E-Learning for Engineering Education During Covid 19 and Impact Assessment

Vaiju Kalkhambkar, Hemlata Gaikwad
Rajarambapu Institute of Technology Rajaramnagar, Shivaji University, Sakharale, MS - 415414, India.

Abstract- **Covid 19 pandemic has affected engineering education significantly. Especially the major stakeholders of it i.e., faculty and students. Various benefits and drawbacks of e-learning were observed. This paper analyses online education during the pandemic and its impact assessment on faculties. An online survey of 150 engineering faculties of various branches in Shivaji University was conducted about the various issues of e-learning. The faculty response was analyzed and significant findings are obtained. The analysis involves Principal Component Analysis (PCA) method. The findings and lessons learned through this work will be useful for the engineering faculties to further enhance the e-learning platform and address the various questions. The work addresses the educational, personal and social impacts of online education on faculties and provides valuable suggestions for the long-term implementation of the offline-online mode.**

Keywords- **Engineering Education; e-learning; Covid 19 impact on faculty; e-learning guidelines; e-learning benefits;**

JEET Category- **Research,**

I. INTRODUCTION

THE COVID-19 has brought about a lot of changes in the education system. Many universities/schools worldwide have changed from traditional undergraduate classrooms to virtual online education and blended learning environment. The instructors use diverse digital learning resources which are flexible by adopting new learning approaches in Engineering Education (Asgari S et al., 2021). The pandemic affected not only educational activities but also people's health and mental health. Many faculties and students got suffered from stress and anxiety.   These psychological problems affected the teaching quality of faculty and students are also got affected while getting an online education. Various active learning techniques online quizzes, one-minute questions, flipped classrooms, true-false questions and case studies can be introduced in online education. COVID-19 has introduced one of the online education options all around the world. These lessons of online

education can be useful for our future (Chakraborty, P. et al., 2021).

In online teaching certain approaches like pre-recorded lectures; active question-answer sessions; quizzes, are more suitable and preferred by faculty and students. In online mode offering laboratory online is a challenge but virtual labs or live digital and remote labs can be the possible solutions. (Grodotzki, J, et al.,2020). The virtual lab needs to improve by using software or online applications that could represent the real labs (Alkabaa, A. S., 2022). Many faculty faced a lack of hardware, software and tools for the online delivery of content. The absence of a whiteboard/ blackboard, lead to a lack of online writing tool (Asgari, S., et al., 2021).

Effective online teaching depends on various factors such as encouraging contact between faculty and students, collaborative learning, active learning, feedback, learning diversification, and application of technology (Coman, C., et al., 2020). The lack of proper internet connectivity, relatively higher workload prevented students from elevated performance while adapting to online education. The students were bored, frustrated and anxious about their study issues and future career (Aristovnik, A., et al., 2020). Thus, the pandemic has allowed students to acquire new knowledge and skills useful for their careers and future development (American Society for Engineering Education, 2020).

During the pandemic, many Engineering colleges shifted to web Based/mobile-based teaching-learning for their students. The changeover compelled them to create interest in faculty and students regarding online education. Slowly this created a strong and effective use of web-based teaching-learning systems with innovations by the faculties. The designing of teaching-learning strategies should consider the learner's and instructor's, perceptions and learning support systems (Jung, Y & Lee, J., 2018).

Several advantages are there with e-learning. Easy Accessibility, affordable in nature, flexible options, and life-long learning are some of the benefits of online pedagogy. Online learning is accessible easily to everyone with easy availability in rural and remote parts of the country. It is a relatively cheaper option for education in terms of transportation costs, accommodation, and overall cost of learning. Time flexibility is one of the best aspects of online teaching-learning (Dhawan S., 2020). Global online education

faced a major challenge of technological limitations, communication and exhaustion of the faculty and students. Thus, online education should provide effective communication and interaction between students and teachers in addition to sharing of study material and information (Matsouka, M., et al., 2021).

