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ICT-enabled teaching and learning modalities followed in pharmacy education during COVID-19 in India

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ABSTRACT

The transformation from conventional to online teaching and learning created an unprecedented learning environment and many challenges for the trainers and learners during COVID-19 in India. In this context, many synchronous and asynchronous online teaching tools were used to continue the pharmacy educational process and to develop and update the instructional strategies with suitable online tools & interactive methodologies. Indian Ministry of Education (MoE) initiated massive online open courses platforms which were utilized to understand the fundamentals of pharmacy-related subjects. Introductory and advanced pharmacy practice experiences learning was provided to students through online simulation activities, video reflection, case, and problem-based online discussions, and objective structured clinical and practical examination. Virtual conferencing applications and digital education platforms of MoE were majorly used to conduct the pharmacy education during the crisis and investments in digitization become mandatory in pharmacy education and COVID-19 fast-forwarded its process. Information and communication technology enabled continuity of pharmacy education during the pandemic and improved the student-teacher contact hours, self-paced, collaborative, and contextual learning environment in India.

INTRODUCTION

COVID-19, the pandemic has altered the definition of the way of life. With the rise of cases and rate of mortality, it has evolved into a severe global threat (Walker *et al*., 2020). COVID-19 has so far affected 220 countries, infected over 27.3 million people, and has cost the lives of over 41 lakhs in India (Adebisi *et al*., 2020; Javaid, 2020). The first lockdown was initiated on March 24, 2020 with the suspension of various services. This crisis has called a halt to the day-to-day activities of mankind. Education, the most profound activity, was halted in schools, colleges, and universities around the world as a proactive measure to prevent the spread further (Choudhary, 2020; Kasrekar and Wadhavane-Tapaswi, 2020). The Government of India announced the closure of all educational institutions on March 16, 2020 (Ramanujam and Fernandes, 2020). By the mid of April, it was estimated that schools and higher education institutions were closed in 145 countries, affecting 1.5 billion learners worldwide during the pandemic, which constitutes 89.4% of the overall enrolled learners (Marinoni *et al*., 2020; Technology Enabled Teaching, 2016). In India, over 32 crore students are also affected similarly (Marinoni *et al*., 2020). The repercussions of COVID-19 have affected all education systems. In the pharmacy education system, the ramifications are quite prominent due to the peculiarities necessitating in-person didactic lectures and tutorials, laboratory experience, clinical rotations, case presentations, projects, clinical clerkship, and internships. The hands-on approach is a fundamental requirement in the practical aspects of the curriculum, which has been unfortunately suspended to prevent further escalation of the disease (Linways, 2017; Relhan, 2016). The Pharmacy Council of India has permitted the completion of pharmacy education in online mode till the COVID-19 has

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subsided and has requested colleges/institutes to continue with case-based learning or objective structured clinical examination (OSCE) and objective structured practical examination (OSPE).

Pursuing higher education for Indian students has been extremely strenuous and jeopardizes the country's future economy (Concept of ICT, 2020). Technological progress and development can be utilized for the expansion and advancement of the quality of education (Concept of ICT, 2020; Concept of Information, Communication and Educational Technology, 2020). In the present scenario, continuing education in an online mode can be challenging as it is essential to meet the student's educational criteria by incorporating various teaching strategies adopted by teachers and technology accessible. This can be achieved using new pedagogies and creative learning models. Colleges and universities can utilize this opportunity to transform and enhance their digital resources into quality certified programs and courses. Assessments and examinations can be executed using self-proctored and proctored means through digital modes, offering convenience, mobility, and uninterrupted education (Concept of Teacher Education, 2020).

According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), information and communication technology (ICT) is a diverse set of technological tools and resources used to transmit, store, create, share, or exchange information. In simpler terms, ICT is the transmission of information via telecommunications technologies (Walker *et al*., 2020). It comprises wireless networks, internet (websites, blogs, and emails), live broadcasting technologies (radio, television, and webcasting), recorded broadcasting (podcasting, audio and video players, and storage devices), and telephony (fixed or mobile phones and video conferencing). ICT has been associated with higher productivity, efficiency, and educational outcomes. Education, research, and learning have been influenced by the implementation of ICT. With the emergence of social distancing and several practices, the situation calls for a transformation in the delivery of education from conventional teaching practices to technology-driven e-learning programs. Education and healthcare are the basic requirements for the evolution of the nation. The access to quality education and health care has broadened with the advancement in technology. In this context, we focus on collating and developing the understanding of various ICT-enabled teaching modalities and instructional strategies followed by pharmacy educational institutions and other educational governing bodies during COVID-19 in India (Information and communication technology, 2020).

