IoT-enabled devices: Innovation in technology for the promotion of distance learning and E-learning in COVID-19

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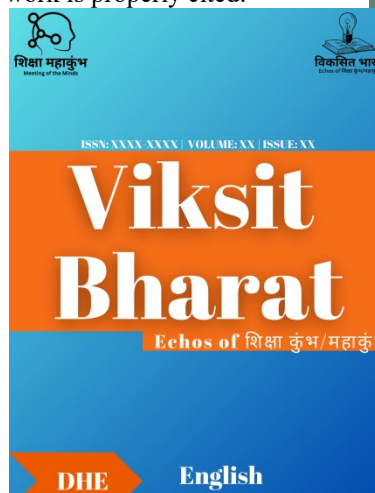
Abstract
Distance learning is in demand whenever education is widespread. Distance educational standards have received a significant amount of attention considering that they are necessary for everyone's safety during COVID-19. Despite having an impact on everyone's daily lives on a global basis, Covid-19 has severely destroyed everything. No industry appears to be immune from the effects of this pandemic. The education sector was significantly impacted by the lockdown in all nations, and the federal government and administrative organizations have opted to close academic departments for safety reasons. Nevertheless, at a certain period, technology and IoT gadgets played a crucial role in the continued existence of work, allowing people to transition from traditional jobs to work-from-home or online jobs, traditional classes to online classes, and from traditional money to electronic money. Furthermore, IoT gadgets, such as iPhones, smartphones, tablets, apps, desktops, and laptops, support and promote e-learning in virtually every aspect of life. Technology has advanced significantly. Thanks to the development of software and apps that meet the demands of business professionals, academics, educators, students, and the general public. The Zoom app and Google Meet allow for the creation of virtual classrooms, which facilitates distance learning, additionally, by offering networks all around the world, telecommunications corporations promote the technology. The teaching cannot be halted for an extended period due to the timely availability of networks, performance enhancements, and upgrades. In the typical classroom, teachers might not have a well-thought-out lesson plan before entering the education services. The need for the virtual classroom demands that academics have carefully prepared notes, presentations, and database management. Thanks to the Internet of Things, in COVID-19, gadgets can now instantaneously provide services. This article will concentrate on technological developments for conferences, online meetings, and education through the optimal use of networks and their timely availability to promote E-learning and remote learning, which people no longer desire.

Keywords: IoT-enabled devices, COVID-19, Distance learning, E-learning, Technology, Gadgets.

Introduction
Over the past couple of years, there has been a tremendous improvement in education. The phrase "education" relates to a lot more than texts, also it refers to the setting within which a child or other individual acquires basic academic achievement. Both the quality & environment that "education" had vastly enhanced thanks to automation. Its adoption to study virtually and indeed the widespread overuse of e-books inside the curriculum are indeed creations of technological development. Cognition plus technological innovations have improved for the betterment of the said field of education. As just a result, innovation in education boosts study. [20]

Gadgets that are associated with the Internet of Things (IoT) offer network infrastructure to somehow be outside the usual standard devices such as Consoles, tablets, handsets, etc. Those Internet-of-things gadgets are fully assimilated with high-resolution equipment,

facilitating faster worldwide web communication and interaction. Gadgets can also be operated and monitored remotely if desired. [21]

83.2% of all 12- to 17-year-olds, accordance to an eMarketer estimate, own a cellphone. Furthermore, 31.0%

of respondents stated that their child had a mobile between the ages of 6 and 10, whereas 73.0% of parents stated broadened their child had a device between the ages of 11 and 13. [22]

