

Effect of E-Learning on Public Health and Environment During COVID-19 Lockdown

Avani Agarwal, Sahil Sharma, Vijay Kumar, and Manjit Kaur*

Abstract: E-learning is the most promising venture in the entire world. During the COVID-19 lockdown, e-learning is successfully providing potential information to the students and researchers. In developing nations like India, with limited resources, e-learning tools and platforms provide a chance to make education available to middle and low income households. This paper gives insights about three different online services, namely Google Classroom, Zoom, and Microsoft Teams being used by three different educational institutions. We aim to analyze the efficiency and acceptability of e-learning tools among Indian students during the COVID-19 lockdown. The paper also aims to evaluate the impact of e-learning on the environment and public health during COVID-19 lockdown. It is found that e-learning has potential to reduce carbon emissions, which has beneficial impact on the environment. However, the mental health is impacted as e-learning may lead to self-isolation and reduction in academic achievements that may lead to anxiety and mental depression. Due to usage of electronic devices for learning, the eyes and neck muscles may be put in strain, having deleterious effects on physical health.

Key words: e-learning; environment; health; COVID-19

1 Introduction

E-learning and online education provide an opportunity for students to increase their knowledge base in a flexible environment while using limited resources and capital. For a developing country like India, online tools can help students achieve productive and diverse education by incorporating various themes in different areas of interest. The online platforms are slowly gaining popularity due to the improvements in design, visuals, ease of navigation, and quality content.

-
- Avani Agarwal and Sahil Sharma are with the Department of Computer Science, Thapar Institute of Engineering and Technology, Patiala 147001, India.
 - Vijay Kumar is with Department of Computer Science and Engineering, National Institute of Technology, Hamirpur, Himachal Pradesh 177005, India.
 - Manjit Kaur is with Department of Computer Science Engineering, School of Engineering and Applied Sciences, Bennett University, Greater Noida 201310, India. E-mail: manjit.kaur@bennett.edu.in.

* To whom correspondence should be addressed.

Manuscript received: 2020-06-15; accepted: 2020-08-05

Many studies have shown that e-learning can help improve the knowledge base and make understanding of concepts easier by providing bite-sized, collaborative, and interactive content. Studies have proven that a personalized and assisted learning-based curriculum is better than the traditional curriculum. The best quality of education can be provided through e-learning tools by personalizing the guidance and mentorship according to the needs of students^[1,2]. The e-learning platforms give students flexibility and empower students by allowing them to learn at their own pace and schedule. A student can choose the time and day to learn or consume the content provided on these various platforms. We have material available at our disposal, which can be either free of cost or paid, open for a lifetime or a limited amount of time.

Moreover, the content consumed on an online platform is consistent and standardized in comparison to the different teaching styles of professors. A diverse range of options are provided to users by e-learning^[3,4]. Open online course providers are edX, Udacity, and Coursera, and Udemy provides both free and paid online courses

that cover various topics from diverse fields. These online platforms not only fulfill the current need of educators but also create new demands which then help improve the current services being provided to students^[5]. There are websites like GeeksforGeeks and Tutorials point which enjoy popularity among engineering students. YouTube also provides the content to students pursuing different majors and fields, for example, Khan Academy is one of such YouTube Channels that helped build basic concepts of high school students by keeping the material easy to understanding, participation, and interaction. The YouTube channel posts videos after thoroughly researching the topics to help students understand even the small and hidden concepts of mathematics^[6].

In India, universities and colleges integrate the Internet and web pages into classroom teaching. Teaching staff makes lecture slides, assignments, and important notifications available to the students via a course site. The study material may be downloadable as a PDF file or a PowerPoint file. Students may participate via online-discussion forums and examinations may be conducted by using an e-learning tool. However, despite the advancing technologies in higher education, institutes have failed to incorporate the e-learning practices in main-stream activities and tap the benefits of online learning^[7,8]. The teachers may be interested in adopting online tools, however the student's attitude and aptitude learning towards online platforms, standardization, and interactive content of an online platform play critical roles in determining the behavior roles of students towards the e-learning environment^[9-12].

Usually the mode of instruction through e-learning platforms is designed by professionals who lack the knowledge of psychological aspects of the domain on students. Quality of interactive content needs to be controlled and updates regularly to capture the interests of the students. A learning context model helps realize adaptive technological implementations and personalizing learning environments. Such environments improve the quality and increase the quantity of learnings of the students^[13]. In the recent years, robots have helped increase learning in Science, Technology, Engineering, and Mathematics (STEM) concepts. A construction-based approach which collaborates educational robots can be used to teach complex principles and algorithms like that of computer science programming languages. LEGO multi-robots may be used for construction-based approach towards collaborating learning^[14].

The main objective of this paper is to evaluate the

impact of e-learning on the environment. This paper also evaluates the effects of e-learning on health of the students and researchers. Finally, the case study of e-learning tools adopted in India during COVID-19 lockdown is also considered.

The remaining paper is organized as follows: Section 2 discusses the impact of e-learning on environment. Section 3 discusses the implication of e-learning on social life. Section 4 presents the case study of e-learning during COVID-19 lockdown. Section 5 concludes the paper.

