

E-learning for Undergraduate Students Amid The Pandemic: Teachers' Perspective

Ushveen Kaur¹, Nitya Chutani², Pragun Handa³

^{1,2,3}Sri Guru Gobind Singh College of Commerce, University of Delhi (New Delhi), India,

¹ushveenkaur@scc.ac.in

²nityac1996@gmail.com

³pragun.one@gmail.com

Abstract : The COVID-19 induced lockdown caused significant disruptions in the education sector, leading to prolonged closure of colleges in India and worldwide. As a result, teachers were forced to switch to online teaching using the available resources, which presented a major challenge since they were accustomed to traditional teaching methods. This study aimed to understand the teachers' perspective towards e-learning, including their motivation, knowledge about technology, infrastructure support, and the problems they faced while teaching undergraduate students. We conducted a quantitative analysis on primary data collected from a sample of 163 teachers from the University of Delhi and other institutes in North India. We used exploratory factor analysis and two-step cluster analysis to analyze the data. Three factors were identified to have a bearing on an effective online teaching process: infrastructure support provided by the institute and overall efficiency; overall resource availability, and online

content management. Our cluster analysis revealed that teachers can be divided into two clusters based on their technical knowledge and the infrastructure support available from the institute, respectively. We found that for e-learning to be effective, institutional support in terms of infrastructure and training is necessary, and instructors' motivation to learn new techniques is also imperative.

Keywords : e-learning, education, blended learning, teacher's perspective, online teaching

1. Introduction

With COVID-19 taking over and leaving the world shut in a blink of an eye, the pandemic made people find themselves locked in a new world, depending on digitalization more than ever, acquainting themselves with the unlimited tools, software, and creativity which this tech world offers (Dhawan, (2020), Rapanta et al., (2020)). From future doctors, engineers to budding economists and leaders of tomorrow, everyone caught themselves stuck in this novel environment, working tirelessly, experimenting with new tools, finding their niche, the new normal in this virtual setting.

As different industries tried to steer and adjust themselves to the emotional, physical and mental exhaustion which the new work culture entailed, the education industry came as no exception. The

Ushveen Kaur

Sri Guru Gobind Singh College of Commerce,
University of Delhi (New Delhi), India,
ushveenkaur@scc.ac.in

traditional classroom learning also took its form, with e-learning, blended learning, and online teaching tools coming to the rescue. E-learning is a form of formal learning system that uses various technologies and tools to facilitate teaching and learning process. In an e-learning setup, geographical hurdles are eliminated (Aboagye et al. (2020)). Blended Learning, on the other hand, is a model of education where online teaching methods are combined with traditional classroom teaching methods such that the most appropriate features of both the models are used so as to benefit the students and teachers in the best possible way (Amenduni, F., Ligorio, M.B. (2022)).

The education sector has and continues to escalate to take new forms, crossing the boundaries that the physical classrooms constructed, by offering immense learnings through a medium of diverse learning mechanisms. For instance, the online courses introduced by the Ivy league colleges like Harvard and webinars conducted by various educational bodies aim to educate people and give them a chance to inherit quality learning irrespective of the restrictions which the physical boundaries may pose. In fact, some studies show that an online distant-learning technique had better student grades than of offline learning (Gonzalez, T.; De La Rubia, M.A.; Hincz, K.P.; Comas-Lopez, M.; Subirats, L.; Fort, S.; Sacha, G.M.(2020), Iglesias-Pradas, S.; Hernández-García, Á.; Chaparro-Peláez, J.; Prieto, J.L.(2021)). However, this familiarity with methods of e-learning existed majorly in developed countries (Anuradha M., Tarushikha S., Rahila U. (2021)). That meant a disadvantage for the developing and transition economies.

The shift in student-teacher physical classroom setting to a virtual space impacted the lives of both the students and teachers in ways one can't even imagine. Additionally, as stated by the United Nations Educational, Scientific and Cultural Organization (UNESCO, (2020)), this wave of pandemic seized the rights of approximately 290 million students, taking away their chance at education, hindering their growth and learning processes (Reimers, F.M. (2022)). While e-learning had its own share of pros and cons, several research studies were undertaken across various regions and groups to study the situation and analyze the scope of online education in the given as well as in the coming times. Various measures were taken by the government of independent nations, in an effort to minimize the adversities that the pandemic brought into the education sector, in an effort to make

education accessible to all. As educational institutions and authorities helmed their way and progressed to make e-learning accessible to all, a ray of hope to revolutionize the education sector arose as students gradually started finding themselves at ease with the support of their teachers, peers and the institution. So much so that the educational institutions have even started thinking of making online teaching a complementary part of the regular curriculum, taking a form of blended or hybrid learning models.

While an effort was made to make this transition easy and smooth for the students by helping them in all possible ways, little was done to understand the perspective of the agents that make learning possible - the teachers. Consequently, little was done to assist the educators or the teachers, who have been equally affected by the pandemic. From taking a complete one-eighty, by making their lesson plans online-friendly to navigating their path in this chaos, teachers were expected to enable such transition smoothly. It became imperative therefore, to identify and address the issues which the teachers had to face.

While planning the future of e-learning, it is essential to pay attention not only to the students but also to the teachers and the instructors, who bear the responsibility to direct the system. Thus, the study, firstly aims to address the issues which the teaching fraternity in a developing country setting, experienced during e-learning. Secondly, it aims to identify ways that can make e-learning more effective, especially from a teacher's perspective.

2. Literature Review

Covid-19 outbreak brought everything to a standstill and effected every aspect of human life as the economies worldwide experienced huge growth slowdowns (Flores & Gago, (2020); Wargadinata et al., (2020)). Resultantly, it cannot be denied that the developing countries were severely impacted due to the lack of all types of infrastructure (Jægera & Blaabæk, (2020)). One such severely impacted sector was education.