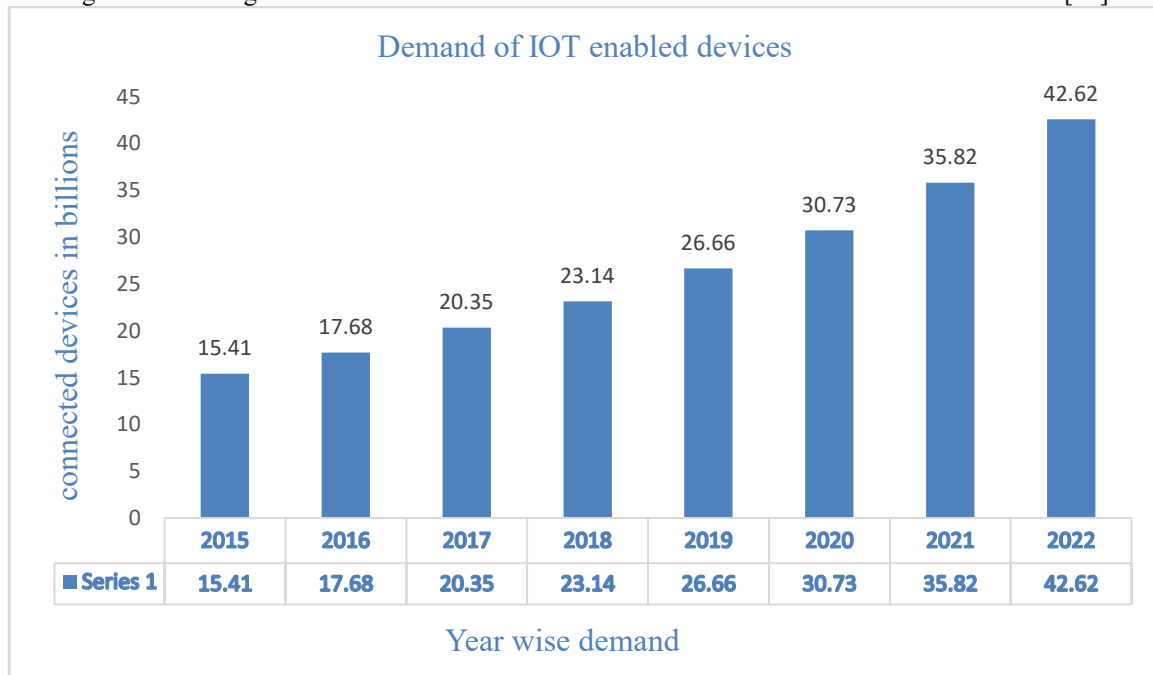Fig 1.1 is showing the demand and use of IoT devices versus the connected devices in billions[21]

Demand of IOT enabled devices

	2015	2016	2017	2018	2019	2020	2021	2022
■ Series 1	15.41	17.68	20.35	23.14	26.66	30.73	35.82	42.62

connected devices in billions

Year wise demand

Fig 1.1 Demand and usage of IoT devices

Literature review

The goal of Bozkurt, Aras, et al. (2015) is to examine the most recent developments in the field of distance education research from 2009 to 2013. The American Journal of Distance Education (AJDE), Distance Education (DE), The European Journal of Open, Distance, and e-Learning (EURODL), The Journal of Distance Education (JDE), The Journal of Online Learning and Technology (JOLT), Open Learning: The Journal of Open, Distance, and e-Learning (OL), and The International research of Study in Open and Distributed Learning were the seven peer-reviewed academic publications that were deeply analyzed to identify the dynamics (IRRODL). Researchers reviewed 1,225 papers for this study, and 861 papers were included in a systematic review and filtered using the specific criteria. To analyze the published reports, content analysis was generally utilized. [1]

The study by Bagheri, M., and Movahed, S. H. (2016, November) explains the ways modern institutions and

courses can be transformed by IoT devices. Authors had already partitioned the use of such IoT in academic achievement into four different categories: education-learning improvements, which further include providing broader and deeper educational experiences, security systems, one that makes university buildings secure and safe, and health monitoring, which gives Uni students access to the highest medical services, and university resource management and environmental tracking. Researchers too have highlighted how the IoT technology potentially affects the learning model for learning. The assessments of the Canvas business model illustrate that brand elements are greatly influenced by IoT. Cost savings, individualized instruction, improved efficiency, higher reliability, convenience, and cooperation are just some of the possibilities. Creating interactive and customized partnerships has also led to new strategic partnerships and channels. [2]

Van Deursen, A. J., and Mossberger, K. (2018), The "Internet of Things" (IoT) has the potential to improve

society in several regulatory arenas, namely those related to power, nutrition, mobility, community security, as well as the atmosphere. Furthermore, to leverage emerging tools and minimize wider implications, government leaders will also have to pay a lot of attention to the expertise that individuals may need. Researchers believe that providing a better understanding of the IoT to individuals will fluctuate due to the diverse capabilities and resources, enabling some individuals to gain a competitive edge whereas negative physical and emotional affect others in new and interesting ways. Experts focus on changing new platforms and competencies needed, plus they clarify how and why the IoT differentiates from technological breakthroughs from such a system design context, highlighting workers and service users and being able to use this knowledge. Ultimately, they offer a roadmap driving prospective Internet-of-things-of-things social research and practice through merging both challenges of digital literacy and Internet-of-things expertise. [3]