2 Impact of E-Learning on Environment

E-learning can effectively reduce the energy usage and emission of carbon dioxide. According to a study in the Netherlands, e-learning not only has potential to reduce carbon emissions but also helps decrease the carbon footprint and carbon impact of students and travel staff. Moreover, e-learning not only reduces cost and time but also is helpful to restore the environment. It is also helpful to eliminate the necessity of traveling from one place to another. There are some impacts on environment due to e-learning^[15].

2.1 Impact on forest

According to National Wildlife Foundation, 60% of schools and universities' waste is paper. Sixteen trees are needed to generate the one-ton paper. The recycling of ten tons paper is equivalent to the use of 100 barrels crude oil^[16]. E-learning not only reduces the cutting of trees for paper generation but also reduces the resource required for recycling the paper. The registration, administration, curriculum, and study materials are digitalized and will also reduce 50% of students' cost.

2.2 Impact on air

University of West Georgia studied that if hundred students did not travel to schools/universities, carbon dioxide emissions may be reduced by 10 tons. The study of the Netherlands reported that e-learning reduced the percentage of carbon dioxide emissions and carbon footprint of students and staff^[15]. As per literature, 350 million printer's cartridges became dead every year and 1000 years are required to decay these cartridges. These materials can be easily eliminated through the e-learning^[16].

3 Implication of E-Learning on Social Life

The e-learning contents are responsible for solving the environmental issues. However, it can significantly affect

the social and mental health of students^[16].

3.1 Impact on mental health

The excessive exposure of electronic device greatly affected the mental health of users. According to American Psychiatric Association, the extreme use of e-learning may lead to social isolation. The e-learning not only reduces the academic achievement but also is responsible for mental depression. The e-learning is also responsible for sleep deprivation due to the deadline of assignment submissions. According to Harvard analysis, it is observed that sleep deprivation has direct relation with the academic outcomes.

3.2 Impact on physical health

The study of materials and completion of assignment on digital media require a lot of time on electronic devices. The excessive use of electronic device has a great effect on physical health of users. These are responsible for mortality rate due to over-sitting on electronic gadgets. The eyestrain and muscle injuries may be possible due to overuse of computers.

4 E-Learning Tools Adopted During COVID-19 Lockdown in India

On March 25th, 2020, India's Prime Minister Mr. Narendra Modi imposed a nationwide lockdown as a countermeasure to control the coronavirus pandemic. The lockdown was later extended on April 11th, 2020 in various states of India due to the increase in the number of coronavirus patients across different regions of the country. Universities, schools, and educational institutions were closed, and students went back to their homes. Hence, the educational institutions had to rely on e-learning and online education tools to provide students the necessary study material, schedule lectures, and to conduct examinations. The lockdown acted as a catalyst to help teachers adopt online tools. As of April 2020, according to the Ministry of Human Resource Development, India, platforms like Diksha, e-pathshala, NROER, NIOS, e-yantra, and FOSSEE are endeavors of the government to help educate the masses online. SWAYAM, an initiative by the Indian government, gets 50 000 views daily. Some other online methods adopted in different universities across India are (1) video and audio meetings, tools like Zoom, Loom, Gotomeeting, Skype, Bluejeans, Webex, and Google meet are being used; (2) discussion and collaboration boards make use of slack and flock; (3) storage and sharing files are

supported by Dropbox and Nextcloud; and (4) document, presentation, spreadsheet, and videos are made using G-suite, Prezi, GitBook, Confluence, Office365, and Adobe Acrobat. With teachers adopting and using e-learning techniques and tools to educate students, we aim to analyze the efficacy and acceptability of teaching aids provided and adopted among students of educational institutions, during the COVID-19 lockdown in India, by conducting a survey in three different educational institutions — Google Classroom, Zoom, and Microsoft Teams. The objective was to analyze the students are willing to adopt e-learning practices as a part of their classroom learning by conducting surveys in various educational institutions.

While conducting the surveys at the three educational institutions, it was presumed that the students had an internet connection, access to a mobile or a laptop, previous knowledge to operate a mobile phone or personal digital device, understood the default language of the platform, and the sampling done can be mapped to larger scales with minimum errors.

Case study 1: Thapar Institute of Engineering and Technology (TIET), Patiala, India

Thapar Institute of Engineering and Technology is a private engineering college located in Patiala, Punjab, India. The educational institution offers various courses in different fields of engineering. The traditional methods used for classroom teaching are whiteboard, blackboard, and a smart board that enable teachers to display presentations and write notes. In the laboratories, computers and necessary hardware and software are provided to students for experimentation and performing assignments. 75% attendance is mandatory to pass a course. Each course has an official website where course coordinators post important information, syllabus, marking scheme, lecture slides, and laboratory assignments. Details regarding quizzes and tests are notified to students via group representatives or via an update on the course site. Mid-semester tests and end-semester tests are conducted every semester, which are scheduled according to a date sheet that is made available on the web portal — Webkiosk, which is allocated to every student. Apart from these official websites, students have access to myHerupa, an initiative taken by Thapar students, where updates regarding coursework for each subject are made available for the first-year, second-year, and third-year engineering students. During the COVID-19 lockdown, the college