METHODS

This paper comprises the literature taken from Indian government portals such as the Ministry of Education (MoE), University Grants Commission (UGC), portals of internationally accepted organizations like UNESCO, and various other websites that have published articles on the various ICT modalities for students during COVID-19 pandemic. A search was conducted in various ICT modalities for students during the COVID-19 pandemic. A search was conducted in various databases such as PubMed and ResearchGate using keywords "ICT" AND "Indian Pharmacy education" AND "COVID" to understand the implementation of instructional strategies followed in online mode, but the articles found were not relevant to our review. The search for the materials relevant to the paper was initiated from May 2020 till June 2021 (Fig.1). Among the 33 data selected, 2 articles were excluded due to repetition and 1 article was excluded due to no relevant information supporting our paper. Direct telephonic conversations were made with 15 pharmacy institutions, out of which 12 responded. Through this, we understood the various online tools utilized for the conduct of lectures, practical, examination purpose, and documentation of various forms such as patient profile form, intervention form, etc. which were adapted and followed during the COVID-19 crisis.

Synchronous online teaching and learning methods followed in pharmacy education

This method is similar to that of a traditional classroom, except that it is performed online, with the lecturer and student both logging into the learning platform at the same time and date (Mishra, 2018; Synchronous and Asynchronous Learning Methods & Tools, 2020). It enables the delivery of information simultaneously to multiple geographically dispersed learners (Information and communication technology, 2020). This allows direct interaction of the student with the lecturer and helps the students in clearing immediate clarifications and doubts. This strategy was proven to be more practical as it considers the student's emotional and psychological needs, which may be interrupted by the present crisis. Many lecturers have found this method quite efficient and effective in teaching students. This teaching could be done in the form of direct teaching, presentations, quiz, simulations, etc. (Mishra, 2018; Synchronous and Asynchronous Learning Methods & Tools, 2020; Wintemute, 2019). Majorly, video conferencing applications (VCA) were used to conduct sessions.

Online Didactic Teaching: With restraint on face-to-face teaching strategies, didactic teaching is now delivered through online VCA. Features such as audio/video conferencing, instant messaging, and screen sharing allow discussions, dialogues, and sharing of presentations, making it feasible. It also enables active learning that engages students in real-time scenarios and allows activities such as think-pair-share, brain-dumps, and quick thinking, making possible creative learning.

Clerkship/Internship Case Discussion: VCA applications such as Zoom, Google Meet, etc. have made it easier to conduct case presentations through online means. Features such as screen sharing help others to follow and interact during this discussion. These activities have made possible the continuity of problem-based learning and help to increase understanding of specific patient situations and clinical decision-making. Recording of these discussions facilitates the documentation and conduct of the activities.

Webinars: With the transition to online education, webinars have been conducted on a wide range of topics. Webinars are accessible to students from various geographical locations, putting an end to travel restrictions to attend seminars hosted in different locations. The instant messaging option helps in test-based communication of information and instant replies to questions.

Asynchronous online teaching and learning methods followed in pharmacy education

This method is the opposite of synchronous teaching, here there is no particular time or date specified to log into the learning platform, also there is no real-time interaction of the