There is a need for infrastructure development, training for teachers to inculcate innovative pedagogy to adapt to the new teaching-learning environment. Also, colleges, educational institutions and universities need to re-frame the syllabus, development of infrastructures and develop various assessment methods for the online mode of education (Kotari, M., 2021). Apart from the classes, examinations or grades, the knowledge, skills and life experiences need to be enhanced which makes a holistic development of students to cope with any situation (Bhattacharyya & Thander, 2021).

Though the adoption of online teaching is highly acceptable, the quality of online teaching and courses must be improved. The advantage of online learning is the ease of access from anywhere with good network signals. But online learning makes students boring easily and needs to make easy by providing study materials, assignments, short question-answers, and online activities during teaching-learning time (Suryaman, H., & Mubarok, H., 2020). The students should be supported to improve their morale, provide the best quality learning tools, give and receive feedback from students, provide training for students and teachers on new tools and technologies, diversify instructional delivery methods, and broaden access to online learning (Abu Talib et al., 2021). The main task during the pandemic was to actively engage students, projects, and research. It is required to develop applied methodologies and design for effective digitalization of education (Teräs, M.,2020). Also, the institutions need to revise their existing policy frameworks by designing new strategies and technical structures to support the teachers in successfully implementing online education. The use of technology is required in all aspects like attendance, delivery methods, examinations, evaluations, assignments, results, software, devices, internet speed and power backup (Joshi A, 2020).

The implementation of online education in developing countries has many challenges. They can be named: i) personal ii) instructional, iii) learning style, iv) situational, v) content suitability vi) organizational and, vii) technological. The development of e-learning structures and resources for online engineering education creates challenges in the adequate design of learning facilities and related intelligence (Banday, M. T, 2014). In any education system especially online education faculty play an important role in imparting quality education to the students. To achieve this the faculty, need to upgrade their skills by attending skill-enhancing programs and training programs (Khan Z. H., 2021). In online teaching-learning, the faculty need to change from the old methods of teaching-learning to new methods with advanced ITC technology. The student's feedback regarding new pedagogy is necessary to check whether the students pace with the new methodology (Lapitan Jr, 2021). Also, Technology-related factors i.e., ease of use, organization-related factors i.e., training support, environment-related

factors i.e. user attitude, and impact-related factors i.e. academic performance, Learning experience, degree of engagement and skill development, influence the students' e-learning (Eze S C, 2020). The pandemic has enforced careful and appropriate planning to minimize the impact of the pandemic on engineering education especially challenges related to academic responsibilities, family and financial problems (Asgari, S., et al., 2021).

The literature on online education thus provides a wide insight into the various aspects of online education including its importance, shortcomings, the role of the teacher, the role of students, and the positive and negative sides of online education. The most important thing is that the revised sudden mode of online education has suddenly affected the major stakeholder of the education system i.e., teachers. The impact of this sudden change from offline to online mode needs to be addressed. This impact can also provide some important insights into online education. Considering the above facts this study focuses on the following points:

i) This study provides useful information about the effect of online education on one of the major stakeholders of Engineering education i.e., faculties.
This analysis plays an important role in the development of the professional, personal and social life of Engineering faculties in online education.
ii) This analysis creates awareness about the various online platforms, active learning tools and pedagogical technologies.
iii) This work supports building confidence in online engineering education.
Considering the above aspects following are the main contributions of the proposed work:

1) To analyze the online education effects on faculties in Engineering Institutes in a pandemic situation.
2) To analyze the effects of online education on teaching-learning styles of faculties of Engineering colleges.
3) To analyze the effect of online education on the professional, personal and social life of Engineering faculties.
4) To summarize the overall merits and demerits of online education and provide recommendations.

II. ONLINE ENGINEERING EDUCATION DURING COVID19

The Covid-19 pandemic had affected the education systems, especially engineering education. In India during the lockdown, around one thousand universities and around forty thousand colleges conducted classes through online mode. In online learning and teaching, the faculty and students faced many problems. They have to adopt new methods of teaching learning and evaluation.

