

Review Article

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Information and Communication Technologies: A Saviour for the Education System During the COVID-19 Pandemic

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ABSTRACT

Information and Communication Technologies, have rapidly evolved in recent years, influencing various aspects of our lives like work, sports, and education and a significant number of people restructured Information and Communication Technologies as a catalyst for change. The COVID-19 pandemic brought significant changes worldwide, particularly in education. Due to a strict lockdown, which resulted in the closure of all educational institutions, the teachers relied heavily on Information and Communication Technology tools to maintain teaching and monitor students' progress remotely. The purpose of this paper is to provide an overview of COVID-19's effects on education, utilization of Information and Communication Technology in education, the role of Information and Communication Technologies in education, different Information and Communication Technology tools used during covid-19, perception of Information and Communication Technology users, benefits of e-learning during covid-19 for students and teachers as well as factors affecting online classes during pandemic (encouraging and hindering).

Keywords: Benefits of E-learning during covid-19, Education during COVID-19, ICT role in education, ICT tools used in education during COVID-19, Impact of COVID-19 on education, and Perception of ICT users and Utilization of ICT.

Introduction

A number of technological developments have occurred at the start of the twenty-first century, affecting every aspect of our lives. Information and communication technologies (ICTs), which are constantly developing are present in every aspect of life, including the workplace, sports fields, educational institutions, and personal as well as social settings [1]. Furthermore, a significant number of people and reorganized ICTs as a catalyst for change, including changes in working conditions, how information is handled and exchanged, how it is taught and learned, how research is conducted, and how people access information communication technologies [2].

Information Communication Technology (ICT) was coined by Lord Stevenson (1997) as an extension of Information Technology (IT) for educational purposes. This was done in consideration of using electronic forms. The combination of computing, telecommunication, and broadcasting can deal with information on electronic devices like calculators, TVs, phones, and computers.

Research globally shows that integrating ICT in education improves learning and teaching. For instance, a study from Japan's National Institute of Multimedia Education found that increased exposure to educational ICT boosts student achievement. When teachers are digitally literate, they enhance students' higher-order thinking skills and offer innovative learning opportunities, preparing them for technological

changes in society and the workplace [3].

In 2019, India's population was 1.366 billion (Rural population- 895 million and Urban population- 471 million), with 503 million active internet users, representing 37% of the total population. Rural India accounted for 227 million internet users, while urban areas had 205 million. Approximately 71 million children aged 5-11 accessed the internet with family assistance. Mobile devices were the primary mode of access for 99% of users, with 88% connected via 4G networks. These figures highlight widespread digital adoption across India, influencing communication, education, and daily activities significantly [4].

Impact of COVID-19 on the Education System

The Covid-19 outbreak had a profound global impact, marking one of humanity's most severe calamities. Among its significant changes is the transformation of education. Education is crucial for nation-building and innovation is essential to adapt to the new normal and ensure uninterrupted teaching and learning processes [5].

WHO recommended social distancing as a key COVID-19 prevention measure. This led governments worldwide to close educational institutions to prioritize health and safety, impacting 90% of enrolled students globally. UNESCO reported that 63 million teachers were affected in 165 countries, with 1.3 billion learners worldwide unable to attend school or university. In India alone, around 320 million learners were affected [6]. This situation gave rise to the use of ICT tools by the teachers to keep in touch with students and also to motivate them also ICT became an integral part of newly established institutions.

Closing educational institutions early was a necessary step for public health, though it impacted students' exam preparation and created potential time constraints in future academic years.

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Teachers have mitigated these issues by providing online revision lectures to keep students engaged and on track with their studies, ensuring continuity and support during the disruption [7].

To support the WHO decision, the Ministry of Human Resource Development (March 2020) shared various free digital e-learning platforms for students so that they may capitalize on and continue their learning during lockdown [8]. The ministry also issued an advisory for Higher Educational Institutions to continue teaching through online mode and requested teachers to teach from home. In addition, The MHRD initiated a campaign on April 10, 2020 'Bharat Padhe Online'. COVID-19 changed the traditional teaching model to the educational technology (EdTech) model where teachers and students were exposed to new innovative educational methodologies and ICT has taken over the whole educational system. Respecting the government decision, many higher education institutions (HEIs) like IITs, IIMs, JNU, IGNOU, SAUs, and many others started to put their efforts to use technology in support of remote learning, distance education, and online learning during the COVID-19 pandemic [9&10].