was temporarily shut down. All classroom activities and lectures were suspended on campus. Students and teaching faculty members went back to their homes; many situated far from college. The teachers of the university used e-learning tools and methods to provide education online for students. Lectures were pre-recorded and shared via WhatsApp and Google Drive links. Videos of laboratory assignments were pre-recorded and uploaded on course sites. Many teachers scheduled live online lectures using Zoom application to make material accessible to students. Zoom Video Communication provides a remote conferencing service. It allows video conferencing of 100 participants up to forty minutes free of cost. Paid subscriptions are also available to allow more participants and to increase the time limit. The service also allows one-to-one video conferencing and group conferencing, and allows users to message all members of a meeting at once or message a selective group of people, providing stimuli to activate students' auditory and visual senses, thus enhancing and replicating their in-person interactions^[9,10]. Slides were uploaded on the course site, and students were notified. For the courses, Image processing (UCS615) and Innovation and Entrepreneurship (UTA012), the third-year students pursuing the BEng degree in computer

science submitted their assignments via Google forums. A Google form was then circulated among the students of the Thapar Institute of Engineering and Technology, where students answered questions regarding the e-learning platforms used by educators to impart education online (see Figs. 1–3).

Case study 2: National Institute of Technology, Hamirpur (NIT-H), India

National Institute of Technology is a public college located at Hamirpur, Himachal Pradesh, India. The Ministry of Human Resource Development, India funds it. It is an engineering college for undergraduate students in various engineering courses. The on-campus practices include classroom teaching using tools such as whiteboards and blackboards. Teachers sometimes use slides to deliver their lectures. Apart from these tools, there is a web portal for students, which notifies them about their semester grades. All relevant information is circulated using messaging applications like WhatsApp. The use of smartphones helps make material accessible to students^[11]. To make study material available and to conduct tests for the first-year students pursuing the MEng degree in Computer Vision and Image Processing during the COVID-19 lockdown, Google Classroom has been adopted by

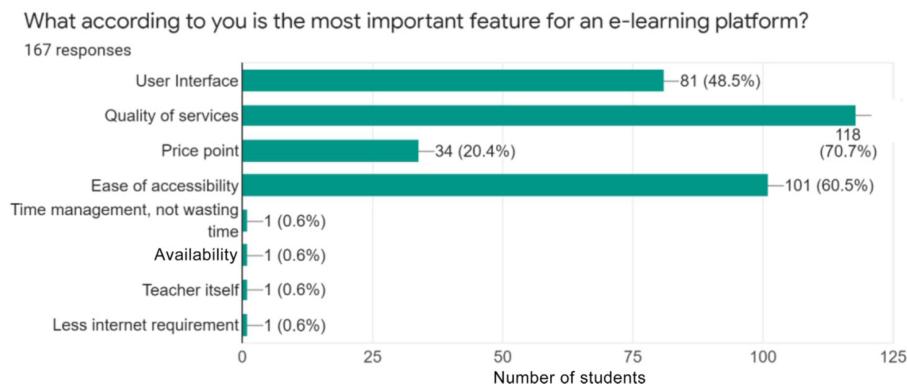


Fig. 1 Most important feature of e-learning for Thapar Institutes.

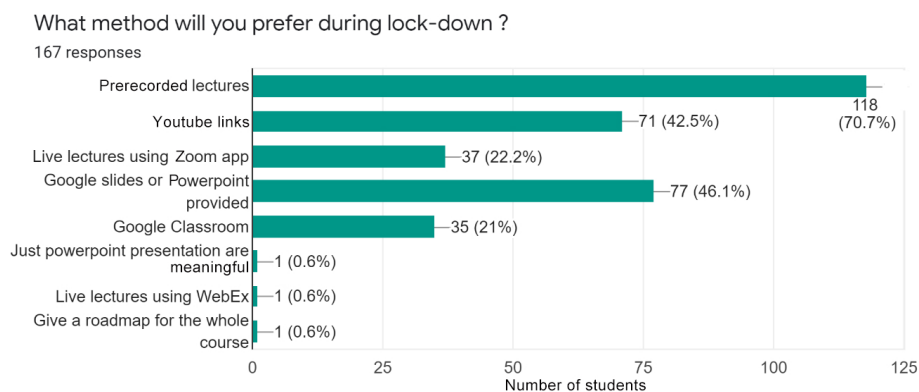


Fig. 2 Mode of preference for learning during COVID-19 lockdown.

Do you think education institutes should adopt tools provided by e-learning on a daily basis?
167 responses

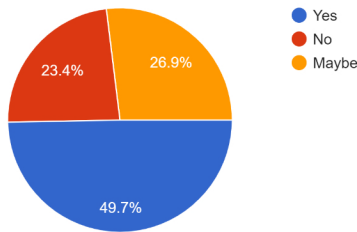


Fig. 3 Response to the question of whether e-learning methods should be adopted in daily classroom teaching.

the institute. To use this platform, a user has to sign into the Google Classroom. While using the G Suite for education account, the user clicks on whether they are a teacher or a student. The G Suite account is set up by an accredited college. Using Google Classroom services, slides are uploaded, and assignments are given to the students. This study material is available to the students via Google Classroom, and they turn in their assignments by submitting them to a private electronic mail account. Video links are also provided using Google Classroom. The marks and grades of

students are made available on the platform. Timed and pre-scheduled quizzes are also being conducted via this platform. Computer Vision and Image Understanding assignments were submitted via the Google Classroom platform. A survey was conducted by circulating a Google forum among the first-year students pursuing the MEng degree in computer vision to gain the feedback and viewpoint of students on e-learning tools and teaching aids being provided during the COVID-19 lockdown (see Figs. 4–6).