Educational institutes of all types, primary, secondary and tertiary, faced major disruptions and had to look for alternative teaching and learning methods (Liguori and Winkler (2020)). Educational Institutes were pushed to move to the e-learning model as it was impossible to continue teaching without it (Demuyakor, (2020); Ratten, (2020)). E-

learning, which started as a simple exchange of educational material in e-mails in developed countries for distant learning has moved to more sophisticated models with use of high-end technology tools now (Bordoloi, R. (2018); Kentnor, H. E. (2015)). However, e-learning and its models like blended learning, flipped learning, flexible model, station rotation and all others which were implemented due to compulsion, gave mixed results in different geographies. They, thus remain a topic for research to evaluate the competing models for their suitability to a particular course and institute.

There are now a slew of studies related to understanding the pros and cons of various e-learning models used for teaching and learning, and how some institutes developed their own online learning platforms amongst other aspects. (Marinoni et al., (2020); Radha et al., (2020); Zhu & Liu, (2020); Shahzad et al., (2020)).

Studies have also been conducted to understand if online e-learning models increase the socio-economic gap or if success of these models is dependent on educational or economic background of the student (Dawadi et al. (2020)).

In a bid to understand the student's perspective, the studies indicate that students still prefer offline mode of teaching for science subjects like chemistry and biology, where performing experiments in lab physically is imperative for understanding course content (Wahid et al. (2020)). Some students found it difficult to cope up to the new online teaching methods due to lack of communication with the teachers (Ronnie et al. (2020)). Access to online platforms used, technical glitches in between the class, lack of technical knowledge and support were cited as the major hindrances by the students (Aboagye et al., (2020); Chung, (2020) ; O'Keefe, (2020)). Lack of access to hardware devices such as desktops or laptops or tablet has been cited as another major hindrance faced by students (Adnan & Anwar (2020); Moawad (2020)). Coming to a developing country like India, where not all students have access to either hardware infrastructure or online access needed for e-learning- the role of teachers, institute and the government gained importance. A study in West Bengal, India states that 30.6% students couldn't attend the online classes conducted at all due to lack of hardware and software infrastructure (Kapasia et al., (2020)).

A lot of studies have concluded that internet connectivity and network issues were identified as the main barrier in online learning (Berezhna et al., (2020); Jena, (2020)). Students cited that network issues while the class was going on or an unstable internet connection led to loss of interest in the class and thus became the major reason for non-participation of students in online classes (Mamun et al., (2020); Naciri, (2020)). In developing countries, even if internet facility is available, maintaining a stable network connection is difficult, especially in a situation when everyone in the house is working from home and each member of the house is using the same internet connection. Poor network or unstable network is a one of the common problems faced by students (Rose, (2020); Wargadinata et al., (2020)). Scholars working on the issue thus suggest that the universities and educational institutes should provide the hardware infrastructure like a tablet or laptop to every student to facilitate the learning process (Kwabena & Boateng, (2020)).

For effective learning, not just hardware and software infrastructure but a conducive environment too is extremely important. Studies show that most of the students do not have a private room or a quiet learning space to attend classes. Students do not interact in the class or answer to the teachers queries due to noisy background. It is very difficult for a student therefore, to concentrate in class if the learning environment is not conducive (Chang & Fang, (2020); Demuyakor (2020) ; Ronnie et al., (2020)).

Studies have been conducted to understand the psychological state of student during COVID times and understanding its effect on their education. The times were such that every household was facing difficult situations, seeing one's family members and friends in pain leads to stress, anxiety and sometimes even depression. Mental health issues negatively impact the student's motivation to further engage in the online classes (Cao et al., (2020); Dorn, (2020); Tandon, (2020); Xiong et al., (2020)).

However, as time progressed and people started to get accustomed with the ins and outs of this form of education, many people along with the educational institutions and governments started to see this mode of education as an opportunity to change the face of education in the coming times. And, thus the e-learning models, blended learning models like hybrid

classrooms, flipped learning and peer to peer learning, have gained immense popularity. However, institutions need to understand that for blended or e-learning to become successful, the question is not just with regards to how the students adapt, but also how the instructors deliver, the infrastructure available and a lot of other factors. It demands cooperation from government, stakeholders and undertaking institutions to provide the required support to the teachers and institutes to come up with relevant resources and models of learning (Aliyyah, R. R., Rachmadtullah, R., Samsudin, A., Syaodih, E., Nurtanto, M., & Tambunan, A. R. S. (2020)). Along with the required budget and advanced software that determine the success of blended learning or any other model of the study, it's the highly motivated teachers who make it a reality. (Lalima, D., & Dangwal, K. L. (2017)). The study by Zhang, W., Wang, Y., Yang, L., & Wang, C. (2020) also emphasized that despite getting support from the government, there was a lag in the implementation of policies as the teachers lacked basic technological knowledge required to conduct the classes. It also hinted that the success of online education is, to a large extent, contingent on teachers' online teaching ability and experience.

As is evident from several studies- the educators have the potential to shape the education sector, but it's unfortunate that during and after the pandemic, little was done to address their needs, demands and trauma which took a toll on them amidst this chaos. While a lot of teachers across the globe found themselves stuck in this new era of tech-classrooms, a few of the dynamic and keen teachers, through a series of unlearn and learn, adapted themselves to this new environment, making the process of communicating and perceiving education a lot more fun and enriching.

While a huge part of literature highlighted and addressed the issues that the students faced, and the losses that occurred, little was done to address the issues of teachers, who are the ones to steer the future of the generation. Hence, our study would attempt to examine the scope of E- learning and its varied forms in the Indian education sector from a teacher's perspective. Through this research, we aim at unfolding this under-researched area of study, which holds the potential to reinvent the education system, molding the way the education sector might operate or take a new turn in the coming era. So, our research questions are as follows-

Research Question 1 - What are the factors or parameters that determine the effectiveness of online teaching and therefore e-learning?