A. Online Engineering Education Opportunities

The lockdown refocused education towards online mode to Adapt to the changing scenario. Thus, Indian academicians had to overcome all resistance that was raised. This requires a

Change of mindset from traditional offline to online mode as online mode requires more engagement as compared offline mode of teaching-learning. The requirement of uninterrupted web services and power supply becomes the biggest challenge in online mode. Advancement in telecommunication technology was one of the benefits of online education mode. The colleges and universities in India used online mode using various tools like Zoom, Skype, go to a meeting, CISCO Webex, Microsoft Teams, Google Classroom and Canvas. The online education mode required various tools and techniques for teaching learning and assessment. Various ICT tools and online platforms were used for online communication between students and teachers. Student assessment and evaluation were one of the challenges for the faculties.

There was significant use of the learning material in soft forms. Sharing the study materials in soft form was very easy. There was large use of learning management systems by the faculties and students. The covid 19 moved the faculties towards the blended mode of teaching and learning. Blended Learning is not only a mere mixture of online and face-to-face modes but also a well-planned combination of activities in both modes. The activities mainly focus on learning outcomes and learner-centered instructional activities.

B. Challenges in Online Engineering Education

Several technologies are available for online education but sometimes they create some difficulties. These difficulties and problems associated with modern technology range from downloading errors, issues with installation, login problems, problems with audio and video, and so on. Sometimes student finds online teaching to be boring and unengaging. Online learning requires a large time and flexibility that students face difficulty to attend. Personal attention is a difficult task during online teaching-learning. Two-way interaction is difficult during online mode. The teaching-learning process does not reach its full potential unless students practice it regularly. Also, online content is mostly theoretical and students are unable to practice and learn it effectively. The lack of community, face-to-face solving of technical problems, and difficulties to understand instructional goals are the major hurdles to online learning. The students are unable to balance their work, family members, and social lives when they study online mode.

Though there was a high willingness of the faculties and students to online education, there were many difficulties and technical issues, supply and internet interruptions, time management, keeping motivated and absence of offline interaction. Also, the absence of fundamental online learning resources like computers, android mobiles, power supply, and e-skills, were the problems in many parts of the country. The lack of e-learning, tools i.e., Information Communication Technology (ICT) tools was the major issue in implementing online education. The orientation and competencies of faculty and students towards the changed online scenario also was a great concern.

C. Challenges in Teaching and Learning

The availability of various platforms and online tools, students and teachers face problems while using them. Some of the challenges highlighted are summarized as follows: Broadly identified challenges with e-learning are accessibility, affordability, flexibility, learning pedagogy, life-long learning and educational policy. In developing countries like India, rural and economically backward children are unable to afford online learning devices, the online education poses a risk of exposure to increased screen time for the learner. Therefore, it has become essential for students to engage in offline activities and self-exploratory learning.

Student assessments and examinations are carried out online, the online platform creates confusion among teachers, students and parents. The method adopted to conduct online assessments and examination varies as per the convenience and expertise of the faculty and learner compatibility. The lockdown adversely affected the colleges with internal assessments and examinations and also the various state and central level examinations like the Common Entrance Test (CET). Various state-level exams, job recruitment exams, university exams, andentrance exams were postponed across India.

There were economic, social and psychological impacts on the student's and faculty's life. They are away from the normal schedule of schools. The Increased and unstructured online time spent has exposed the students and faculty to the risk of cybersecurity. The students were exposed to the harmful and violent content of the internet. Still, the students and faculties have to rely on online and digital technology.

Also, the faculties were unable to face the sudden changeover of the teaching-learning techniques and adapt to online mode. There was a lot of confusion in using online teaching-learning tools. teachers were in dilemma as to which platform to use, which online methods to apply. It was difficult to implement a proper teaching-learning system to fit the online system of teaching.