Case study 3: Manav Rachna International School, Mohali, India

Manav Rachna International School is a private school for primary and secondary education. The school has traditional tools like whiteboards and blackboards to teach students from Class One to Class Ten. The school also has smart boards, smart class, and projector, which allow teachers to display slides, play videos, and make interactive content for the students. The pupils of a class make notes in their notebooks. These notebooks may be evaluative or checked by an assigned teacher. During the COVID-19 lockdown, the online

What is the best feature of Google Classroom according to you?
16 responses

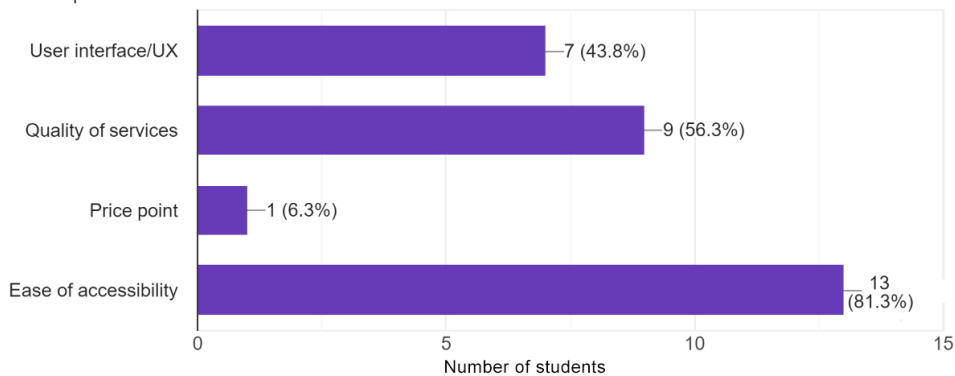


Fig. 4 Best feature of Google Classroom according to the National Institute of Technology, Hamirput students.

What other online education tool or method will you prefer?
16 responses

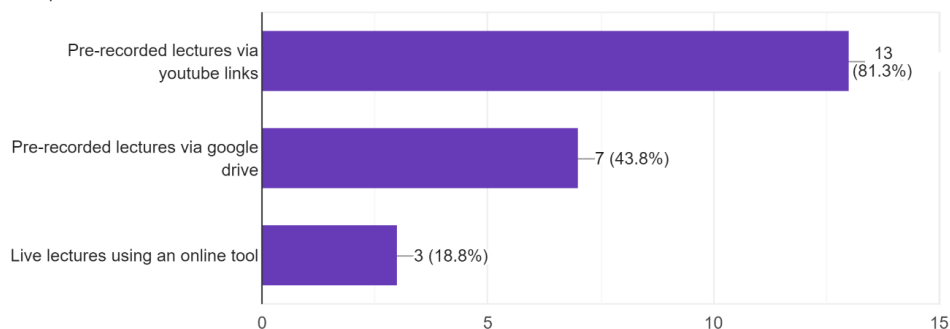


Fig. 5 Online education tool preferred by NIT-H students.

Do you think few features of online education should be added in daily day to day basis education

16 responses

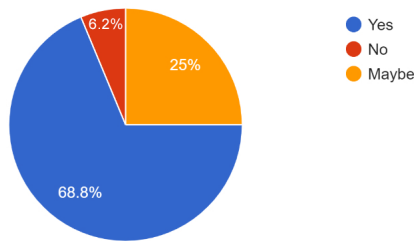


Fig. 6 Response towards the e-learning methods in NIT-H.

education tool used is Office365, a solution provided by Microsoft. The products provided by Office365 to educators and teachers include Outlook, Teams, Excel, Word, PowerPoint, OneNote, Publisher, and Access, according to the official Office365 website. The school is using the e-learning tool Teams provided by Office365. The lockdown initiated the process of providing official IDs to teachers and students using manavrachna.net. The teachers can make various teams for different classes. The chat option allows teachers to chat with parents and students either one to one, or by making a group of all students or selected students. The assignment section provided by Teams allows teachers to post assignments. Its design notifies teachers if a student has viewed the assignment, has turned in the assignment, and if the student has not opened the assignment by displaying view, turned in and not turned in, respectively. The students can submit their assignments by clicking on the add work button to upload their solved assignments. The class notebook section allows students to solve mathematics questions easily due to user-friendly design. It allows the teachers to view all the notebooks at once. However, students can only view their notebook. The quizzes and tasks assigned may be timed, and time bounds are facilitated by the class notebook section. The files tab allows the teachers to post relevant study material or reading material for students to view. Along with these tabs and options, the post tab is used to view all the notifications, tasks, and assignments uploaded by the teachers of different subjects for a team. The students from Class One to Class Nine were surveyed to gain insight about the acceptability of e-learning tools being used to combat COVID-19 lockdown among young children, aged 5 – 15 years old.