Covid-19 has transformed Indian education by shifting towards e-learning. Positive outcomes include digital adoption, collaborative teaching, enhanced digital literacy, global exposure, and a preference for Open and Distance Learning [11]. The shift of the Indian education system to online learning is driven by increased smartphone use and better internet access. Teachers adopted new digital tools and underwent training to improve online instruction. Innovations like "Bring-Your-Own-Device" (BYOD) testing and auto-proctoring were introduced to maintain exam integrity. This digital transformation has the potential to democratize higher education by overcoming traditional barriers and making learning more accessible and affordable for all students [12].

Academic institutions quickly accepted online teaching during the pandemic, acknowledging the importance of technological infrastructure. Teachers worked to deliver quality education online despite challenges like limited technology and concerns over physical and mental health. However, recreating the interactive classroom experience digitally remained a significant challenge [13].

Desktop publishing/graphic designing, web quest designing, accessing the internet, multimedia skills, saving a document, composing questions, encrypting, participation in an ICT community of practice, and hyper-linking were the digital competencies required for teachers to integrate ICT and e-books during COVID-19 pandemic [14].

Expanding 4G network access to address internet connectivity issues, implement faculty development programs focusing on effective online teaching techniques, and advocate for creating online teacher communities to foster inclusive development among educators in Indian higher education [15].

During the COVID-19 pandemic, ICT has revolutionized education, evolving from a supplemental tool to a critical component during the pandemic. It enhances educational content, boosts student engagement, ensures universal access, promotes equity, and supports professional development for teachers, promoting innovative teaching practices and improving learning outcomes [16].

Utilization of ICT in education

With the support of ICT, COVID-19 pandemic was unable to attack the education sector to a great extent.

ICT reduced the barrier of social distancing as well as the impact of shutdown on the education sector. Students were in regular contact with their respective teachers with the help of online classes. So many national & international Webinars, Faculty Development Program, Workshop, Symposium, Quiz, etc have been organized by different institutions with the help of ICT. Successful implementation of ICT brought change which was more about influencing and empowering teachers and supporting them in their engagement with students in learning rather than acquiring computer skills and obtaining software and equipment. The rapid increase in internet connectivity has been an important catalyst for using ICT [17].

WhatsApp was the most used application for online learning followed by Google Classroom, Zoom, and Facebook. Half of the respondents were satisfied with online lectures. Respondents felt that online lectures were effective and inefficient. Effectively implemented because of the conditions that require online study and inefficient because the costs incurred more [18]. Utilization of ICT depends on various factors, some of which are discussed below:

Technology Adaption: Even with technological advancement many people resist change without understanding the need and importance of it and when a situation arises, all should adapt to change willingly and unwillingly. This was the situation that occurred in teaching before covid-19 pandemic. Many faculties have resisted the change when they had been asked to take virtual classes for students; because of the pandemic situation, the faculty has to change their mindset towards the virtual classroom and adopt technology for the betterment of students.

Teaching and learning: Teaching and learning are always in demand and when the lockdown started due to COVID-19, it was a challenge for faculty to adopt virtual learning and teaching and there was the wide adaption of technology in the teaching-learning process.

Student Engagement: It is always a challenge whether offline or online. During the lockdown, faculty initially worried about student engagement, but online classes saw attendance rates up to 20 times higher than usual.

Faculty Experience: Faculty experiences directly and indirectly influence their engagement and commitment. Initially, there was a lot of disturbance in the minds of faculty when they adapted the technology for virtual classrooms. As they started experiencing it, it became a habit, they began to love teaching students online. Some experiences of teachers were, that teaching online is better than regular sessions, as one can focus on his/her family, no traffic, no traveling, and mental peace [19]. Online learning allows students to study at their own pace, with the flexibility to revisit or accelerate through concepts. Online education can increase student retention rates significantly, from 25% to 60%. This flexibility and accessibility make online learning a strong substitute for traditional classrooms [20]. Ninety-five percent of the teachers felt online teaching was a viable alternative to classroom teaching at the time of the pandemic [8].