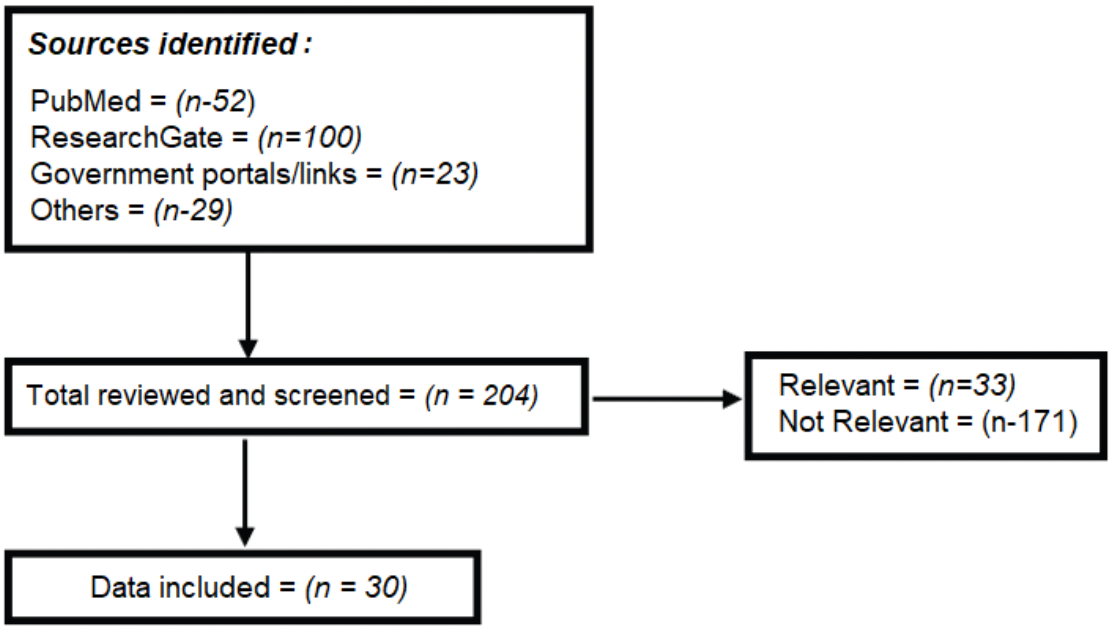

Figure 1. Flowchart on search strategies.

participants (Asynchronous learning, 2020; Priscila, 2020). It is demonstrated by the time lag between when instructions are delivered and when they are received by the learners (Information and communication technology, 2020). Here, the study materials could be in the form of pre-recorded videos, lecture notes, and assignments. It can be accessed by the students at any preferable time, making this method highly flexible when compared to synchronous teaching. This method enables the readers to read at their own pace and understand the concept. Also, this method makes it affordable for the readers to access the required content, which is readily available (Asynchronous learning, 2020; Wintenute, 2019). In this method, there will be a monthly interaction of the lecturer with the student, which could be via e-mail or any other method to assess the progress of the students. Some online platforms available include -YouTube, Khan's Academy, Flipgrid, etc.

a. Assignments/Online Tests: Completion of assignments can be achieved through online portal submission, which is convenient and sustainable as it reduces paper utilization. Online tests can be conducted using different types of questions rather than a particular format such as pick-one test, pick-multiple tests, fill-in-the-blankets, matching list, sequence, and composition questions. This can be conducted by proctoring (monitoring of candidate during exam achieved through the live online exam, recorded proctoring, or automated proctoring), unproctored (unsupervised exams with no time limits), or self-proctored (unsupervised exams with provisions to choose date and time, but the time limit is applicable) means.
b. Course works: Online course works are offered in OpenWHO, Massachusetts Institute of Technology, and Harvard University. Industry. Elearning (Edx), CourseEra, UMC, etc. helps to assess and gain an understanding of new topics in the pharmacy curriculum. These course works enable understanding further on selective topics and offer assessment and course completion certification as well. Also, open source platforms like Moodle, Chamilo, etc. were used for many online courses by educational institutions.
c. Clerkship/internship Documentation: Learning management system (LMS) applications can be used for the submission of clerkship and internship activities documentation. The use of Flipgrid enables the recording and uploading of videos of the case presentations as short clips which can be easily used for documentation purposes.
d. Virtual Labs/Simulation Activities: The use of virtual labs enables easy to access at any time and a better understanding of concepts. Animal Simulator is one such application that enables the simulation of animal experiments, which is used in explaining concepts of pharmacology. This helps to reduce the harm to animal subjects. Also, simulation activities such as patient counseling, medication history interviews, etc. can be conducted through online mode, thus incorporating teaching strategies into pharmacotherapeutics lectures.

UGC and MoE initiatives on digital education in India

The University Grant Commission (UGC) was founded on December 28, 1953, and was formally established as a statutory organization of the Government of India in 1956. It is bestowed with two key tasks: providing funds and coordinating, determining, and maintaining university education standards in India. The Ministry of Education (MoE) came into existence on September 26, 1985, and comprises The Department of School Education & Literacy and The Department of Higher Education (DHE). The department of higher education is working to deliver superlative higher education and research opportunities to the country. ICT has empowered the education sector to adapt to the innovations and practices of online learning. This crisis has stated the prospective need for ICT and allowed the country to perceive and utilize many ICT-driven initiatives (Sharma, 2021).