Research Question 2 - How do the teachers place themselves on the factors identified above? In other words, how do they see e-learning from their teaching experience?

So, through the study, we would be able to highlight the problems faced by the teachers, and the factors that need to be focused so that the teachers are better able to deal with the e-learning system. The recommendations from this study could help make online learning, in pure, or in other forms like say, a blended form, as an effective learning method.

3. Methodology

The study used quantitative techniques involving primary data collection and analysis. A primary survey was conducted wherein a self-administered questionnaire was circulated online amongst the teachers of the University of Delhi and other institutes of North India to record responses. The questionnaire consisted twenty Likert scale type questions, wherein the respondents were required to respond to each statement on a five-point Likert scale of agreement. The scale was such that 1= "Strongly Disagree", 2= "Disagree", 3= "Can't Say", 4= "Agree", and 5= "Strongly Agree". Apart from this, the questionnaire also consisted of some other multiple choice and open-ended questions which were designed to get insights into the various beliefs and characteristics relevant to the study.

The statements in the questionnaire covered various parameters like the efficiency, ease of conducting online lectures, and several other facets of the online education system. The responses were recorded as interval data on a scale of 1 to 5 and they were then taken to be as quantitative variables which explain the degree of agreement on the respective statements. Out of thirty-four variables so identified, nine variables central to the research question were chosen for factor analysis. The chosen variables are labelled as follows:

A. Effective teaching: e-learning as a method of teaching is different from that of classroom teaching. This variable explains the degree of agreement of teachers to the statement "e-learning is an effective method of teaching for the students

in higher education.” Hence, the variable tries to understand the perception of teachers regarding the overall effectiveness of e-learning for higher education studies.

- B. Practical teaching: Practical subjects involving a science/computer lab require greater need of student-teacher interaction. Thus, the students may entail difficulty in understanding and resolving doubts virtually. Furthermore, some students might even lack suitable infrastructure at home in the form of a working computer or laptop to learn practical based subjects. Therefore, this variable was used to measure the effectiveness of e-learning for practical subjects by posing the statement “e-learning techniques can do justice to practical teaching subjects”.
- C. Infrastructure: Infrastructure refers to the basic physical and organizational structures, and facilities that help in the functioning of an organization, for example- hardware and software tools, and content availability for the teachers. This variable explains the degree of agreement of teachers to the statement “Your institution has appropriate infrastructure required to facilitate e-learning.”
- D. Funding: Funding refers to the availability of financial resources to an organization. It is necessary to maintain basic operations and to invest in building of new infrastructure facilities, which should therefore facilitate smooth conduct of e-learning. This variable explains the degree of agreement of teachers to the statement “Your institution has the funding for e-learning infrastructure.”
- E. Software Availability: To facilitate e-learning, various software tools and applications are required. These can range from online video-conferencing applications to group emailing tools facilitated by their respective institutions and other third-party sources. This variable explains the degree of agreement of teachers to the statement, “There are abundant useful and relevant computer software to support your teaching tasks.” This was incorporated to gain insight into the respondents' understanding, attitude and compatibility with various software tools and applications available.
- F. Resource Availability: For e-learning, teachers require resources, like informative websites,

research blogs etc. These help teachers to better conduct their lectures and act as supplement to their course material. This variable explains the degree of agreement of teachers to the statement “There are abundant useful and relevant websites to support your teaching tasks”.

- G. Maintaining Content: This variable explains the degree of agreement of teachers to the statement “Designing, updating, managing, and maintaining e-content is easy.” Teachers need to manage and deliver a lot of educational content for the students, like notes and assessments. This variable gives us an insight into the enhanced workload of teachers due to online teaching, and the ease with which teachers are able to organize and provide content to students.
- H. Devices Available at Home: Another factor imperative for smooth conduct of online lectures is that both teachers and students have devices sufficiently available at home. These devices could comprise laptops, smart phones, tablets, routers etc. This variable explains the degree of agreement of teachers to the statement “There is enough electronic/computer infrastructure at home so as to take e-classes from home.”
- I. Technical Support: Technical support implies that teachers have sufficient guidance, support, and assistance from their institutions to facilitate e-learning. As e-learning is a fairly new method of teaching, the teachers require an adequate amount of assistance to adapt to this method. Thus, a good technical support team or guidance is a must to develop e-learning and teaching. This variable explains the degree of agreement of teachers to the statement “Your institution has enough computer support staff to assist you in conducting e-learning classes.”

The study was able to collect data on 163 teachers. The data so collected was analyzed using the statistical software SPSS. The study employed an exploratory factor analysis (EFA) followed by a two-step cluster analysis to achieve the objectives of the study. An EFA is based on the idea that measurable and observable variables can be reduced to fewer latent variables which share a common variance and are unobservable. This is referred to as reducing dimensionality. (Yong and Pearce, (2013)). Nine variables explained in the aforementioned paragraphs were grouped into three factors using the EFA. These

factors have a bearing on the effectiveness of online teaching from the perspective of teachers. Next, we classified the respondents into two clusters which depict the differences between the groups of teachers on the basis of variables identified with the help of EFA, and a few variables that were categorical in nature. Cluster analysis is a technique that groups the subjects (or respondents) so that each subject is more similar to other subjects in the group than to subjects outside the group. (Romesburg C, (2004)). By categorizing data into two or more groups, cluster analysis allows for a succinct and understandable summary of the respondents (Hair Jr, (2014)). When clusters need to be created based on a combination of continuous and categorical variables, we use a two-step cluster analysis. Only continuous data types are compatible with the other two clustering techniques- hierarchical and k-means. Since our variables were both, continuous as well as categorical, we had to use two-step cluster analysis. The following section explains the findings of the study.