The use of ICT in learning during the COVID-19 pandemic can improve student learning outcomes and the effectiveness of learning and use of ICT significantly influences teacher teaching performance. To achieve them, lecturers need to analyze differences in learning designs that have integrated ICT or not,

discuss the steps in preparation of learning designs that integrate learning media based on ICT, and apply how to develop learning designs that integrate learning media based on ICT [21].

Many institutions executed faculty development programs online to boost the positivity among faculty during the crisis. Faculty felt that there is not much difference between online and offline sessions as they can share PPT, play videos, and use board and marker as regular classrooms. This provided a hybrid system of teaching through offline and online teaching [19].

Role of ICTs in education

ICTs affect each aspect of life and administration including the education sector and they assist in promoting changes and enhancing the quality and conditions of work, managing, substituting, and disseminating information in surpassing the teaching-learning approaches and concerning the whole administration.

COVID-19 has brought a new change from the traditional chalkboard to virtual, from pen to touch screen. Virtual classes started experimenting with the existing technical facilities [22]. Creativity is the key to a teacher's success to be able to motivate students to keep their enthusiasm for learning online and not become a psychological burden. The use of a variety of ICT applications in online learning is beneficial for teachers during the online learning process. Teachers need to get familiar with their teaching by utilizing complex online media packages effectively, easily accessed, and understood by students [23].

An amalgamation of ICT as a teaching and learning tool allows teachers to instruct and students to learn. It was present in a variety of settings, including educational networks, simulations, and drill and practice sessions. ICT is utilized in schools as a management and organization tool. Achieving learning objectives during COVID-19 was also aided by it. It served as a helpful tool for creating assignments, gathering information, documenting, corresponding, conducting research, and other tasks [24].

Different ICT tools used during COVID-19

There are many ICT tools and services that play an efficient role in the smooth functioning of the teaching and learning process during a pandemic. The ICT tools are Desktop, Laptop, Tablet, Projector, Digital cameras, Mobile phones, Smart TVs, Internet, Smartwatches, Scanner, Printer, Photo-copier, Pen drives, CDs, DVDs, Web-boards and Interactive whiteboards [25].

During lockdown, faculty used a variety of ICT tools for online teaching. This included web conferencing platforms like Apache OpenMeeting, Google Hangouts, Skype, WebEx, and Zoom. Learning Management Systems such as Canvas, Edmodo, and Google Classroom helped organize courses, while presentation tools like Google Slides, Mentimeter, PowerPoint, Nearpod, Prezi, and SlideShare were used for interactive content delivery. Collaboration tools such as Google Docs, Google Slides, and Google Spreadsheets facilitated project work. Assessment tools like BookWidgets, Classkick, Flipgrid, Google Forms, Kahoot, and Socrative were also utilized. Platforms like Zoom, Google Meet, YouTube, Free Conferences, Microsoft Teams, and Dingtalk connected teachers and students effectively during COVID-19, ensuring continuous education delivery [26, 27, 28 &29].

Google Classroom is highly effective for in-class and remote learning, allowing easy sharing of information and assessment of student work. It requires access to computers and the Internet.

Teachers can upload materials and supervise online assignments, making it ideal for distance learning during the COVID-19 pandemic due to its flexibility, user-friendly interface, efficiency and accurate learning evaluation processes [5] Figure 1, 2 &3[30].

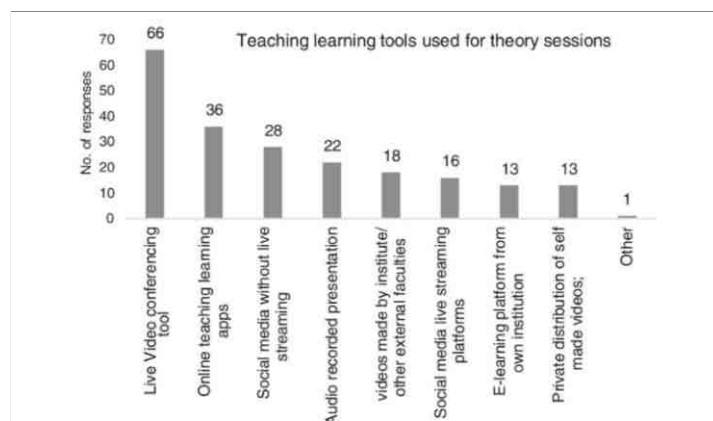


Figure 1 Graph showing the popularity of various online teaching tools for THEORY classes.