For the past several years, India has been steadily promoting the digital revolution in education and the ongoing pandemic has accelerated the usage of technological tools and digital platforms to enhance the learning process (Sharma, 2021). NMEICT stands for National Mission on Education through Information and Communication Technology, which was launched in 2009 to provide opportunities to secondary stage students to adapt ICT skills and grasp knowledge through the computer-aided learning process (Technology Enabled Teaching, 2016). In addition, the National Education Policy 2020 envisions the establishment of a special unit to plan the development of digital infrastructure, digital content, and capacity building to oversee e-learning demands (Sharma, 2021).

To address the issues of distant learning, MoE has launched several initiatives to assist students, educators, and lifelong learners in their pursuit of knowledge (Table 1). Various innovative initiatives such as Manodarpan—a platform for providing psychological help to students and the iGOT portal for COVID-19 management training modules were launched in response to pandemic issues (Sharma, 2021). The Indian Government has set into motion errands to use technological resources to ensure the accessibility of higher education to all capable students (Technology Enabled Teaching, 2016). Such strategies will help in being well-prepared to overcome probable crises or socioeconomic fallout in the future and ensure the continuity of education (Sharma, 2021).

Instructional strategies for online learning and teaching in pharmacy education

Instructional strategies are techniques utilized by teachers to help students become self-reliant, proactive, and strategic learners. These strategies can encourage students and aid them in focusing their attention, organizing information for understanding, memorizing, monitoring, and evaluating their progress. Various grade levels and subject areas can be covered by instructional strategies to accommodate a range of student differences. Some instructional strategies that are utilized and effective in health education programs are group discussion, role-playing, cognitive organizing, cooperative learning, issue-based learning, independent learning, and service learning (Lin *et al*., 2011). The online platforms or tools which are selected for conducting the online teaching and learning must have few technical features like lecture plan and scheduling, notification, cloud storage, content delivery, assessment, and reporting features that include attendance, etc.

The shift to the online mode of teaching due to the pandemic has made it difficult for the students to achieve objectives and competencies of pharmaceutical training and education through these strategies. As a result, preceptors and faculty have creatively incorporated instructional strategies in an online setting to attain the objectives of pharmacy education. (Table 2).

RESULT

Through this paper, we were able to assess that the synchronous online teaching modality was utilized mainly for the conduct of lectures, group discussions, and for conducting webinars in various pharmacy institutions. Apart from that, asynchronous methodology was employed for conduct of examination, assignment workup, and submission, coursework completion, documentation of internship paperwork, conduct of simulation activities, etc. The commonly used synchronous online tools include Zoom, Google Meet, and Microsoft Teams, whereas the asynchronous online tools were utilized often includes Emails, LMS Portals, and Animal Simulator.

Apart from these, six initiatives or platforms by UGC and MoE on digital education were mainly used for the conduct of online pharmacy education, which are listed as follows: 1. Study webs of active–learning for young aspiring minds (SWAYAM), 2.SWAYAM Prabha, 3.National digital library (NDL), 4.Virtual labs, 5. e-PG Pathshala, 6. National Programme on Technology Enhanced Learning (NPTEL). Many of these platforms were used for the delivery of curriculum contents and to offer MOOCs. Also, educational universities and pharmacy colleges were contributed for the development of online courses and its related resources. These six initiatives were further assessed and briefly described in Table 1. Each initiative either includes courses or subjects or study materials that can be availed by the pharmacy students to strengthen their knowledge and understanding on various pharmacy subjects like Anatomy & Physiology, Biochemistry, Microbiology, Pharmaceutical Analysis, Pharmacology, Organic and Inorganic chemistry, etc. Similarly, other initiatives like e-Shodh Sindhu (Consortia for Higher Education E-Resources), Shodh Shudhhi (Web Based Plagiarism Detection Software system), etc. were utilized by the institutions as well as the students for their educational purposes.