4. Findings

A. Exploratory Factor Analysis

We had two objectives to be achieved through the EFA – first, summarization of data, i.e., to identify the underlying themes that explain the effectiveness of online teaching-learning processes from a teacher's perspective. Secondly, we wanted to achieve data reduction to arrive at fewer representative variables from the set of more extensive variables for use in subsequent cluster analysis. Guided by the literature, a total of nine variables were chosen for factor analysis. To ensure the credibility of the results, it was assured that the data collected was free from outliers. These variables were checked for outliers using a confidence interval approach wherein a standardized normal variate (commonly referred to as the Z-score) is computed for each value and if it lies outside the range of ± 2.5 standard deviations, it is treated to be an outlying value or simply an outlier. No such outliers were found in our data so no value was dropped. Moreover, data clear of outliers is an important assumption to be met before proceeding with the EFA. Certain statistical and conceptual assumptions were also checked for as will be discussed in a while. The study needs to be sure that the variables are sufficiently interrelated, so that it can be used to form factors relevant to the objective of the study. The data collected was thus judged on the following parameters, providing authenticity to the study.

Firstly, following the rule of thumb for factor analysis design, efforts were made to strive for maximum number of observations per variable. It must be the case that the sample size is such that there happen to be at least five cases per factoring variable. (Hair Jr, (2014)). For a total of nine variables included in the factor analysis, a sample size of 163 respondents were taken into consideration, giving us an observation to variable ratio of 18.1 observations per variable, with five cases per variable being the benchmark or the qualifying number.

Next, to authenticate the results received, the data collected was evaluated to check its factorability. That requires meeting of three important assumptions- Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy should be greater than 0.5; Barlett's test of Sphericity should be significant (Kaiser, H. F. (1974)), and the determinant should have a non-zero value. (Tabachnick and Fidell, (1989)). The KMO in our study was found to be 0.705, which is greater than 0.5. Next, about the Barlett's test- its null hypothesis is that the correlation matrix is an identity matrix. Rejection of the null hypothesis leads us to conclude that the data is suitable for dimension reduction. Since the p-value was 0.000 (i.e. $p < 0.05$), we were able to reject the null hypothesis of Barlett's test at a 5 percent level of significance. Additionally, the Measure of Sampling Adequacy (MSA) was used to provide reliability to the results furnished by factor analysis, which states that a variable must have an MSA score greater than 0.5 or above, in order for the data to be factorable. A variable having a MSA score below 0.5 is omitted from the data to add to the credibility of the results. The factors found in our study had an MSA score greater than 0.6, providing a strong foundation for the factor analysis to be performed. Also, the three factors so extracted were found to explain 65.706 percent of the variance in the data which is good as social sciences treat solutions above 60% as satisfactory. (Hair Jr, (2014)). The finding of three factors could also be confirmed through the scree plot criterion wherein the curve flattened beyond the third factor.

Finally, we had to choose the factor rotation method which shall provide a meaningful and straightforward factor solution in the form of a simplified rotated component matrix. To do so, the EFA was first conducted with the Direct Oblimin Method- an oblique method of rotation. The correlation between the factors or components as shown by the component correlation matrix depicted no significant correlation (i.e., a correlation greater

than 0.32). Hence, it was concluded that instead of an oblique method, an orthogonal method of extraction should be used. Thereafter, we tried all three orthogonal methods- Quartimax, Varimax, Equamax. Finally, the Varimax Rotation method was chosen as it gave the most simplified structure. The three factors so formed after performing the Varimax rotation method with Kaiser normalization are depicted in the rotated component matrix shown in below.

After assessing the cross loadings, communalities and respecifying the factor models, we were able to get three highly loaded factors with factor loadings

Table 1 : Rotated Component Matrix

Variable Name	Variable Meaning *	Component		
		1	2	3
Infrastructure	Your institution has enough infrastructure required to facilitate e-learning.	0.792		
Technical_support	Your institution has enough computer support staff to assist you in conducting e-learning classes.	0.791		
Funding	Your institution has the funding for e-learning infrastructure.	0.733		
Practical_teaching	e-learning techniques can do justice to practical teaching subjects.	0.719		
Effective_teaching	e-learning is an effective method of teaching for the students in higher education.	0.690		
Resource_availability	There is no shortage of useful and relevant websites to support your teaching tasks.		0.860	
Software_availability	There is no shortage of useful and relevant computer software to support your teaching tasks.		0.859	
Devices_home	There are enough electronic/computer infrastructure at home so as to take e-classes from home.			0.884
Maintaining_content	Designing, updating, managing, and maintaining e-content is easy.			0.738
* Given in this column are statements on which level of agreement was asked as per the following Likert-scale: 1- Strongly Disagree, 2- Disagree, 3- Can't Say, 4- Agree, 5- Strongly Agree				

greater than 0.5, given the sample size of 163. Factor loadings of ± 0.50 or greater are taken to be practically significant. (Hair Jr, (2014)) Post the process, the newly formed factors were then evaluated and labeled, representing the three distinct groups of variables which are then further used in the research to get the desired results.

These factors are explained as follows –

- 1) Infrastructure Support and Efficiency: The factor consists of variables ranging from infrastructure to the overall efficiency of online education. The variables included under this factor are Effective teaching, Practical teaching, Infrastructure, Funding, and Technical Support. These variables explain teachers' perception about e-learning as a mode of education and the institutional support provided by the institutions which can further influence the growth and impact of this learning method. The variables also point towards the relationship between infrastructure support and the effectiveness of e-learning.
- 2) Overall Resource Availability: The factor consists of two variables i.e., Software availability and Resource Availability. The factor explains teachers' views regarding the availability of online resources and software which are required to conduct online lectures. Thus, this factor accounts for teachers' perceptions towards the availability of required technology and content.
- 3) Online Content Management: The factor consists of two variables i.e., Maintaining content and Devices available at home. The factor assesses the capabilities of the teacher if he/she has the required knowledge, devices, and platforms to accumulate and make content available to the students. It also indicates the interconnectedness of device availability with content management as for example, devices like tablets and notepads could enable better content management.