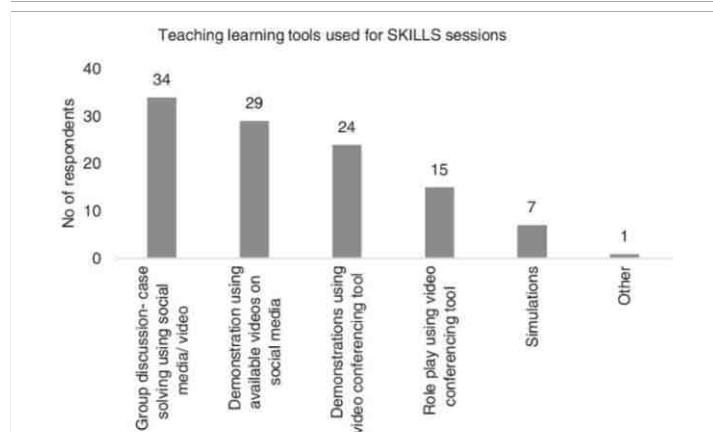


Figure 2 Graph showing the popularity of various online teaching tools for SKILLS sessions.

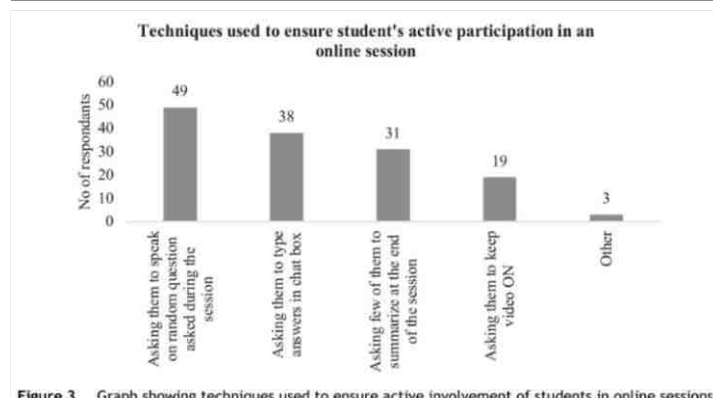


Figure 3 Graph showing techniques used to ensure active involvement of students in online sessions.

In addition to the mentioned ICT tools, the University Grants Commission (UGC) has issued the circular along with the ICT initiatives of MHRD and UGC. These initiatives are highly informative to both faculty members and the students to enhance their knowledge either in their fundamentals course (or) in advanced course (or) in preparing for a competitive examination (or) in a specific field of their interest. The initiatives include DIKSHA (Digital Infrastructure for Knowledge Sharing), e-PG Pathshala, VidyaDaan, PM e-vidya, SWAYAM (Study Web of Active Young and Aspiring Mind), SWAYAM PRABHA, CEC-UGC YouTube channel, National Digital Library (NDLI) and Massive Open Online Courses (MOOCs) [31&32].

Government Initiatives: Included e-content courseware in UG subjects, Shodhganga, e-Shodh Sindhu, Vidwan, Manodarpan and All India Radio, supporting the teaching-learning process [27].

Private Platforms: Learners utilized platforms like Byju's, Unacademy, upGrad, Vedantu, Toppr, and Khabri for additional learning resources and support [31].

These initiatives collectively supported education continuity and access during the challenging period of the COVID-19 pandemic.

Perception of ICT users:

Unified Theory of Acceptance and Use of Technology (UTAUT) and Technology Acceptance Model (TAM) theories were used to discover the perception of ICT users as a newly adopted technology among teachers and general staff. The study revealed some intentions to use ICTs which were mentioned in Figure 4 [33]:

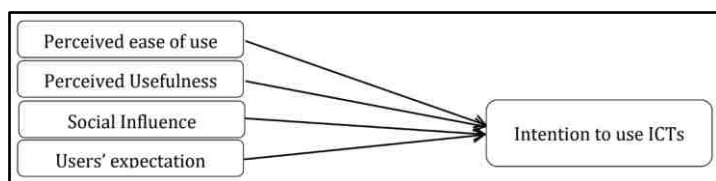


Figure 4: User intentions to use ICTs

Students believe that the design of courses is an important factor that distinguishes a successful online learning experience from a failed one. Research data indicate an improvement in learning outcomes in online classes compared to traditional classes due to increased motivation of students [34&35].