Ramlowat, D. D., &Pattanayak, B. K. (2019), Address practical applicability from the aspect of diverse learning professions, such as comp sci, healthcare, virtual learning, consumer sustainable training, etc. Social interaction has changed into connectivity between us all and everyone, meaning alludes to human, personal, and equipment communications collectively, well with the advent of the technology of Thing (IoT). Technology has been able to include several aspects of human life as a result, including confidentiality protections, medical, disposal, surveillance systems, as well as more. Throughout this study, they emphasize the impact of Technology in boosting education quality.[4]

Al-Emran, M., Malik, S. I., & Al-Kabi, M. N. (2020) Al-Emran, M., Malik, S. I., and Al-Kabi, M. N. (2020) emphasize significant innovations in the implementation of IoT education-related applications as well as offer a variety of opportunities and obstacles for upcoming experimentation. The above meta-analysis explicitly covers the projected implementation of wearable computing, sustainable IoT, healthcare instruction and training, vocational and technical, including IoT in academia. The introduction of IoT as well as its implementations across impoverished countries are found to be in relatively beginning stages, and independent research is highly recommended.[5]

The variations amongst digital learning, digitalization as well as investments in infrastructure, realistic technologies enabling digital learning, and traditional classrooms for legislation students attending colleges and universities are thoroughly discussed in Ametova, O. R., &Mustafoeva's (2020) article. [6]

Ananga, P. (2020) presented a comprehensive review of the available literature mostly on subjects of teaching methods, e-learning, ideologies of acquisition & associated relevance regarding e-learning, along with an analysis of all these concepts. It must have been observed that although learners seem to be the primary concern overall education system, e-learning promotes simply shedding a spotlight upon particular interests. This research's major assessment seems to be that e-learning should serve as a service mechanism throughout education, and then it implies that continuous improvement necessitates academics who already are engaged and determined. [7]

The research by Makamure, C., &Tsakeni, M. (2020) demonstrates academics' perspectives on this transformation and respective judgments on which Web 2.0 technologies to employ to create online rooms. Furthermore, the combined accessibility, usefulness, and significant difference exists, plus multimedia of smartphone direct messaging programs made them a popular alternative. The study also demonstrated how administrators encountered difficulties customizing conventional practical experience exercises toward computer-based instruction, which resulted in the adoption of teaching assistant methodologies.[8]

The 2020 study by Almaiah, M. A., Al-Khasawneh, &Althunibat intends to examine the major obstacles which the existing e-learning systems must overcome and the primary elements that encourage their utilization during the COVID-19 outbreak. The above research used the interview method and NVivo software for thematic analysis. At six universities throughout Jordan and Saudi Arabia, the interviewers comprised 31, e-learning technology professionals and 30 participants. Overall findings of this research present key guidelines for judgment calls, administrators, programmers, and scholars, encouraging participants to become more knowledgeable about the vital aspects of said effective implementation of e-learning technologies even during the COVID-19 ebola outbreak.[9]

To enable Publish/Subscribe communication between Internet of Things (IoT) and Robotics modules, Coronado, E., and Venture, G. (2020) provide simple code examples. The technological viability of NEP for providing quality systems is illustrated through a short description of two separate examples undertaken outside the research labs. The very first application example rapidly highlights whether NEP can be utilized to enable the creation of End-User Development (EUD) platforms for IoT-aided Communication. To implement Internet - of - things HRI in a crowded place, the following application example outlines innovative programming infrastructure incorporating reducing sensors gadgets, a holistic and

integrated approach to perceiving functionalities, as well as ROS-based humanistic robotics. Ultimately, research benchmark findings indicate how NEP delivered good performance statistics while grouping related networks operating in nearby as well as immediate area networks than a well-established province technology (ROS using rosbridge). [10]

The modern efficient approach enabling virtual learning within higher education is presented by Ilieva, G., &Yankova, T. (2020), which is based upon IoT technology. This system that has been explained aggregates complete data, simplifies the process of choosing the most appropriate educational content, as well as minimizes dishonesty in both exams and assessments using webcams, an EEG, face recognition, and an eye tracker. smartwatches, GPS tracker via deep learning techniques, and face recognition machine learning techniques to deliver lectures and seminars, conduct exams, deliver lab experimentation, and mark attendance. [11]