As we wanted to achieve data reduction too through the EFA, the significantly loaded variables that loaded meaningfully on the respective factors were identified to serve as the clustering variables in the ensuing Cluster analysis.

B. Cluster Analysis

Following factor analysis, a two-step Cluster

analysis was performed on the nine highly loaded variables from EFA and four other variables which were categorical in nature. Categorical variables are those that take a value of “1” if the teacher uses online discussion/video meet/voice conferencing/PPT as a part of online teaching, and “0” if the teacher does not use any of the above methods. Two-step clustering analysis was used for reasons explained in the method. The two-step cluster analysis further gave rise to two clusters, namely clusters A and B, exhibiting the diverse characteristics which these groups possessed. The results are produced in Table II. The sizes of the first and second cluster are 79 and 84 respectively. The ratio of cluster sizes (biggest to smallest) is 1.06, indicating that cluster sizes are suitable. This is because a solution with a few larger clusters is preferable to a solution with numerous small clusters. (Norušis, M. J. , (2012)). That said, a good cluster solution is characterized by greater similarity (cohesion or homogeneity) of elements within a cluster, and greater differences (separation or heterogeneity) between the clusters. The Silhouette coefficient with its value ranging from -1 to +1 measures both cohesion and separation. Our Silhouette measure is 0.2, which is higher than 0, indicating that the cluster solution we obtained is acceptable and good. (Norušis, M. J. (2012)).

In two-step cluster analysis, the log-likelihood choice for distance measure is also chosen because only a log-likelihood criterion can be used when the data is a mixture of continuous and categorical variables. If the data contains both categorical and continuous variables, only the log-likelihood criterion can be used. (Norušis, M. J. (2012)). There are two criteria for determining the number of clusters automatically: BIC (Schwarz's Bayesian Information Criterion) and AIC (Akaike's Information Criterion). Because our findings do not differ between the two criteria, the results are only provided for the BIC criteria. The BIC coefficient for two clusters is the lowest, according to the auto clustering statistics. As a result, two clusters emerged, as indicated in Table II

Characteristics of Cluster A and B have been explained as follows:

The average score for the variable 'Resource Availability' is 3.52 for cluster A and 2.62 for cluster B. This goes to show that the respondents in Cluster A feel that there are enough resources available to sustain and implement e-learning in the long term. Similarly, the average score for Cluster A for

Table 2 : Cluster Analysis

Cluster A (Size = 84)	Cluster B (Size = 79)
Use Online Discussion 1 (88.1%)*	Use Online Discussion 0 (0%)*
Use Video Meet 1 (66.7%)*	Use Video Meet 0 (83.5%)*
Use Voice Conferencing 1 (63.1%)*	Use Voice Conferencing 0 (84.8%)*
Resource availability (3.52)**	Resource availability (2.62)**
Software availability (3.07)**	Software availability (2.35)**
Infrastructure (3.21)**	Infrastructure (3.96)**
Devices home (3.8)**	Devices home (3.15)**
Funding (3.01)**	Funding (3.62)**
Technical support (3.27)**	Technical support (3.73)**
Maintaining_ content (3.18)**	Maintaining_ content (2.78)**
Use PPT 1 (84.5%)*	Use PPT 1 (70.9%)*
Effective teaching (3.64)**	Effective teaching (3.94)**
Note: *Values in parenthesis indicate frequency of respondents whose responses are coded 1 or 0 on the variable **Values in parenthesis indicate the average score on the variable	

'Software Availability' is 3.07 as compared to 2.35 for cluster B, implying that the respondents in Cluster A believed that they have sufficient software to conduct lessons efficiently.

The average score for 'Infrastructure' is 3.21 for cluster A and 3.96 for cluster B. This shows that the respondents in Cluster B believed that they had adequate infrastructural support available from the institute as compared to the respondents in Cluster A. Parallel to this, the average score for 'Funding' is 3.01 for cluster A and 3.62 for cluster B. This goes to show that the respondents in Cluster B feel that there is adequate funding available from the institute to implement e-learning as compared to the respondents in Cluster A. The average score for 'Technical Support' is 3.27 for cluster A and 3.73 for cluster B. This implies that respondents of Cluster B have more technical support and guidance from the institute as compared to the respondents of Cluster A.

The average score for 'Devices available at home' i.e., the devices is 3.80 for Cluster A and 3.15 for Cluster B. Thus, it is safe to say that as compared to Cluster B, Cluster A has sufficient devices to conduct classes or initiate the exchange of information virtually. Following this, the average score for 'Maintaining Content' for cluster A, 3.18 was greater as compared to 2.78 of cluster B. Thus, it can be concluded that Cluster A is more comfortable with managing and delivering content online as compared to the respondents in Cluster B. The average score for 'Effective Teaching' is 3.64 for cluster A and 3.94 for cluster B. Thus, it can be concluded that both Cluster A and Cluster B are optimistic about adopting e-learning as an effective mode of teaching and learning but those in Cluster A seem to be relatively less optimistic.

The results indicate that a majority of respondents in Cluster A, around 88.8%, 66.7%, 63.1% incorporate Online Discussions, Video Meet, and Voice Conferencing respectively in their lesson plan whereas a majority of respondents in Cluster B, around 100%, 83.5% and 84.8%, respective to variables don't use these tools. On the other hand, a majority of respondents from both Cluster A and B, 84.5% and 70.9% respectively, use PowerPoint (PPT) presentations as a tool for teaching. This reflects wide familiarity of teachers with PPT as a mode.