4.1 Results from case study 1: Thapar Institute of Engineering and Technology

The students pursuing the BEng degree in different majors at the Thapar Institute of Technology were surveyed. Out of 167 students surveyed, 126 were males and 41 females. 43.1% of students surveyed were third-year students going to the fourth year while 31.1%, 21%, and 4.8% of students surveyed were the first-year, second-year, and fourth-year students, respectively. Although the number of female students surveyed is significantly less than that of male students, the modal choice of preferences for every question asked on the survey was the same for the two genders. Hence, it can be said that gender does not influence e-learning.

The survey was conducted in April 2020 and questions included the most important feature for students for an e-learning platform, their preferred choice of online education tools, how often were users using Zoom application to view live college lectures on a weekly basis, if users were satisfied with the e-learning methods adopted by their institution, and if the user thinks that educational institutions should adopt tools provided by e-learning platforms on a daily basis. 118 students out of 167 students regarded the quality of services provided by e-learning platforms as an important feature, while 101 students and 81 students were in support of ease of accessibility and user interface, respectively. Other students regarded the price point of e-learning tools to be the most important feature of an e-learning platform. 70.7% of students surveyed preferred pre-recorded video lectures provided via YouTube links as the most convenient e-learning tool. Pre-recorder lectures provided via Google Drive links and Slides uploaded on course sites enjoyed a majority of 71 students and 77 students, respectively. It is observed that 33.5% of students are satisfied with e-learning tools. However, 32.9% of students are not satisfied with these tools. 52.7% of students agreed on using the Zoom application to view live lectures at least three times a week. The majority of the students (60.5%) were not satisfied with the e-learning methods adopted by the institute. However, 49.7% of students thought that educators should try to utilize tools provided by online education platforms daily (see Table 1).

Table 1 Students' response to survey conducted regarding e-learning practices adopted by teaching faculty of Thapar Institute of Engineering and Technology.

Item	No.	Item in detail	Number of students (max $n=167$)	Number of males ($n=126$)	Number of females ($n=41$)	Model
Distribution of students	1	First-year students	52	32	20	-
	2	Second-year students	35	25	10	
	3	Third-year students	72	61	11	
	4	Fourth-year students	8	8	0	
Most important feature of an e-learning platform. (Multiple choice correct)	1	User interface is the most important feature of e-learning platforms	81	61	20	Quality of service is the most important feature of e-learning platforms
	2	Quality of service is the most important feature of e-learning platforms	118	93	25	
	3	Ease of access is the most important feature of e-learning platforms	101	77	24	
Preferred choice of e-learning tool during COVID-19 lockdown. (Multiple choice correct)	1	Pre-recorded lectures shared via YouTube links are a preferred choice of online education tools during COVID-19 lockdown.	118	95	23	Pre-recorded lectures shared via YouTube links are a preferred choice of online education tools during COVID-19 lockdown.
	2	Pre-recorded lectures shared via Google Drive links are a preferred choice of online education tools during COVID-19 lockdown.	70	55	15	
	3	Google Slides uploaded on the official course site are a preferred choice of online education tools during COVID-19 lockdown.	77	60	17	
	4	Live lectures using Zoom application are the preferred choice of online education tools during COVID-19 lockdown.	37	29	8	
How frequently was the Zoom application used weekly to access lectures? (Single choice correct)	1	Zoom application used at least thrice a week to access live lectures.	88	65	23	Zoom application used at least thrice a week to access live lectures.
	2	Zoom application used twice a week to access live lectures.	30	22	8	
	3	Zoom application used once a week to access live lectures.	49	39	10	
Is the student satisfied with the e-learning tools adopted by the institute during COVID-19 lockdown? (Single choice correct)	1	Not satisfied with the e-learning methods adopted by the institute during COVID-19 lockdown.	101	79	22	Not satisfied with the e-learning methods adopted by the institute during COVID-19 lockdown.
	2	Satisfied or may be satisfied with the e-learning methods adopted by the institute during COVID-19 lockdown.	66	47	19	
Should e-learning tools be adopted in daily classroom teaching? (Single choice correct)	1	E-learning tools should be or may be adopted in daily classroom teaching.	128	98	30	E-learning tools should be or may be adopted in daily classroom teaching.
	2	E-learning tools should not be adopted in daily classroom teaching.	39	28	11	

4.2 Results from case study 2: National Institute of Technology, Hamirpur

Sixteen first-year students pursuing computer vision at NIT-H, were surveyed in April 2020. Out of 16 students, 5 were females, and 11 were males. Table 2 shows the survey of Google Classroom services were being used during the COVID-19 lockdown. The questions included in the survey were if Google Classroom was helpful

in teaching outside the classroom, what was the best feature of Google Classroom according to the students, if students were satisfied with Google Classroom teaching, if the submission of assignment for Computer Vision and Image Processing using the Google Classroom was convenient, was it easy to conduct quizzes on the online platform, if it is easy to access Google Classroom material, if the laptop or mobile devices were preferred

Table 2 Students' response to survey conducted regarding e-learning practices adopted by teaching faculty of National Institution of Technology, Hamirpur.

