the internet.

g. When you look at a computer display for a lengthy amount of time, you get eye strain. This ailment causes back ache, eye pain, neck pain, fatigue, decreased vision, and difficulties focusing.

h. Educators devote as much time to their pupils as parents do to their children. As a result, the classroom will become an integral part of each life of a student. That is why, if feasible, any school that incorporates technology into education should simultaneously promote up to 30 minutes of good physical exercise

8.   Conclusion and Recommendations

With smart gadgets, modern technologies are enhancing today's learning with increased teaching and learning. This technology enhances the classroom experience by transforming the education platform to allow sophisticated real-time search, sharing, collaboration, and communication. Smart education, smart training, smart instructors, smart analytic, smart reporting, and smart learning spaces are all examples of smart education solutions. The differences between conventional and new technology continue to exist, as do the gaps between traditional and modern education, which is merely the conventional hesitation to adapt to modern means. Smart education, with the assistance of advanced technologies, simplifies the tasks of educating, studying, connecting, and cooperation, and makes rapid alerts more productive.

New technologies are finding their footing in the learning industry. More research should be conducted to offer a stronger link between technology and education, so that the application of rising technological trends can leads to a revolution in educational models and architecture, radically re-imagining how people approach learning in general.

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