III. EFFECT OF ONLINE EDUCATION ON FACULTIES

A. Negative Effects of the pandemic on Faculties

The COVID-19 pandemic has affected the overall life of humans in various ways. The impact level is very strong in the education sector and especially in the engineering education sector and the faculties. Following are some negative effects of the pandemic:

i)   Economic impact
The COVID-19 pandemic has affected the business trips, travel industry, hotel industry, event industry, airline industry and almost all industrial sectors. The economic condition of students to pay educational fees, internet charges, etc. was also affected. Many private institutions have to stop the salary of faculties for many months or paid the salary in a few percentages of the total e.g 50 %, 60 %, etc.

ii)   Physical Health and Lifestyle
Lockdown during the pandemic and social distancing norms forced people to stay at the home creating a negative effect on their physical and mental health. Ceased exercise, physical and sports activities, irregular sleeping time, and over

and unbalanced food habits resulting in obesity and other health issues.

iii)   Increased Screen time

Online teaching learning as an alternative to classroom learning has increased online professional duties, increased online evaluation time and use of computers for lecture preparation. This excessive screen time has increased health hazards, loss of attention, eyestrain, myopia and eyesight problems.

iv)   Disturbed Educational Activities

The pandemic closed all the engineering institutes and ceased academic, educational, administrative, research and teaching-learning activities. Educational activities like admission, exams, entrance tests and exams conducted by universities, colleges and other institutions have been postponed for an uncertain period. This all leads to severe challenges for students, faculties, researchers, parents and educational institutes.

v)   Evaluation and Assessment System

Almost all the examinations including internal and external have been canceled or postponed because of the pandemic during the peak of educational activities, i.e., assessment and evaluation. Thus, the educational system got affected and hurts teaching-learning activities.

vi)   Professional Growth and Development

This pandemic has affected the professional career of the faculties working in different private and public colleges and universities. All faculty promotions, bonuses, and faculty development programs have been postponed and canceled. This has created job insecurities, and social and economic problems among students, teachers and parents.

vii)   computer skills and knowledge

The sudden change in the teaching-learning mode required sufficient knowledge of computers. Most of the Engineering faculty have good computer literacy but a few faculties lack sufficient computer knowledge i.e., skills and knowledge to conduct online lectures.

viii)   plagiarism and copyright issues

Teachers have to deal with plagiarism and copyright issues while creating e-content for online teaching. Most teachers take care of plagiarism but a few of the teachers ignore or have to lack awareness about plagiarism and copyright.

ix)   time is taken for online teaching

The time taken for online teaching is more than classroom teaching. The creation of e-content requires more effort and time than offline classroom teaching.

B.   Positive Effects of Pandemic on Faculty

Though the pandemic of covid 19 has created many negative effects on education, educational institutions and faculties have tried their best to provide support to students during the pandemic. The Indian education system has transformed from a traditional system to a new educational system. The following points are the positive impacts.

i)   Blended Learning

The COVID-19 pandemic has accelerated digital technologies in the education system. The educational system has moved towards the blended mode of teaching-learning with online and offline methodologies. New ways of delivery and assessments of learning opened immense opportunities for a major transformation in the area of curriculum development and pedagogy.

ii)   Learning Management Systems

Various learning management systems are available in the online education system. Faculties are using learning management systems for teaching-learning systems. It has created a great opportunity for institutions to develop and strengthen learning management systems.

iii)   Use of soft learning material

Most of the study materials are now available in soft forms like presentations, pdfs, etc. During the pandemic situation, students were unable to collect hard copies of study materials and hence most of the students used of soft copies materials for reference.

iv)   Collaborative work

There are new opportunities for collaborative teaching-learning systems. Collaborative work can be among teachers or across the world to get benefit from each other.

v)   Use of Digital Literacy

The pandemic has revolutionized digital technology in teaching-learning and resulted in increased digital literacy. Faculty can easily use the resources available in digital mode.

vi)   Electronic Information sharing

Learning materials can be shared easily and queries can be resolved through online communication modes like phone calls, e-mail, SMS, WhatsApp and Facebook, etc.

vii)   Worldwide exposure

Educators and learners can interact with peers from around the world. The educators and learners have now adapted to the international community and interaction are easily possible.

viii)   Better time management

Faculty and Students can manage their time more efficiently and effectively in online education mode.

ix)   Open and Distance Learning (ODL)

During the covid 19, the faculties and students have preferred Open and Distance Learning modes for self-learning and learning from diverse resources for their learning.