Item	No.	Item in detail	Number of students (<i>n</i> = 16)	Number of males (<i>n</i> = 11)	Number of females (<i>n</i> = 5)
Most important feature of an e-learning platform. (Multiple choice correct)	1	Ease of accessibility is the most critical feature of e-learning platforms.	13	8	5
	2	User Interface is the essential feature of e-learning platforms.	7	5	2
	3	Quality of services is the most crucial feature of e-learning platforms.	9	7	2
Preferred choice of e-learning tool during COVID-19 lockdown, other than Google Classroom. (Multiple choice correct)	1	Pre-recorded lectures shared via YouTube links are a preferred choice of online education tools during COVID-19 lockdown.	13	8	5
	2	Pre-recorded lectures shared via Google Drive links are a preferred choice of online education tools during COVID-19 lockdown.	2	2	0
	3	Live lectures via Zoom or Google meet are a preferred choice of online education tools during COVID-19 lockdown.	1	1	0
What are the benefits of e-learning? (Multiple choice correct)	1	With online learning, there is the ease of access.	11	7	4
	2	With online learning, there is consistency.	7	5	2
	3	With online learning, the schedule is flexible.	13	8	5
	4	With online learning, there is the use of limited resources.	8	5	3
Is the student satisfied with the e-learning tools adopted by the institute during COVID-19 lockdown? (Single choice correct)	1	Satisfied or may be satisfied with the e-learning methods adopted by the institute during COVID-19 lockdown.	16	11	5
	2	Not satisfied with the e-learning methods adopted by the institute during COVID-19 lockdown.	0	0	0
Should the features of online learning be adopted into daily classroom teaching? (Single choice correct)	1	Some features of online learning should be or may be adopted in daily classroom teaching.	15	10	5
	2	Some features of online learning should not be adopted in daily classroom teaching.	1	1	0

to access Google Classroom, what was the best feature of the platform provided according to students, what was another online educational tool that students preferred, what were the advantages of online education according to students, if the students were satisfied with the online learning tool adopted by the university, and if students wanted to incorporate few features of online education with daily classroom teaching. For a few questions, responses were recorded on a scale of 1–5, one being unsatisfactory, and five being satisfactory. 81.3% of the

students surveyed thought that the ease of accessibility was the best feature of Google Classroom and pre-recorded lectures shared via YouTube links enjoyed a majority of 13 students out of 16 as the preferred online education tool (see Table 3). The majority of students voted for the flexibility of schedule as the advantage of online education.

4.3 Results from case study 3: Manav Rachna International School

Table 4 shows the survey conducted in Manav Rachna

Table 3 Students' response to survey conducted regarding Google Classroom practices adopted by teaching faculty of National Institute of Technology, Hamirpur on a scale of 1 – 5, with five being maximum. The values are averaged.

No.	Item	Number of students (max $n = 16$)	Number of males ($n = 11$)	Number of females ($n = 5$)
1	Google Classroom helped in teaching outside of the classroom.	4.125	4.182	4
2	Students are satisfied with Google Classroom as an e-learning tool during the COVID-19 lockdown.	4.187	4.273	4
3	Submission of digital image processing assignments using Google Classroom was convenient.	4.500	4.636	4.2
4	It was convenient to answer quizzes on Google Classroom.	4.187	4.272	4
5	It is easy to access learning material in Google Classroom.	4.812	4.818	4.8
6	It was easier to use Google Classroom on the laptop than on Mobile.	3.937	3.909	4

Table 4 Students' response to survey conducted regarding e-learning practices adopted by teaching faculty of Manav Rachna International School, Mohali.

Item	No.	Item in detail	Number of students ($n=91$)	Number of males ($n=49$)	Number of females ($n=42$)
Students division among various levels from nursery to Class 9.	1	Nursery and Kindergarten	42	21	21
	2	Grades 2–5	31	15	16
	3	Grades 6–9	18	5	13
Are students satisfied with the Microsoft Teams tool being used during COVID-19 lockdown? (Single answer correct)	1	Students are satisfied or may be satisfied by the Microsoft Team tool being used during COVID-19 lockdown.	90	48	42
	2	Students are not satisfied with the Microsoft Teams tool being used during COVID-19 Lockdown.	1	1	0
Features of Microsoft Teams preferred by students. (Multiple answers correct)	1	Students like the Chat/Call Tab feature supported by Teams.	70	37	33
	2	Students like the Assignment Tab feature supported by Teams.	56	29	27
	3	Students like the Post Section Tab feature supported by Teams.	23	11	12
	4	Students like the Files Section feature supported by Teams.	21	10	11
	5	Students like the Class notebook Tab feature supported by Teams.	35	20	15
Are students able to achieve their learning outcomes through e-learning? (Single choice correct)	1	You will be or may be able to achieve the required learning outputs from these sessions?	82	41	41
	2	You will not be able to achieve the required learning outputs from these sessions.	9	8	1
What are the benefits of e-learning? (Multiple choice correct)	1	With online learning, there is the ease of access.	45	25	20
	2	With online learning, the schedule is flexible.	39	18	21
	3	With online learning, there can be interactive content.	36	16	20
Should the features of online learning be adopted into daily classroom teaching? (Single choice correct)	1	Some features of online learning should be or may be adopted in daily classroom teaching.	77	41	36
	2	Some features of online learning should not be adopted in daily classroom teaching.	14	8	6

International School, Mohali, India. Out of 91 students surveyed, 49 students (53.85%) were males, and 42 students (46.15%) were females. 98.90% of students were satisfied with the Microsoft Teams tool being used during the COVID-19 lockdown. Students preferred interaction and personalization as 76.92% of students favored the Chat/Call option of the Microsoft Teams application. 61.54%, 25.27%, 23.07%, and 38.46% of students liked the assignment tab, post section tab, files tab, and class notebook tab feature, respectively. 90.10% of students felt that they could achieve their learning outcomes via Microsoft Teams application being used during COVID-19 lockdown. 49.45%, 42.85%, and 39.5% of students felt that ease of access, the flexibility of schedule, and interactive bite-sized content are the benefits of e-learning platforms. 84.61% of students were in favor of the adoption of online learning tools into daily classroom teaching (see Table 5).