Finally, the two clusters can be briefly interpreted as- Cluster A consisting of the technically equipped teachers and Cluster B consisting of teachers equipped with adequate infrastructure facilities and support from the institute. While the teachers in Cluster A appeared to be technically equipped and at ease with the various software tools required for the minimum efficient flow of education, they seemed a bit dissatisfied with the infrastructural support and training provided by the institute and thus remained relatively less optimistic about the prospect of e-learning becoming the face of online learning. On the contrary, cluster B, consisted of the teachers who had full and much better access to training and infrastructural support as provided by their respective institutes, but however, failed to innovate and administer the technical tools provided, as compared to the respondents in Cluster A. While Cluster A was rich in terms of skill sets required and their motivation, they lacked the infrastructure support, which the group of non-motivated teachers in Cluster B boasted of.

The implications of findings from EFA and Cluster Analysis are discussed in the conclusion section.

5. Conclusion

While it is not surprising that Covid-19 caused disruptions that hindered the learning process, the effectiveness of the coping mechanisms adopted by governments and educational institutions played a crucial role in mitigating or exacerbating these disruptions. The study emphasized that the major question underlying the scope and future of virtual or online education should not only be dominated by the students and other administrative issues but also by the attitude and coping mechanisms of the teachers who tend to play a vital role in the development of the education sector. So, the study has attempted to particularly highlight the problems faced by the teachers, and therefore the factors that need to be focused so that the teachers are better able to deal with the e-learning system. For that, a primary data-based study covering a sample of 163 teachers from University of Delhi and other prominent higher education institutions was done.

Factor analysis was done to achieve the first objective of identifying the parameters which determine the effectiveness of e-learning. The study identified three key factors that determine the effectiveness of e-learning: infrastructure support provided by the institute and overall efficiency; overall resource availability, and online content management. Next, a two-step cluster analysis was done to achieve the second objective of classifying the teachers on the basis of how they perceived e-learning on several parameters. Through a two-step cluster analysis, the study found that there are two distinct groups of teachers: Cluster A, consisting of technically equipped teachers lacking institutional support, and Cluster B, consisting of teachers equipped with adequate infrastructure but with little motivation to adopt newer online teaching techniques.

In conclusion, the study has revealed that the success of e-learning and blended learning relies heavily on the coordinated efforts of both teachers and institutions. To ensure an effective e-learning experience, institutions must take two key actions to positively affect teachers' perceptions about e-

learning. First, they must provide technical, financial, and infrastructural support, including access to devices and requisite software. Second, teachers must incorporate the knowledge and support received to be innovative and motivated in making their lesson plans e-friendly, ensuring that the quality of lessons delivered is not hampered.

For future research, it is recommended to expand the study by including dimensions such as gender, years of experience, and government support. About gender – female teachers are more likely to face greater time constraints devoted to teaching activities due to the care economy burden (Ferrant G., Pesando L.M., Nowacko K., (2014)). Secondly about years of experience – freshman teachers may be better placed in online teaching skills vis-à-vis senior teachers as online teaching is a technically intensive exercise (Wu, Sheng-Yi, (2021)). Additionally, government initiatives to aid teachers and institutes should be evaluated in light of the appropriateness of learning models - offline, online, and blended.. In summary, an effective e-learning experience requires a holistic consideration of all aspects, including infrastructure, software availability, resource availability, content management, availability of devices at home, effective and practical teaching, infrastructure, funding, technical support and the stakeholders, namely teachers, institutions and students.

References

- [1] Aboagye, E., Yawson, J. A., & Appiah, K. N. (2020). COVID-19 and E-learning: The Challenges of Students in Tertiary Institutions. *Social Education Research*, 2(1), 1–8. <https://doi.org/10.37256/ser.212021422>
- [2] Adnan, Muhammad, and Kainat Anwar. (2020). Online Learning amid the COVID-19 Pandemic: Students' Perspectives. *Online Submission 2*, no. 1 : 45-51
- [3] Aliyyah, R. R., Rachmadtullah, R., Samsudin, A., Syaodih, E., Nurtanto, M., & Tambunan, A. R. S. (2020), The perceptions of primary school teachers of online learning during the COVID-19 pandemic period: A case study in Indonesia. *Journal of Ethnic and Cultural Studies*, 7(2), 90-109
- [4] Amenduni, F., Ligorio, M.B. (2022). Blended Learning and Teaching in Higher Education: An International Perspective. *Education Sciences*. 12 , 129 . <https://doi.org/10.3390/educsci12020129>
- [5] Anuradha Mathrani, Tarushikha Sarvesh & Rahila Umer (2021) Digital divide framework: online learning in developing countries during the COVID-19 lockdown, *Globalisation, Societies and Education*, DOI: <http://10.1080/14767724.2021.1981253>
- [6] Assunção Flores, Maria, and Marília Gago (2020). Teacher education in times of COVID-19 pandemic in Portugal: national, institutional and pedagogical responses. *Journal of Education for Teaching*, 1-10.
- [7] Baticulon, Ronnie E., Nicole Rose I. Alberto, Maria Beatriz C. Baron, Robert Earl C. Mabulay, Lloyd Gabriel T. Rizada, Jinno Jenkin Sy, Christl Jan S. Tiu, Charlie A. Clarion, and John Carlo B. Reyes (2020). Barriers to online learning in the time of COVID-19: A national survey of medical students in the Philippines. *medRxiv*.
- [8] Berezna, Svetlana, and Ivan Prokopenko (2020). Higher Education Institutions in Ukraine during the Coronavirus, or COVID-19, Outbreak: New Challenges vs New Opportunities. *Revista Romaneasca pentru Educatie Multidimensionala* 12, no. 1Sup2, 130-135.
- [9] Blundell, Richard, M., Dias, Robert Joyce, & Xiaowei Xu, (2020), COVID-19 and Inequalities, *Fiscal Studies* 41, no. 2, 291-319.
- [10] Bordoloi, R. (2018), Transforming and empowering higher education through Open and Distance Learning in India. *Asian Association of Open Universities Journal*
- [11] Chang, Chiu-Lan, and Ming Fang, (2020). E-Learning and Online Instructions of Higher Education during the 2019 Novel Coronavirus Diseases (COVID-19) Epidemic. In *Journal of Physics: Conference Series*, vol. 1574, no. 1, p. 012166. IOP Publishing.
- [12] Chung, Ellen, Geetha Subramaniam, and Laura Christ Dass, (2020). Online Learning Readiness Among University Students in Malaysia Amidst