During the COVID-19 pandemic, both teachers and students preferred Google Meet as the platform for online teaching. Teachers conducted regular, interactive lectures according to the timetable and reported meaningful interactions and effective doubt resolution. Overall, e-learning platforms were perceived positively, enhancing access to e-resources and improving ICT competencies among students in relevant courses and streams [36].

Boomers (who were born between 1946 to 1964) considered online learning during the Covid-19 pandemic as a useful alternative for education, enhancing ICT literacy among teachers and students. They acknowledged their need for ICT training to effectively use online learning platforms and increase teacher confidence [37].

English teachers from Indonesia had a positive perception about the usefulness and ease of use of the online system during the pandemic Covid-19 and the teachers showed a positive attitude towards it. Teachers' intention to use the technology in teaching online and their involvement in it is quite high. They thought that the online learning system was less effective because of the lack of communication and interaction quality between teachers and students [23].

Positive perceptions include, traveling time being saved, more convenient, able to get more knowledge, and increased technological literacy. Simultaneously negative perceptions were the low motivation to study in online classes, lack of interaction with teachers, disinterest in taking online classes, hard to stick to a study schedule, not being uncomfortable with offline classes, and not understanding the content delivered in online classes [38].

IT students perceived that online learning during COVID-19 was an effective learning method, fun/enjoyable, activated participation, access to online material, ability to learn at own pace, comfortable surroundings, online lecture records are useful for studies, quality was satisfactory, reduced interaction with the lecturer and friends, social isolation and technical problems [39].

Some student-teachers with strong digital skills found online learning beneficial during the pandemic. They appreciated the flexibility, interactive learning opportunities, and ease of access to resources. Many expressed a desire to continue online learning even after the pandemic ends [40].

Some studies show that students can even perform better in an online learning environment. The authors investigated the relationship between students' perception of the practice of online learning, social affiliation, and the educational climate, controlling age and gender. They claim that successful online learning requires the use of active learning strategies to create opportunities for communication and exchange [41].

Benefits of E-learning during COVID-19 for Students

The Internet offers resources to students to enhance learning and consolidate knowledge in long-term memory. Advantages of ICT in learning include motivation for students, promotion of cooperative learning and interactive classrooms, fast communication across distances, facilitation of collaborative research globally, digitalization of school processes such as applications and admissions, facilitation of e-conferences for research teams, and the availability of e-learning tools like online resources and platforms for language teaching [42].

Ease and quick sharing of educational material, updated learning material, access to study resources effectively, flexibility in time and space, wide and diverse interactions, quick feedback, accommodates different types of learning styles, the possibility of working with e-learning, access to higher education for all applicants and improved collaboration and interactivity among students [43]. Saves time and money, increases general awareness, easier attendance, is environment friendly and distance is no longer a barrier to learning [44].

ICT supports cognitive processes by reducing students' memory load and promoting a problem-solving attitude. It expands learning opportunities by providing vast information and independent and active learning, offering flexibility in time and location. It enables focused studies by allowing students to analyze their strengths and weaknesses. It facilitates collaboration with peers and experts both within and beyond school. Various applications streamline the teaching-learning process, benefiting both educators and learners [45].

Benefits of E-learning during covid-19 for teachers

ICT aids in the professional development of teachers by offering opportunities to enhance language skills and expand knowledge through e-journals. It facilitates learning innovative teaching methods and enables collaboration with students on projects and assignments. Teachers can access teaching materials, assign homework, and participate in training programs and workshops for their continuous growth. Moreover, ICT empowers teachers to guide students in utilizing online resources like e-books, e-journals, and social platforms such as LinkedIn for better subject mastery, ultimately assisting in curriculum development aligned with teaching objectives [45]. Teachers can diversify teaching methods with vivid visuals like photographs and videos, which enhance learning compared to traditional methods.