IV.   CASE STUDY AND ANALYSIS

A.   Survey Data

A questionnaire was prepared for the teaching faculties working in different Engineering colleges under Shivaji university. The questionaries are based on the educational, personal, and social impacts of online education on faculties. The most relevant 20 questions were prepared based on the above impacts. A sample of 150 teaching faculties from different engineering institutes under Shivaji University is collected and analyzed and useful suggestions and comments are provided that are useful for the faculties considering online education.

The google forms were circulated to various colleges at Shivaji University. The primary data for information was collected. The data includes the name of branches. The branches are

mainly software branches and hard or core branches. The core branches include Electrical, Mechanical, Automobile, and Civil Engineering, and other branches are taken as the soft branches.
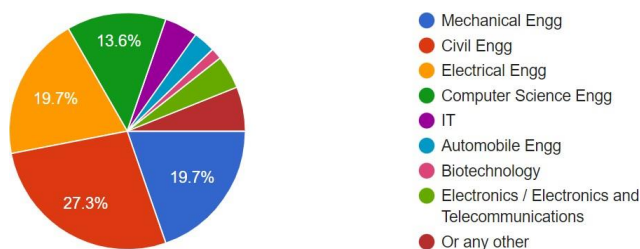

Fig. 1. Questionnaire response by various branch faculties

The age group of faculties was taken in the sets of 25-30 years, 31-40 years, 41-50 years, and 51-60 years. This diversified age group can give appropriate feedback and suggestion on online teaching and learning. In addition, the name of the faculty and the college name and e-mail ID of the faculty was collected to have any further discussion if required.

The faculties of various colleges and departments responded to the survey questions positively. The inputs from 150 faculties were collected and analyzed to get the overall effects of online education on faculties. Faculties from various age groups responded. Age group 25-30 years-18 % response, 31-40 years-41 % response, 41-50 years-29 %, and 51-60 years- 12 %. Thus, the feedback is given by all age faculties.

B.   Survey Questionary Analysis

The designed survey instrument was tested for its reliability. The Cronbach's alpha is found to be 0.82, which indicated the high reliability of the data instrument. The questionnaire was checked twice with the help of experts in the field for checking face and content validity. The questions were answered by all the faculties and suitable suggestions were provided by them. The following discussion provides the summary of the response to questions

1.   Mode of Engineering Education
Q.1 Which is the better mode of Engineering Education.?
About 25% of faculties of various branches and colleges had given the preference to mix mode of teaching i.e., the online plus offline mode can be preferred as per the suitability. Surprisingly 72.5 % had given preference to the physical classrooms.

2. Active / Synchronous Online Mode
Q.2 Which mode of education is more suitable?
Most of the faculties i.e., about 80 % preferred the active and synchronous online mode rather than their own recorded or pre-recorded class videos. Thus, teachers are more comfortable and surer about the quality of education in an active online mode.

3. Teaching Skill Improvement
Q3. How much is your online teaching skill improved during the pandemic situation?
More than 50 % of faculties agreed that their online teaching skills have improved during the pandemic situation due to the extensive use of online modes.

4. Increase in Workload
Q.4 How your workload is affected because of online education?
The faculty have to face an increased workload during the pandemic situation. More than 62 % of faculties provided feedback that the workload was significantly increased. Many institutions have conducted all the academic load as per the timetable through online mode including the online practical conduction using laboratory conduction videos.

5. External Disturbances
Q. 5. How do external and natural disturbances like internet connectivity, electricity supply affect online education? About 56 % of faculties found the online mode very disturbing. They have to depend on the power supply, andinternet connectivity and if anything goes off, it creates a big disturbance in the teaching-learning process.

6. Lecture Preparation Time
Q.6. Have you got time to prepare your online teaching material?
In terms of time available for the preparation of the lectures there was diverse opinion. But about 50 % of faculties found little time for the lecture and online material preparation.