- Covid-19. Asian Journal of University Education 16, no. 2, 45-58.
- [13] Crompton, H.; Burke, D.; Jordan, K.; Wilson, S.W.G., (2021). Learning with technology during emergencies: A systematic review of K-12 education. *Br. J. Education Technology*. 52, 1554–1575
- [14] Dawadi, Saraswati, Ram Giri, & Padam Simkhada, (2020), Impact of COVID-19 on the Education Sector in Nepal: Challenges and Coping Strategies.
- [15] De Oliveira, M. M. S., Penedo, A. S. T., & Pereira, V. S. (2018), Distance education: advantages and disadvantages of the point of view of education and society, *Dialogia*, (29), 139-152.
- [16] Demuyakor, John. (2020), Coronavirus (COVID-19) and online learning in higher institutions of education: A survey of the perceptions of Ghanaian international students in China, *Online Journal of Communication and Media Technologies*, Vol no. 3, e202018.
- [17] Department of education and early childhood development, Blended learning, A synthesis of research findings in Victorian Education system, 2006-2011
- [18] Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of Educational Technology Systems*, 49(1), 5–22. <https://doi.org/10.1177/0047239520934018>.
- [19] Dorn, Emma, Bryan Hancock, Jimmy Sarakatsannis, and Ellen Viruleg, (2020). COVID-19 and student learning in the United States: The hurt could last a lifetime. *McKinsey & Company*.
- [20] Ellis, R. A., Steed, A. F., & Applebee, A. C. (2006). Teacher conceptions of blended learning, blended teaching and associations with approaches to design. *Australasian Journal of Educational Technology*, 22(3).
- [21] Ferrant G., Pesando L.M., Nowacko K., (2014). Unpaid Care Work: The missing link in the analysis of gender gaps in labour outcomes, December 2014, OECD Development Centre.
- [22] Gonzalez, T.; De La Rubia, M.A.; Hincz, K.P.; Comas-Lopez, M.; Subirats, L.; Fort, S.; Sacha, G.M. (2020) Influence of COVID-19 confinement on students' performance in higher education. *PLoS ONE*, 15, e0239490.
- [23] Gonzalez, Teresa, M. A. de la Rubia, Kajetan Piotr Hincz, M. Comas-Lopez, Laia Subirats, Santi Fort, and G. M. Sacha, (2020), Influence of COVID-19 confinement on students' performance in higher education, *PloS one* 15, Vol no.10, e0239490.
- [24] Hair Jr, J. F. *Multivariate Data Analysis* Joseph F. Hair Jr. William C. Black Barry J. Babin Rolph E. Anderson Seventh Edition
- [25] <https://en.unesco.org/themes/educationemergencies/coronavirus-school-closures> (2020)
- [26] Iglesias-Pradas, S.; Hernández-García, Á.; Chaparro-Peláez, J.; Prieto, J.L. (2021) Emergency remote teaching and students' academic performance in higher education during the COVID-19 pandemic: A case study. *Comput. Hum. Behavior*, 119, 106713.
- [27] Jæger, Mads Meier, and Ea Hoppe Blaabæk, (2020), Inequality in learning opportunities during Covid-19: Evidence from library takeout, *Research in Social Stratification and Mobility* 68, 100524
- [28] Jena, Pravat Kumar, (2020). Impact of pandemic COVID-19 on education in India.
- [29] Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika*, 39(1), 31-36.
- [30] Kapasia, Nanigopal, Pintu Paul, Avijit Roy, Jay Saha, Ankita Zaveri, Rahul Mallick, Bikash Barman, Prabir Das, and Pradip Chouhan, (2020), Impact of lockdown on learning status of undergraduate and postgraduate students during COVID-19 pandemic in West Bengal, India, *Children and Youth Services Review* 116, 105194
- [31] Kentnor, H. E. (2015). Distance education and the evolution of online learning in the United States. *Curriculum and teaching dialogue*, 17(1), 21-34