We also identified the different teaching strategies that would match the online teaching methodologies for conduct of pharmacy education. These are as follows: 1. Cooperative learning, 2. Independent Studying/ Cognitive Organizing, 3. Case based learning (CBL), 4. Problem based learning (PBL), 5. Viva voce, 6. Examination, 7. Simulation activity, 8. OSCE. Major 8 key online application or platform related technical features that serve the purpose of conduct of online pharmacy education, which are listed below: 1. Virtual Meeting, 2. Lecture plan, 3. Notification, 4. Cloud storage, 5. Content development, 6. Content delivery, 7. Track student progress, 8. Reporting. Taking into account these teaching strategies and essential technical features, we were also

Table 1. Initiatives by MoE related to online pharmacy education.

Platform/Programme	Description	Teaching modality	Type of content	Graduation level	Subjects	Link
SWAYAM (Study Webs of Active–Learning for Young Aspiring Minds, 2020)	Massive Open Online Courses are divided into 4 quadrants – video lectures, specifically prepared reading material that can be downloaded/ printed, self-assessment in the form of tests and quizzes and an online discussion forum for clarifying doubts	Online	Audio-Video e-content	UG/PG	• Research Methodology and Statistical Analysis • Academic Writing • Academic and Research Report Writing • Animal Physiology • Analytical chemistry	https://swayam.gov.in/
SWAYAM Prabha (Study Webs of Active -Learning for young Aspiring minds Prabha, 2020)	Group of 34 DTH channels dedicated to broadcast high-quality educational programmes 24 hours a day and includes new content of at least 4 hours which gets repeated 5 more times throughout the day	DTH- Channel	Audio-Video e-content	UG/PG	• Microbiology • Biochemistry • Life science • Biomedical Science • Chemistry • Mathematical Sciences	http://www.swayamprabha.gov.in/
NDL (National Digital library of India, 2020)	This virtual repository of learning resources is more than simply a repository with search and browse capabilities; it also offers a variety of services to the learning community and supports ten of the most frequently spoken Indian languages in the user interface.	Online	Digital content (Books, Audio books/ Lectures, video lectures, lecture presentations/ notes, simulations, question paper, solutions)	UG/PG	Search can be refined to pharmacy related topics or subjects to acquire the required or related resources.	https://ndl.iitkgp.ac.in
Virtual Labs (Virtual Lab, 2020)	Web-enabled remote access to labs built for remote operation and observation in a variety of science and engineering disciplines, allowing students to learn fundamental and advanced ideas through remote experimentation while piquing their interest.	Online	Accelerated Hands on learning to use Simulator (web-resources, video-lectures, animated demonstrations and self-evaluation)	UG/PG	• Inorganic Chemistry • Organic Chemistry • Physical Chemistry • Spectroscopy • Advanced Analytical Chemistry • Computer-Aided Drug Design • Biochemistry • Microbiology • Molecular biology • Cell Biology	http://www.vlab.co.in/
e-PG Pathshala (Pathshala, 2020)	It includes interactive, curriculum-based e-content in 70 subjects from a variety of fields. e-Adhyayan (e-Books) and e-Pathya (Software driven course/Content bundle) are two of its verticals.	Online	Digital content (curriculum-based e-content, Video-lectures & quiz)	PG	• Analytical Chemistry/ Instrumentation • Biochemistry • Biotechnology • Pharmaceutical Science • Chemistry	https://epgp.inflibnet.ac.in/Home
NPTEL (National programme on technology Enhanced learning, 2020)	Online repository featuring 522 courses from engineering, basic sciences, and selected humanities and social sciences disciplines, as well as integrated indexing of all video and web courses	Online/ DTH-Channel	Digital content (Video or web content)	UG/PG	• Anatomy • Biochemistry • Physiology • Microbiology • Pathology • Pharmacology • Biotechnology • Chemistry and Biochemistry	https://nptel.ac.in/

Table 2. Model instructional strategies for online pharmacy education.