7. Effectiveness of Online Lectures
Q. 7 Do PPTs/videos/animations make online lectures effective?
Though offline teaching is more effective as per the faculty's opinion, the presentations, videos, and animations make the online lectures moderately effective.

8. Sharing the Study Material
Q.8 Sharing course material with students in the online platform and enriching course study is easy or difficult?
As per the answers from faculties, sharing the study material was quite easy using the online platform, This has enhanced the study of the students.

9. Face Face Vs. Online Teaching-Learning Benefit
Q.9. Does face-to-face instructions provide a deeper level of learning compared to the online mode?
Almost 90 % of engineering faculties agreed that Face-to-face instructions provide a deeper level of learning compared to the online mode. Thus, engineering education remains effective only in offline mode being the comfort of both the faculty and students.

10. Student-teacher interaction in Online Mode
Q.10. How is student-teacher interaction in online education compared to offline mode?
About 56 % agreed that student-teacher interaction in online mode is merely passive. Rather the teacher is only delivering the content and students remain passive in their interaction. A few responses are sometimes observed in the interaction hence few have responded that interaction has a moderate effect.

11. Making online Lectures Interactive

Q.11 Which online mode you found effective to make the online lecture more interactive?
There are various ways like chat box discussions, using quizzes, polls, etc. to make online lectures more interactive. Among the all-interactive ways, the audio interaction is simpler and more effective. About 48 % of faculty found it more effective.

12. Educational Ethical issues
Q. 12 Does online education creates educational ethical issues like lying, copying, etc.?
As per the faculty's experience, about 67 % agreed that online education creates educational ethical issues like lying, copying, etc. These ethical issues were mainly observed in online tests and examinations. Many times, students have shown reluctance to give examinations in a proctored and monitored environment.

13. Effectiveness of Online Exams
Q. 13 How effectively can online tests, quizzes and exams assess the knowledge of students as compared to offline modes? It was difficult for the faculties to conduct the online examinations effectively i.e., about 54.5 %. Thus, online tests, quizzes and exams to assess the knowledge of students as compared to offline modes were less effective. Also, students were not attending the exams seriously and ethically.

14. Conduct laboratory sessions
Q. 14 What is the best way to conduct practical sessions during online mode?
Hence the conduction of practical sessions in the laboratory to verify the various concepts is of prime importance. There are various modes of online Practicals like virtual lab mode, pre-recorded mode and live online practical conduction. 45.5 % of faculties agreed that the virtual lab practical sessions can be more effective.

15. Phobia and Pressure of Internet Connectivity
Q.15. Does Online education leads to phobia and pressure on teacher for losing internet connectivity?
The teachers have shown a mixed response about the phobia and pressure of internet connectivity. About 29 % of faculties feel more pressure and 40 % do not have any pressure from internet connectivity. This is based on the availability of internet connectivity.

16. Stress and Health Issues
Q. 16 Does excessive screen time cause stress and health issues to teachers?
Nealy 50 % of faculties feel that stress and health issues caused moderate health problems to the faculties. This stress will be depending on the workload of the faculties.

17. Economy of a Faculty
Q. 17 As a teacher how the pandemic situation has affected your economy?
The pandemic situation has affected the economy of the world in all sectors. Faculties economy has also got affected during the pandemic. Many institutions had given less or nearly half of payments to the faculties. They have to manage their economy in hard conditions during the lockdown. Hence 62 % of faculties agree about the economic problem during covid 19.

18. Time for Self-Development
Q. 18 Have you got sufficient time for your self-growth during online education platforms?
The pandemic had changed all routines of the faculties. They were unable to get sufficient time. Many faculties i.e., more than 60 % agreed that they got very little time for their self-development during the pandemic.

19. Effect on Personal Life
Q. 19 How much online education has affected the personal life of faculties?
The faculty's personal life was affected and there were mixed effects as per the responses given by the faculties. Some have gotten little affected, a few have got moderately affected and a few got more affected due to the pandemic.