Online sessions can be recorded for future reference. Technology enables easy administration of tests and quizzes with quick access to results, facilitating personalized teaching based on individual student learning patterns [46].

Time flexibility, location flexibility, catering to a wide audience, wide availability of courses & content, and Immediate feedback were the strengths of online learning and the opportunities were, Scope for Innovation & digital development, designing flexible programs, strengthening skills: problem-solving, critical thinking & adaptability, Users can be of any age and an innovative pedagogical approach [47].

Factors affecting online classes during a pandemic

Encouraging Factors

²⁷Zhang *et al*, 2020 identified factors affecting users' willingness to use the DingTalk platform which was, perceived usefulness, perceived ease of use, usage behavior, and usage attitude.

Elumalai *et al.* (2020) [48] found factors affecting the quality of e-learning during the pandemic was, there was a positive relationship between the quality of e-learning and the considered seven factors: administrative support, course content, course design, instructor characteristics, learner characteristics, social support and technical support from the student's perspective.

Nature of Content: Content should be comprehensive, and designed with clear goals and learning objectives.

Infrastructure: Adequate infrastructure includes reliable connectivity, fast data speed, possession of suitable devices, high-quality video/audio output, and user-friendly software/hardware.

Competency: Technical skills for basic computer and internet operations and effective communication skills.

Readiness: Learners should be motivated with goal-directed behavior, disciplined in staying organized and responsible, and able to maintain focus on the curriculum, avoiding distractions.

Follow-up: Effective follow-up includes facilitating question-answer sessions, monitoring learner presence and engagement during classes, collecting feedback on previous sessions, assigning assignments, and conducting online evaluations and tests [29&49].

Infrastructure like the latest gadgets, licensed software and applications, high-speed Internet connectivity, and multimedia support (webcam, microphone, etc.) were the essential constituents and needed as the backbone of the online teaching and learning environment [20].

Hindering Factors

Technological Constraints

- Digital Divide, Data Limitations, Poor Connectivity, Device Issues, Non-Recordable Classes, and Technical Issues.

Distractions

- Poor Learning Environment and Noise.

Instructor's Incompetency

- Technophobia, Poor Teaching Skills, Unstructured Content, and Lack of Follow-Up.

Learner's Inefficacy

- Indiscipline, Student Attrition, Unmotivated Learners, and Lack of Interest in Learning.

Health Issues

- Eye Strain and Worsening Health Conditions.
- Addressing these challenges is crucial for improving the effectiveness and accessibility of online education [29&49].

Conclusion

ICT plays a major role in the teaching and learning process by providing effective ways to deliver information to learners. When conventional teaching along with technology was reaching learners efficiently, in 2019 the COVID-19 pandemic happened. The different nations started lockdowns and social distancing as optimum solutions to reduce COVID-19 spread which showed its impact in many fields including the education sector. Due to the closure of educational institutions, the only way to continue the teaching-learning process is e-learning which is possible only with the involvement of Information and Communication Technologies. ICT has many inventions like e-learning platforms, mobile applications, audio-video conference tools, etc., and with the help of Government ICT initiatives, ICT tools, and private e-learning platforms the teaching-learning process has resumed. The major ICT tools used in education during the pandemic were Govt. initiatives like, DIKSHA, e-PG Pathshala, Swayam Prabha, PM e-vidya, CEC-UGC YouTube channel, National Digital Library (NDLI) and SWAYAM, etc., various private online platforms were, Zoom, WebEx, Google Classroom, Google Meet, YouTube, Microsoft Teams and Free Conferences. These ICT tools and platforms are free of cost to use. Similarly, some e-learning platforms utilized by learners on the basis of payment were, Byju's, Unacademy, upGrad, Vedantu, Toppr, Khabri, etc., with the technology teaching-learning process resumed and both teachers and students benefited through online education. Simultaneously there were many factors that facilitated online teaching and also some other factors that led to the failure of e-learning. Thus, with each of these, we have come to the conclusion that during the global crises when everything stopped no doubt ICT was the only savior in many sectors including education, which streamlined the communication process with e-learning during the social distancing phase.

Future scope of the study: Further review study can be done exclusively on the List of ICT tools used during COVID-19 pandemic to resume the education process. Which can cover detailed roles of the different ICT tools.

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