4.4 Results from the three case studies

For all three institutions, the majority agreed with adopting some e-learning practices with daily classroom education. For TIET students, mode of preference for e-learning was pre-recorded lectures via YouTube links. The students of NIT-H also gave preference to pre-recorded lectures via YouTube links apart from Google Classroom as a preferred choice of e-learning tool. Majority of students of Manav Rachna International School and NIT-H found ease of access as the best advantage of e-learning platforms. From the surveys, it can be seen that the students of all three educations would like some features of e-learning tools to be adopted in daily classroom education.

5 Conclusion

In this paper, initially, the impact of the COVID-19 lockdown is discussed on the environment. Thereafter, the impact of COVID-19 lockdown is discussed on the health of the students and researchers. Finally, e-learning environment for three educational institutions during COVID-19 lockdown is discussed. Zoom,

Google Classroom, and Microsoft Teams were not being previously used by TIET, NIT-H, and Manav Rachna International School, respectively. The student's preferences and choices were successfully identified and noted in the three institutions by conducting surveys. From the surveys, it can be seen that the students of all three educations would like some features of e-learning tools to be adopted in daily day to day classroom teaching. For NIT-H and Manav Rachna International School, it was successfully identified that students enjoyed the ease of access of material via e-learning tools. Such tools can be thought to be incorporated in daily classroom teaching. For TIET, students already have online portals where information is updated regularly. Apart from TIET, students at NIT-H and Manav Rachna International School were satisfied with the e-learning platforms being used during the COVID-19 lockdown. From the survey conducted at Thapar Institution of Engineering and Technology, we came to know that even if 60.4% of students were not satisfied with the e-learning practices being used by their institution during COVID-19 lockdown, 49.7% of students were still willing to incorporate e-learning practices in their daily classroom education. From the three surveys conducted, it can be seen that the majority of students are eager to adopt the e-learning platform features in their regular classroom teaching. Out of 274 students, 220, that is, 80.2% of students felt that e-learning platforms' features should be or may be integrated with the daily classroom teaching. The maximum number of students, that is, 73.59% of both the universities preferred pre-recorded lectures being provided via YouTube links as the preferred means of e-learning practice during COVID-19. YouTube links allow students to access the videos any time they like, making the material easily accessible and providing the flexibility of the schedule. Out of the students who answered what they prefer feature of online education, 52.3% supported ease of access, and 48.5% supported the flexibility of the schedule. Students preferred

Table 5 Students from three institutions respond to the adoption of e-learning practices in daily classroom education.

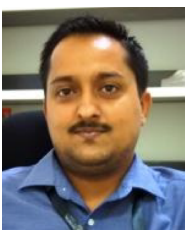
Item	No.	Item in detail	Number of students (<i>n</i> = 274)	Number of males (<i>n</i> = 186)	Number of females (<i>n</i> = 88)	Mode
Should the features of online learning be adopted into daily classroom teaching? (Single choice correct).	1	Some features of online learning should be or may be adopted in daily classroom teaching.	220	149	71	Some features of online learning should be or may be adopted in daily classroom teaching.
	2	Some features of online learning should not be adopted in daily classroom teaching.	54	37	17	

interaction and personalization as 76.92% of students favored the Chat/Call option of the Microsoft Teams application at Manav Rachna International School. At the National Institute of Technology, Hamirpur, 100% of students were satisfied with the Google Classroom practices adopted by their institution. At Manav Rachna International School, Mohali, 98.90% of students were satisfied with the Microsoft Teams' platform adopted during the COVID-19 platform.

To access these platforms, a mobile device and an internet connection are required. It is necessary for the student to be proficient in the English language, which is the standard or default language for many e-learning platforms. There are 560 million internet connections in India, making it the second-largest online market in the world after China^[12]. During the COVID-19 lockdown in India, institutions have adopted many e-learning practices. With the world moving towards digitization, COVID-19 may act as a catalyst to make education online. With students and teachers using these services to educate themselves and masses, new problems and solutions may be discovered, which may help popularize online education in India. In the future studies, from the three case studies, the choices and preferences of the students should be implemented in e-learning platforms and in-depth analysis of student behavior and their choices regarding user interface and flexibility should be underscored.