20. Effect on Social Life
Q. 20. How much has online education affected the social life of faculties?
The faculty's social life was affected and there were mixed effects. Some have gotten little affected, a few have got moderately affected and a few got more affected due to the pandemic.

C.   Principal Component Method Analysis

The Principal component analysis (PCA) is used to compute the principal components and use them to perform a change of basis on the data. PCA forms the basis of multivariate data analysis based on projection methods. The important use of PCA is to represent a multivariate data table as a smaller set of variables to observe trends, jumps, etc. The literature revealed several variables that impacted e-learning during Covid and some of them impact to date. If we want to identify the impact and work on these variables, it creates problems as the number of variables impacting is large. Hence, the question in front of the researchers was "How do we take all the variables and focus on a few selected ones?". In technical terms, this is called reducing the dimension of our feature space, and in other terms dimension reduction. Thus, we used principal components analysis to identify these few on which more focus is required. The specific weight is given to the options of the question on a scale of 3 to 1. Table 1 shows the data extraction method of Principal Component Analysis.

Table 1. Total Variance Explained

Comp.	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.511	12.555	12.555	2.511	12.555	12.555
2	1.995	9.973	22.528	1.995	9.973	22.528
3	1.862	9.309	31.837	1.862	9.309	31.837

4	1.703	8.514	40.351	1.703	8.514	40.351
5	1.480	7.401	47.752	1.480	7.401	47.752
6	1.275	6.377	54.129	1.275	6.377	54.129
7	1.139	5.695	59.824	1.139	5.695	59.824
8	1.042	5.211	65.035	1.042	5.211	65.035
.9	1.007	5.036	70.071	1.007	5.036	70.071
10	.934	4.670	74.741			
11	.814	4.070	78.811			
12	.738	3.692	82.503			
13	.659	3.297	85.800			
14	.591	2.954	88.754			
15	.575	2.874	91.629			
16	.468	2.342	93.970			
17	.368	1.841	95.811			
18	.329	1.644	97.455			
.19	.295	1.475	98.930			
20	.214	1.070	100.000			
Extraction Method: Principal Component Analysis.						

The table shows the initial eigenvalues and extraction sums of squared loadings of the 20 components i.e., questions.

Table 2. The extracted nine important factors

Factors	Eigenvalues	Eigen Values loaded
14. Which is the best way to conduct practical sessions during online mode?	1	0.824
13. How effectively can online tests, quizzes and exams assess the knowledge of students as compared to offline modes?	1	0.796
19. Online education affects the personal life of faculties	1	0.791
20. Online education has affected the social life of faculties	1	0.785
1. Which is a better mode of Engineering Education.?	1	0.777
18. Have you got sufficient time for your self-growth during online education platforms?	1	0.745
9. Face-to-face instructions provide a deeper level of learning compared to the online mode.	1	0.739
10. How is student-teacher interaction in online education compared to offline mode?	1	0.735
12. Does online education creates educational ethical issues like lying, copying, etc.?	1	0.725

Table 2. Gives the nine important extraction factors i.e., the most important questions with their weights. The summary of the important nine factors can be given below:

1. The mode of conduction of labs is an important parameter. The virtual lab is the best mode of conducting online Practicals.

2. The online tests, quizzes, and exams to assess the knowledge of students as compared to offline modes is one important parameter. It is also found less effective in online mode.

3. Online education affects the personal life of faculties is another important parameter. Many faculties agree with it.

4. Online education has affected the social life of faculties is one of the important questions. This has a substantial effect on faculties.

5. The question related to the better mode of Engineering education is having significant weight. Here, the physical classroom is highly voted on.

6. Time for self-growth during online education platforms is one of the important parameters from the analysis. Many agree that less time was available during online education.

7. The other question about face-to-face interaction got importance and was voted on by almost all faculties.

8. The student-teacher interaction in online education compared to offline mode was another important question. Most of the faculties experience it as a passive interaction in online mode.

9. Online education's ethical issues like lying, copying, etc. was the last important parameter. Many faculties found ethical issues in online education.