- [32] Koksai Ilker, The rise of online learning, Forbes Research, Vol 105, 0883-0355
- [33] Lalima, D., & Dangwal, K. L. (2017). Blended learning: An innovative approach. Universal Journal of Educational Research, 5(1), 129-136.
- [34] Liguori, Eric, and Christoph Winkler, (2020). From Offline to Online: Challenges and Opportunities for Entrepreneurship Education Following the COVID-19 Pandemic: 2515127420916738.
- [35] Longmuir, F., Windsor, S., Loeb, I., (2021). Disrupted and challenged learning practices: Students' experiences of 2020 as their final year of secondary schooling, International Journal of Educational Research, Vol 110, 0883-0355
- [36] Mamun, Mohammed A., Rubaiya Matin Chandrima, and Mark D. Griffiths, (2020). Mother and son suicide pact due to COVID-19-related online learning issues in Bangladesh: An unusual case report. International Journal of Mental Health and Addiction, 1-4.
- [37] Marinoni, Giorgio, Hilligje van't Land, and Trine Jensen, (2020). The impact of Covid-19 on higher education around the world. IAU Global Survey Report.
- [38] Medina, L. C. (2018). Blended learning: Deficits and prospects in higher education. Australasian Journal of Educational Technology, 34(1).
- [39] Mirata, V., Hirt, F., Bergamin, P., & van der Westhuizen, C. (2020). Challenges and contexts in establishing adaptive learning in higher education: findings from a Delphi study. International Journal of Educational Technology in Higher Education, 17(1), 1-25
- [40] Moawad, Ruba Abdelmatloub, (2020). Online Learning during the COVID-19 Pandemic and Academic Stress in University Students. Revista Românească pentru Educație Multidimensională 12, no. 1 Sup2, 100-107.
- [41] Mok, K., Xiong, W., Ke, G., Cheung, J., (2021) Impact of COVID-19 pandemic on international higher education and student mobility: Student perspectives from mainland China and Hong Kong, International Journal of Educational Research, Vol 105, 0883-0355
- [42] Moore, R, (2022). How do teachers help shape student learning in two states in Southern India? International Journal of Educational Research, Vol 111, 0883-0355
- [43] Naciri, Aziz, Mohamed Amine Baba, Abderrahmane Achbani, and Ahmed Kharbach, (2020). Mobile learning in Higher education: Unavoidable alternative during COVID-19. Aquademia 4, no. 1: ep20016.
- [44] Nantwi, William Kwabena, and Barfo Boateng, (2020). COVID-19 AND EDUCATION IN GHANA: A TALE OF CHAOS AND CALM. African Journal of Emerging Issues 2, no. 5, 41-52.
- [45] Neuhauser, C. (2002). Learning style and effectiveness of online and face-to-face instruction. The American Journal of Distance Education, 16(2), 99-113.
- [46] Norušis, M. J. (2012). Cluster analysis. IBM SPSS Statistics 19 statistical procedures companion.
- [47] O'Keefe, L., J. Rafferty, A. Gunder, and K. Vignare, (2020). Delivering High-Quality Instruction Online in Response to COVID-19: Faculty Playbook. Online Learning Consortium.
- [48] Radha, R., K. Mahalakshmi, V. Sathis Kumar, and A. R. Saravanakumar, (2020). E-learning during lockdown of Covid-19 pandemic: a global perspective. International journal of control and automation 13, no. 4: 1088-1099.
- [49] Rapanta, C., Botturi, L., Goodyear, P., Guardia, L., Koole, M. (2020). Online university teaching during and after the COVID-19 crisis: Refocusing teacher presence and learning activity. Postdigital Science and Education, 2, 923-945. <https://doi.org/10.1007/s42438-020-00155-y>.
- [50] Ratten, Vanessa, (2020). Coronavirus (Covid-19) and the entrepreneurship education community. Journal of Enterprising Communities: People and Places in the Global Economy.

- [51] Reimers, F.M. (2022). Learning from a Pandemic. The Impact of COVID-19 on Education Around the World. In: Reimers, F.M. (eds) Primary and Secondary Education During Covid-19. Springer, Cham. https://doi.org/10.1007/978-3-030-81500-4_1
- [52] Romesburg, C. (2004). Cluster analysis for researchers. Lulu.com.
- [53] Shahzad, Arfan, Rohail Hassan, Adejare Yusuff Aremu, Arsalan Hussain, and Rab Nawaz Lodhi, (2020). Effects of COVID-19 in E-learning on higher education institution students: the group comparison between male and female. Quality & Quantity: 1-22.
- [54] Sun, A., & Chen, X. (2016). Online education and its effective practice: A research review. Journal of Information Technology Education, 15.
- [55] Tabachnick, B. G., & Fidell, L. S. (1989). Using Multivariate Statistics. Harper & Row. New York.
- [56] Tandon, Rajiv, (2020). COVID-19 and mental health: preserving humanity, maintaining sanity, and promoting health. Asian journal of psychiatry.
- [57] Tomei, L. (2006). The impact of online teaching on faculty load: Computing the ideal class size for online courses. Journal of Technology and Teacher Education, 14(3), 531-541.
- [58] Wahid, Ridzal, Florence Pribadi, and Berlian Ester Wakas, (2020), Digital Activism: Covid-19 Effects in Campus Learning. Budapest International Research and Critics in Linguistics and Education (BirLE) Journal 3, Vol no. 3, 1336-1342.
- [59] Wargadinata, W., Maimunah, I., Eva, D., & Rofiq, Z. (2020). Student's responses on learning in the early COVID-19 pandemic. Tadris: Journal of Education and Teacher Training, 5(1), 141-153.
- [60] Wu, Sheng-Yi, (2021), How Teachers Conduct Online Teaching During the COVID-19 Pandemic: A Case Study of Taiwan, Frontiers in Education, Vol(6), 2504-284X.
- [61] Xiong, Jiaqi, Orly Lipsitz, Flora Nasri, Leanna MW Lui, Hartej Gill, Lee Phan, David Chen-Li et al, (2020). Impact of COVID-19 pandemic on mental health in the general population: A systematic review. Journal of affective disorders.
- [62] Yong, A. G., & Pearce, S. (2013). A beginner's guide to factor analysis: Focusing on exploratory factor analysis. Tutorials in quantitative methods for psychology, 9(2), 79-94.
- [63] Zhang, W., Wang, Y., Yang, L., & Wang, C. (2020). Suspending classes without stopping learning: China's education emergency management policy in the COVID-19 outbreak.
- [64] Zhu, Xudong, and Jing Liu, (2020). Education in and After Covid-19: Immediate Responses and Long-Term Visions. Postdigital Science and Education (2020): 1-5.