Teaching Strategy	Pedagogical activity	Online teaching mode	Type of online platform	Required and optional technical features							
				Virtual meet	Lecture plan	Notification	Cloud storage	Content development	Content delivery	Track student progress	reporting
Cooperative Learning	Didactic Class	Synchronous	Virtual Meeting Platform e.g., Google Meet	✓	✓	✓	✓	✘	✓	✘	✓
Independent Studying/ Cognitive Organising	Assignment/ Assignment Documentation	Asynchronous	Experiential Learning Management System e.g., PharmAcademic	✘	✓	✓	✓	✓	✓	✓	✓
Group Discussion-CBL	Informal Discussions	Asynchronous	Video Reflections e.g., Flipgrid	✘	✓	✓	✓	✓	✓	✓	✓
Group Discussion/ PBL	Formal Case Presentation	Synchronous	Virtual Meeting Platform e.g., Google Meet,	✓	✓	✓	✓	✘	✓	✘	✓
Viva Voce	Formative Assessment	Synchronous	Virtual Meeting Platform e.g., Google Meet,	✓	✓	✓	✓	✘	✓	✘	✓
Examination	Summative Assessment	Asynchronous	LMS e.g., Moodle	✘	✓	✓	✓	✓	✓	✓	✓
Simulation Activity	Experiential Learning	Asynchronous	High and low fidelity Simulation, e.g., Virtual Labs	✘	✓	✓	✓	✓	✓	✓	✓
OSCE	Formative Assessment	Synchronous	Virtual Meeting Platform e.g., Google Meet,	✓	✘	✓	✓	✘	✘	✓	✓

✓–Possible, ✘–Not Applicable.

able to formulate a model instructional strategy notion which would support the conduct of pharmacy education in circumstances that can halt educational activities, such as future pandemics. The model for instructional strategies in online pharmacy education is depicted in Table 2.

DISCUSSION

The availability of MOOC platforms and ICT tools were helpful for the students, teachers even before the COVID-19 period. But the utility of these platforms was more during the COVID-19 period to continue their educational activities. Though the lack of internet and supporting gadgets like laptop, mobile was adding additional financial burden and other technical difficulties to the students and teachers, educational institutions started developing a positive approach towards ICT education because of reduced functional cost and improved operational efficiency (Advantages of ICT in education, 2021). ICT initiatives are necessary for broadening their horizon of learning at a lower cost, and thus it should be encouraged and should be made use of by students in such pandemic scenarios.

Furthermore, conducting an online or offline survey can be helpful to analyze and understand the reach of these ICT initiatives and can be utilized to provide information to those who are unaware, which can further help to maximize the reach and utilization, especially for the continuation of education in pandemic situations like COVID-19 in the future. The availability of content related to pharmacy education was limited in these initiatives, it did not cover all the essential subjects like pharmacotherapeutics, community pharmacy, medicinal chemistry, jurisprudence, clinical pharmacy, hospital pharmacy, toxicology, etc. One of the reasons for lack of content in such platforms or programs may be due to the lack of awareness and support from pharmacy institutions, lack of technical knowledge & support, lack of infrastructure such as recording studios, which help teachers for filming the content. Moreover, the teachers are not getting any monitory benefits for their contributions for content development or delivery under government-initiated MOOCs platforms. There is a need to identify and resolve such shortcomings to improve the content availability in the MOOC platforms to support pharmacy education in the future. Also, lack of availability of network, poor connection due to network issues, lack of availability of gadgets like mobile phones and laptops among students, etc. are also some of the issues that decrease the utilization of such initiatives. Thus, such initiatives are yet to reach marginalized communities of society.

One of the biggest limitations of online learning is the understanding and performing of practical skills, which is an essential part of experiential learning. To overcome this problem, the MoE initiative, Virtual lab can be utilized to enhance the understanding of practical aspects. This platform includes experiments in organic chemistry, inorganic chemistry, biochemistry, and microbiology which can be used for pharmacy education. It uses animated videos to explain experiments or simulators to perform the experiments. It also covers aspects such as aim, procedure, precautions to be taken in real settings, self-evaluation tests, assignments, and references that can be used for further reading.

With the shift to the online mode of teaching, faculty can use various ways to ensure they meet the criteria for pharmacy education. For instance, to provide experiential understanding for the students, they can use various simulation software products like SIMPHARM and other animal simulators to understand the PK PD doses concentration relationship. Preceptors can encourage students to work in groups and prepare presentations on various aspects of a disease, as well as provide a patient case where they could prepare a presentation in the subjective, objective, assessment, and plan format and conduct discussion for students completing their Doctor of Pharmacy or Master's in Pharmacy Practice. They could also host 'clinical debates' allowing students to remain abreast of current events. Hospital rotations can be redesigned in a hybrid format, allowing students to spend half the rotation on-site and the other half attending self-paced modules on various topics like safety reporting, clinical pharmacy operations, etc. To ensure the competencies of pharmaceutical education and training, a checklist can be prepared by education institutions (Moreau *et al*., 2021).