References

- [1] J. G. Ruiz, M. J. Mintzer, and R. M. Leipzig, The impact of e-learning in medical education, *Acad. Med.*, vol. 81, no. 3, pp. 207–212, 2006.
- [2] S. Kekkonen-Moneta and G. B. Moneta, E-learning in Hong Kong: Comparing learning outcomes in online multimedia and lecture versions of an introductory computing course, *Br. J. Educ. Technol.*, vol. 33, no. 4, pp. 423–433, 2002.
- [3] M. Ryan, K. H. Carlton, and N. S. Ali, Evaluation of traditional classroom teaching methods versus course delivery via the World Wide Web, *Journal of Nursing Education*, vol. 38, no. 6, pp. 272–277, 1999.
- [4] J. P. McCarthy and L. Anderson, Active learning techniques versus traditional teaching styles: Two experiments from history and political science, *Innovative Higher Education*, vol. 24, no. 4, pp. 279–294, 2000.
- [5] A. Alkaff, M. N. Qomarudin, S. D. Alkaff, and Y. Bilfaqih, Modelling online course services and comparison of its major providers, *International Journal of Emerging Technologies in Learning*, vol. 13, no. 1, pp. 65–81, 2018.
- [6] C. Thompson, How Khan Academy is changing the rules of education, *Wired Magazine*, vol. 126, pp. 1–5, 2011.
- [7] S. Panda and S. Mishra, E-Learning in a Mega Open University: Faculty attitude, barriers and motivators, *Educational Media International*, vol. 44, no. 4, pp. 323–338, 2007.
- [8] S. S. Liaw, H. M. Huang, and G. D. Chen, Surveying instructor and learner attitudes toward e-learning, *Computers & Education*, vol. 49, no. 4, pp. 1066–1080, 2007.
- [9] H. Nakanishi, K. Kato, and H. Ishiguro, Zoom cameras and movable displays enhance social telepresence, in *Proc. SIGCHI Conf. Human Factors in Computing Systems*, Vancouver, Canada, 2011, pp. 63–72.
- [10] S. Marhefka, E. Lockhart, and D. Turner, Achieve research continuity during social distancing by rapidly implementing individual and group videoconferencing with participants: Key considerations, best practices, and protocols, *AIDS and Behavior*, vol. 24, no. 7, pp. 1983–1989, 2020.
- [11] J. T. Clark, Distance education, in *Clinical Engineering Handbook*, 2nd ed. New York, NY, USA: Academic Press, 2020, pp. 410–415.
- [12] Statista Research Department, Internet usage in India: Statistics & facts, Statista, <http://www.statista.com/topics/2157/internet-usage-in-india/>, 2020.
- [13] L. Tankeleviciene and R. Damasevicius, Towards a conceptual model of learning context in e-learning, presented at 2009 9th IEEE Int. Conf. Advanced Learning Technologies, Riga, Latvia, 2009, pp. 645–646.
- [14] R. Burbaite, V. Stuiikys, and R. Damasevicius, Educational robots as collaborative learning objects for teaching computer science, presented at 2013 Int. Conf. System Science and Engineering (ICSSE), Budapest, Hungary, 2013, pp. 211–216.
- [15] M. Versteijlen, F. P. Salgado, M. J. Groesbeek, and A. Counotte, Pros and cons of online education as a measure to reduce carbon emissions in higher education in the Netherlands, *Current Opinion in Environmental Sustainability*, vol. 28, pp. 80–89, 2017.
- [16] P. C. Sun, R. J. Tsai, G. Finger, Y. Y. Chen, and D. Yeh, What drives a successful e-Learning? An empirical investigation of the critical factors influencing learner satisfaction, *Computers & Education*, vol. 50, no. 4, pp. 1183–1202, 2008.



Vijay Kumar is working as an assistant professor at Department of Computer Science and Engineering, National Institute of Technology (NIT), Hamirpur, India. He received the PhD degree from NIT, Kurukshetra in 2015. He has published more than 100 research papers in international journals/conferences.

He has many book chapters in international reputed publishers. He has supervised many PhD and M.Tech theses on metaheuristics, image mining, and data clustering. He is the reviewer of several reputed SCI journals. He is the member of ACM, CSI, International Association of Engineers, and International Association of Computer Science and Information Technology. His current research area is soft computing, data mining, deep learning, steganography, and pattern recognition.



Avani Agarwal is pursuing the bachelor degree in computer engineering at Thapar Institute of Engineering and Technology, Patiala, India. Her research interest is the domain of edge computing.



Sahil Sharma received the MTech degree from Thapar Institute of Engineering and Technology, Patiala, India in 2015. He is pursuing the PhD degree at Thapar Institute of Engineering and Technology, Patiala, India. He is an assistant professor at Department of Computer Science, Thapar Institute of Engineering and Technology,

Thapar Institute of Engineering and Technology, Patiala, India since August 2019. He has teaching experience of over 4 years. He has multiple research papers in reputed journals in the field of 3D face recognition and reconstruction. His area of research is computer vision, machine learning, deep learning, and face recognition.



Manjit Kaur received the PhD degree in the field of image processing from Thapar Institute of Engineering and Technology, Patiala, India in 2019. She received the master degree from Panjab University, Chandigarh, India in 2011. Currently, she is working as an assistant professor at Department of Computer Science Engineering, School of Engineering and Applied Sciences, Bennett University, Greater Noida, India. Her research interest includes information security, wireless sensor networks, digital image processing, and meta-heuristic techniques. She has published more than 24 SCI/SCIE indexed papers so far.