Digital tools like Moodle, interactive digital services including Google Meets, Microsoft Teams, and Zoom, and social media like Facebook and Twitter, as well as the cellphone, have been emphasized by Jacques, Ouahabi, and Lequeu (2021). The biggest worries about the viability of e-learning- learning, the acquisition of knowledge, and also the appraisal of skills and competence arise within higher academia. Several challenges are being explored in this research through monitoring 81 engineering students in France throughout the period of various training sessions. The overall outcome of said pass the information questions conducted distantly indicates that the trainees attained relevant results which have been equivalent to some of those predicted via facial expression learning. The concurrent methodology towards e-learning provided minor constraints for 91.4percentage points for all participants with adequate resources for hardware and software based on the outcomes of the methods such as surveys. Telecommunications interactions including social media networks are utilized by the 8.6percent of terms million pupils who have been influenced mostly by digital literacy. [12]

Razzaq, S., et. al. (2022), recently presented forward Deep Class-Rooms, a software platform enabling Punjab, Pakistan's state schools, which oversee enrollment plus open courseware. Deep Class-Rooms were considered cheap, but it still demands Radiofrequency technology with reduced processing. Gadget with on access that has

used multilayer computational models enabling attendance management as well as subject matter screening plus virtual education.[13]

Maatuk, A. M. et. al. (2022) article's main demographic is the University of Beng-hazi's Information Technology (IT) institution's student population as well as university staff. This descriptive survey design was in use, while statistical techniques were employed to examine their findings. Requests comprise two distinct varieties being drafted and distributed, in other words, comprehensive evaluations for the learners as well as the educators. This one has four factors being addressed that increase efficiency and effectiveness, that is, how often e-learning was being used, and whenever COVID-19 became common. [14]

Mohamed Hashim et. al. (2022) tends to give 1st understanding of something like the massive modifications altering academics' perspectives, how universities can avail advantage of these opportunities, and now a masterplan towards designing- a creation of strategies that incorporate elements by employing digital workplace techniques using transformation higher, organizations might oversee such key developments throughout the methodologies. [15]

Mondal, S., & Mitra, P. (2022) An in-depth overview of IoT-enabled innovations' achievements in managing the business, commercial, institutional, as well as clinical infrastructures are provided in this systematic review. The Internet of Things (IoT) and other smart applications have quite a substantial impact on malware recognition, reporting, as well as controlling their spread, as has become obvious. [16]

Rahmani, A. M., (2022) addressed the pros, ongoing obstacles, pitfalls, or constraints on the Internet of things in this research. Their research demonstrates that stated pricing, which is employed in 79% of all publications, meaningful (which appears in 64percent in terms of all articles), reliability, & inaccuracy (which is found in 57% including all researched papers), are indeed the three key factors while appraising Distributed application.[17]

Gyimah, N. (2022), In light of the ongoing COVID-19 epidemic, research studies sought to comprehend how modern technology has been implemented in education. This research's information came from International Labour Organization's (ILO) Sectoral Brief and the United Nations Educational, Scientific, and Cultural Organization (UNESCO) materials collectively made up

the main sources of information for this study. It was determined that technical innovation has become quite relevant, especially when it comes to e-learning. [18]

Park, S. J., et. al. (2022) focus on Operational outcomes, including business, care services, construction, teaching, hospitality, & travel should just be included in the research. SCOPUS and Web of Science, 2 internet repositories comprising community publications, are used in this report's literary analysis to determine trends and patterns for something like the epidemic period among numerous sectors. IoT, intelligent machines, architecture, constructions, environment, and COVID-19 were identified as a concentrated search group by the review of 123 manuscripts. It was found that the creation of a structure with such a given purpose included an overlapping understanding of the Internet of Things. Their results reinforce the importance of "intelligent engineering," a product specialty of infrastructure. The article aims to organize fundamental skills required for incorporating the Internet of Things among three key architectural areas, encompassing strategy, development, & implementation, for architectural design integrating IoT.[19]

IoT in education
Millions of examples throughout human ordinary routine now undergoing a major transformation as a result of the Web of Things (IoT), which refers to the connectivity of internet-enabled Devices that aren't ordinary items like cell phones and computers. Academic achievement is part of that list, irrespective of the fact it might not seem like it's a natural use of the IoT. [20]