As future prospects, electronic medical records (EMR) can be made available to the introductory pharmacy practice experiences (IPPE) students, allowing them to practice without threatening the patient safety in a simulated way will be more helpful. Using EMR and videoconferencing, preceptors, and students can interact and share their feedback. Model telehealth teaching modalities can be initiated through which the students can provide patient counselling or any drug-related information to patients or healthcare professionals with the guidance of the preceptor, thereby promoting their communication and patient care skills (Moreau, 2021). Apart from these, high-fidelity simulation or low-fidelity simulations could be incorporated for better experiential learning. High-fidelity simulators are a more advanced form of simulation. These simulators mimic human behavior upon prior entry of data. The model can be disease specific as well. (Lin *et al*., 2011). One such example is my dispense which is a high-fidelity simulation used for community-based experiential experiences both IPPEs and advanced pharmacy practice experiences (Mak *et al*., 2021)**.** Task trainer is a another type of simulation model which is also referred to as low fidelity simulators or moderate fidelity simulators. Extensive programming abilities are not required in functioning these simulators and help the students practice their skills (Lin *et al*., 2011). The limitations of these simulators are that they may be paid and difficult to access by students or the universities. Preceptors and instructors must be trained in all of these areas in order to deliver good teaching to students. When compared to conventional classrooms, the student's involvement was determined to be higher. The amount of time that instructors and students spend together has dramatically grown.

Merits of ICT in pharmacy education

The advent of technology has enabled a generation of learners to arise differently from the conventional teaching and educational methods. It has enhanced and improved the act of self-directed learning. Online modalities have paved a way for flexibility and comfortable learning. The contact hours between the student and teachers have significantly increased and have significantly reduced the teachers/trainers' manual workloads. Technology has reduced the usage of educational resources and

expenditures. Students are given the opportunity to learn at a point in time that can be convenient using the synchronous and asynchronous techniques of teaching. The communication can take place in both means that is in a real-time setting or not live. It can be engaging and effective, thereby providing the opportunity for instant feedback and clarification. It also facilitates the students to work at their own pace.

Limitations

India, being a developing country, makes ICT-enabled teaching & learning a challenge, especially for students in rural areas due to lack of internet or dependable internet services and thereby, making online education ineffective for them. Lack of awareness regarding the UGC and MoE initiatives on digital education limits the utilization of these platforms, and it remains underutilized in some pharmacy colleges.

No data is available regarding the usage of these resources or online platforms by pharmacy students, thus the exact utility remains unknown. Lack of technical knowledge and acceptability of online education among faculty and students is another drawback, making it difficult to provide online education with complete satisfaction. Aside from this, online education modalities fail to provide kinesthetic learning, which makes online learning insufficient once the students are exposed to real-life circumstances.

CONCLUSION

The COVID-19 pandemic has caused many concerns and uncertainty in pharmacy education across the country. The transformation from conventional to online teaching and learning created an unprecedented learning environment and many challenges for the trainers and learners, but these circumstances indirectly helped us to understand more on ICT-enabled teaching modalities and helped us to update our technical knowledge in all aspects. As we know, the future of education will be dependent on technology, and COVID-19 fast-forwarded its process in the Indian education system. Though ICT facilitates conducting didactic and other pedagogical activities, it fails to fulfill the experimental and other kinesthetic aspects of learning and to provide real-time experiences for the learners. In the future, ICT will be a part of pharmacy education setup. So, more investment and awareness are required to ensure continuity of education during any future socio-economic fall-outs or crises. Furthermore, extensive research needs to be conducted to understand the utilization of ICT-enabled pharmacy education and its impact in India.

CONFLICT OF INTEREST

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AUTHOR CONTRIBUTIONS

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work. All the authors are eligible to be an author as per the international committee of medical journal editors (ICMJE) requirements/guidelines.

ETHICAL APPROVALS

This study does not involve experiments on animals or human subjects.

DATA AVAILABILITY

All data generated and analyzed are included within this research article.

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