V. FINDINGS AND SUGGESTIONS

The proposed study has taken the feedback of Engineering faculties regarding the effects of online engineering education during the pandemic situation. From the feedback of the faculties from the questionaries, valuable findings are obtained. Following are some valuable findings and suggestions from the study.

i) *Physical interaction is more effective in Engineering education.* The physical mode can be made more effective using the blended mode of the teaching-learning method. The synchronous online delivery of the lectures is the best and preferred way by the faculties.
In this regard, online education can be blended with offline mode to make it more effective.

ii) *Face-to-face teaching has a deeper level of learning compared to online mode.* Student-teacher interaction is more effective in offline mode rather than online mode.
To make online education more effective, student interaction and involvement in online mode are more important.

iii) *The teaching skill of faculties have improved with the use of online mode.* They can use various tools and techniques in their classrooms.
The improved skills can be used to make the offline classes more interactive and effective.

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iii) The workload of faculty was load was increased during the online mode of education. The lecture preparation, interactive teaching-learning platform awareness, and online tools addition in the class have increased the load of faculties. Suitable modification and guidelines in the workload are required in the complete online mode of education.

iv) Presentations, videos, and animations make online lectures more effective. The sharing of study material is simple in online mode.
The faculties should prepare effective study material and share it with the students

v) Faculty need more time for the preparation of the lectures and study material. Many times, the online mode is found to be disturbing being dependent on power supply, internet connectivity, and the online platform.
Suitable time plans considering the preparation time need to be developed. A firm solution to the continuous power supply and internet connectivity needs to be ensured.

vi) Education ethics is a major issue in the online education system. These ethical issues were mainly observed in online tests and examinations where students show malpractice in it. Also, online tests, quizzes and exams to assess the knowledge of students as compared to offline modes were less effective Suitable platforms for online tests, examinations and assessments need to be provided to the faculties. Also, plagiarism software like Turnitin can be more useful to make the system more ethical.

vii) virtual lab sessions are more effective when it's an online mode of education. As per the experiences and opinions of faculties and students, the online practical sessions are more effective whenever required rather than various modes of online Practicals like virtual lab mode, pre-recorded mode, etc. Suitable virtual lab platforms need to be provided to the faculties in complete online mode when labs are to be conducted online.

viii) The online teaching-learning mode is more stressful and creates health issues. It also creates pressure and phobia about the connectivity and supply problem.
The workload of the faculty needs to be appropriately balanced considering the stress and workload of the faculties when it is completely online mode.

ix) Lockdown has created a huge impact on the economy of the faculties. Along with the stress of the changed teaching-learning mode they have to handle the economic stress. As a suggestion, they need to have a significant economic backup to go through such situations.
The engineering institutions need to ensure regular salaries for the faculty to have an effective online education.

x) There was a significant impact on the overall personal and social life of the faculties. The engineering faculty has got affected on personal, academic, and economic fronts during the pandemic situation. The faculties need to provide suitable programs, training and mentoring support.

VI. CONCLUSIONS

The faculties have successfully faced the challenges of online teaching-learning. They have learned various teaching-learning tools and techniques. They have effectively used various platforms for the evaluation of the students. The practical sessions were conducted using various modes of teaching and learning. The online lecture was delivered, and the online course material was successfully prepared and shared with the students. Thus, faculties have got one of the digital modes of teaching-learning to handle the teaching mode.

Online education during the pandemic has given a new dimension to the teaching-learning process. During the pandemic, though faculties have to work hard to deal with new teaching-learning situations and personal challenges. The personal challenges were the health issue and remaining secure from the coronavirus infection, dealing with the economic challenges during the critical situation when the payments were reduced to half. The complete mode of teaching-learning was itself a stressful experience due to the passive response of students, non-interactive classes, preparation of the study material and classes in online mode. The faculty was unable to give them sufficient time for self-development. Faculty has to deal with the new platforms and acquire the required computer skills to handle these platforms. The various supportive steps related to educational, personal and social fronts can make online education successful.

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