3.1 IoT in Schools
Well with the development of mobile computing as well as the Internet of Things, school systems now can oversee essential resources, enhance data exchange throughout the curriculum, and strengthen school security. Instead of the fixed homework assignments of the past, educators can now use such technology to devise "intelligent teaching strategies." [21]
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Automating classroom chores, attendance tracking, note-taking, and schedule checking is made possible by the use of IoT-enabled devices in classrooms. In light of the numerous advantages of IoT devices, U.S. schools are currently saving $128,000 annually by employing a web-based system control. They save $200,000 a year on paper costs thanks to technology-based devices' cost-consciousness and use of renewable resources, but technology and IoT-enabled devices have now made one-to-one communication possible with online communication and the rapid accessibility of information. [22]

3.2 IoT in Higher Education
Information systems can be integrated within higher education institutions towards significant assistance. However, in broad universities, learners can indeed be assured of security because of automated surveillance systems that can be installed in a range of locations. Because it renders buildings increasingly operational & enables significant energy savings, Ventilation configurations can indeed be adjusted in compliance with utilization & population. Users might analyze, supervise, and secure research areas as well as basic supplies.[23] University education might benefit from just a variety of Prekindergarten technologies, however, there are also no Environments mobile apps that are only accessible on campuses.[23]

IoT in education during Covid-19
To slow the transmission of the breakthrough coronavirus in 2020, institutions throughout the globe have shut down and immediately stopped accepting in-person teaching. Both educators and students had been thrown into full panic mode in the middle of the academic year and heavily depended mostly on Technology to assist them in adapting to disciplined virtual classrooms. That pandemic illuminated a large number of harsh truths of socioeconomic imbalance, too. Even though some learners acquired familiarity with using video conferencing applications including Zoom and other workpieces like virtual reality and augmented reality, other, unusually low graduates, struggled to maintain prerequisites like just a consistent connection to the internet. [24]

According to NWEA estimates, American children from classes 3 to 8 are anticipated to learn only about half as much mathematics as well as about 70% trying to read as they would during a mainstream education year as a result of the transition to virtual classrooms. This same field of e-learning continues to have a lot of territories to cover. Thankfully, emerging Technology as well as the introduction of numerous startups concentrating on technological education have the potential to eliminate the discrepancies. [25]

IoT-enabled devices
Rapid industrialization would be straightforward when it is coupled with wise current technologies. Technology allows this to happen via quickening operations as well as effectiveness. [26]

5G connectivity
By interacting alongside the Internet, 5G technologies can improve overall performance. With IoT devices, 5G connectivity may spread rapidly because it upgrades connections featuring unlimited throughput with negligible speed. Various mobile carriers and many other

enterprises are already researching 5G new tech to provide more efficient services. In 2022, it'll still boost IoT expansion and extend towards new sectors. Consumers can achieve sophisticated Wi-Fi featuring excellent security and speed by implementing 5G offerings. IoT and 5G connectivity are anticipated to bring about a significant transformation that will eliminate all technological concerns. Connecting will also improve IoT services. [27]

Smartboard
One best interpretation of such a tech startup entering education is SMART, which then in 1991 designed the first appropriate media. Through the elimination of educational methods from dark chalk having reigned supreme in the education sector over generations, Interactive whiteboards revolutionized the ways both educators and students participated in the curriculum. [22], Meanwhile, SMART is not the only business with an investment in this American educational system. Like a potential replacement for the SMART board, IPEVO also created a cordless online interface. Startups and Edtech firms are now also offering resources and services to be used in education. Bounce is an app that Ideapaint produced to provide a wider range of academic experiences digitally. [28]

Digitized classes
Today's children can't able to survive with no internet access and electronic devices due to technologically advanced classes. In reality, it's certainly probable as most students carry no fewer than 2 gadgets that are connected to the internet into the classroom. The digital age of higher educational institutes is primarily powered by technology. Therefore, feasible for learners to receive more personalized & lively educational instances, resulting in exactly what students are seeking and expecting to receive from their monetary investment in the institution they attend.

Modern-age technology
These devices boost efficiency as well and assuming institutions desire to stay competitively competitive, are equally essential. Consequently, organizations are taking on digital-age innovations at a quicker pace, implementing the most recent advances like the IoT, cloud computing, accessibility, & statistical analysis through their activities, procedures, & IT infrastructures. The exceptionally well-independent system, the World Wide Web for Everything, & business creativity are three of the cornerstones of today's networks.

Future scope

The adoption of technology in educational institutions emphasizes strengthening the educational environment and improving methodologies for instruction and learning, Modification in Learning Strategies, and Amendments in Teaching Methods in addition to enhancing the learning environment for students. I have consequently categorized the technological evolution in the education sector under the following three groups:

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