Tuning Journal for Higher Education

Perspectives, stakeholders, and competences

COVID-19 SPECIAL SECTION

Teaching-learning process through virtual mode during the pandemic time: Systematic literature review and gap analysis

Ajay Kumar Singh and Mukesh Kumar Meena

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Abstract

Purpose: Due to the COVID-19 pandemic, the Higher Education Institutes (HEIs) was closed temporarily. During this historical lockdown, the face-to-face mode classroom was temporarily got replaced by a virtual classroom. The objective of this study was to analyze the impact of nationwide lockdown on the benefits of the virtual classroom for the teaching-learning process for teachers and students due to change in the teaching-learning process in higher education during the COVID-19 pandemic.

Design: A total of 893 responses have been used for this study. We have collected data through a structured questionnaire on a Likert scale from 305 teachers and 588 students of Higher Education Institutes (HEIs) from all India levels. Descriptive and frequency statistics, t-test was used in SPSS software to analyze the data collected through the primary source.

Findings: The mean difference between expected benefits from the virtual classroom and actual benefits from the classroom is positive for students as well as faculty members. That indicates the overall mean of expected benefits is higher than the overall mean of actual benefits, and that difference value is 0.250055, with a Sig.

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(2-tailed) value of 0.036 which is less than 0.05 for teachers and 0.3872827, with a Sig. (2-tailed) value of 0.000 which is less than 0.05 for students. That indicates the significant difference between means of actual benefits and expected. The mean value of the expected benefit is higher than the mean value of actual benefits for 11 pairs and 08 pairs in the case of teachers and students respectively.

Discussion: Technical barriers are the reasons for not being able to attend the expected benefits from virtual classrooms in full capacity by students as well as by faculty members. Poor digital skills of teachers and students, lack of electricity facilities, less availability and accessibility of internet, connection issues, inadequate facilities, training, funding, and unacceptability of technology, etc. were the barriers to online education at the time of closure of colleges due to COVID-19 pandemic Onyema et al. (2020). Students can also have a casual attitude, less attendance, feeling of isolation and less interaction can lead to mental distress, spending more time in front of a computer could be hazardous for health too Surkhali and Garbuja (2020). Higher Education Institutes (HEIs) faculty members, as well as students, were not able to perceive actual benefits in full in comparison to expected benefits due to the presence of challenges in the virtual classroom as moderators. The higher education authorities, colleges/institutes/universities need to fix the above issues to enhance the quality of the teaching-learning process. The higher education authorities, institutes/colleges/universities must work together to resolve the issues and challenges of virtual classrooms to improve their effectiveness of the virtual classroom. Higher Education Institutes (HEIs) may provide technical support, and training to the faculty members as well as students for a better experience in the virtual classroom. Students who are lacking technical infrastructures such as computers/laptops and internet connectivity may be provided by Higher Education Institutes (HEIs) with financial and technical support to these students.

I. Introduction

The world is facing an unprecedented situation that has arisen due to the novel COVID-19 pandemic. Coronavirus which is known as COVID-19 is an infectious disease that was first reported in Wuhan city of Hubei Province of China in early December 2019 after that it started spreading in other countries as well then on 11th March 2020 WHO declared it a pandemic. Although various pandemics have been faced by the world in previous decades such as in 1918 Spanish flu was caused by the H1N1 virus, in 1957 Asian flu was caused by the H2N2 virus, in 1968 Hong Kong flu was caused by the H3N2 virus, and in 2009 Swine flu caused by H1N1 virus but the situation which has been created due to COVID-19 is unprecedented. As per the WHO report, the COVID-19 global outbreak in 216 countries with

581,837,714 confirmed cases infected with the virus, and 6,419,151 confirmed deaths till 13th July 2022. Although COVID-19 affected all sectors of the economy whether it is the manufacturing and service sectors by distrusting the supply chain and reducing the demand and tourism sector by restricting traveling among countries. But one of the most affected sectors because of COVID-19 has been the Education sector as the lockdown resulted in the closure of schools and colleges across countries.

UNESCO estimated that the pandemic affected 1,576,873,546 learners worldwide which was 90.1% of the total enrolled learners in 190 countries till mid-April 2020 due to the closure of schools but it reduced to 572,324,061 learners which is 32.7% of the total enrolled learners in 30 countries till the 1st November 2020. Global Monitoring of School Closure locally and countrywide and School Open during COVID-19 as per UNESCO, Government of India announced a first countrywide lockdown on 25th March 2020 for 21 days, as the cases were still increasing, the lockdown further extended till 3rd May after that it continued but govt. started giving relaxation regarding economic activities such as open manufacturing sector, various Government offices, and other activities with rules and regulations regarding social distancing, wearing the mask, avoiding unnecessary travel, etc. But schools and colleges remain closed. COVID-19 has disrupted the teaching-learning process of learners and teachers because of the closure of schools and colleges. The examinations were canceled or postponed till uncertain periods, which lead to uncertainties among students, especially for those who were about to complete their schooling and were supposed to take admitted to colleges and among final year students of universities who were likely to take jobs. As per UNESCO total number of 32,07,13,810 learners were affected due by the COVID-19 lockdown in India. Two years into the pandemic, schools have been fully closed for 20 weeks and partially closed for an additional 21 weeks, on average across countries. Data from the UNESCO Global Monitoring of School Closures reveal that about 1 in 10 countries have fully closed their schools for over 40 weeks. School children around the world have missed an estimated 2 trillion hours and counting of in-person learning since the onset of the pandemic and subsequent lockdowns. According to UNESCO at the end of February 2022, while a majority of countries have fully opened schools, 42 countries have opened schools partially and six countries still have their schools fully closed.

Onyema et al. (2020) concluded that COVID-19 disrupted learning, increased student debt, limited access to education facilities, increased job loss in the education sector, and reduced loss of learning among students. Management of schools and colleges encouraged their students and teachers

to continue the learning process through online teaching. In this technology-driven world, with the help of digital platforms such as Zoom, Skype, Google Meet, Microsoft Team, Google Classroom, YouTube, etc., teachers and students can continue their teaching-learning process during this pandemic period. In this period, all the Higher Education Institutes (HEIs)/universities/colleges were closed after instructions from the Ministry of Education (MOE), University Grants Commission (UGC), and All India Council for Technical Education (AICTE). All the teaching-learning practices had been conducted through virtual mode during the lockdown. This was the best time to analyze the actual benefits perceived from the virtual classroom by the teachers and students of higher education in India. The virtual classroom was the best solution available during the lockdown to save the academic year. Students and faculty members were expecting something good with the presence of a virtual classroom in the lockdown time.

II. Review of literature

Online teaching and learning could be advantageous through which teachers can motivate students, complete syllabus, provide accessibility to learning and teaching from any time and any place, etc. Online learning is more flexible in access as it can provide content and instruction at any time, from any place (Castro and Tumibay 2019). However, technological and infrastructure support is required for the successful implementation of online teaching and learning. Online teaching and learning can be fruitful for students as well as teachers to complete their syllabus and assessment, provide moral support, and reduce stress levels during the COVID-19 pandemic. it would also enable the interaction between the teachers and learners. But for effective learning and teaching, infrastructure and technological support are required. A study by Cheawjindakarn et al. (2012) recognized five critical success factors for online learning such as institutional management which comprises the framework, operation ability, and cost of the program, learning environment which consists of the course management system, technical infrastructure, access and navigation of the program, an instructional design which includes objectives, content quality, learning strategies, the psychology of learning and learning assessment of the course, services support for the course as training, communication tools, help desk, and course evaluation. Kuo et al. (2013) analyzed the interaction between learner and content of the study such as the design of online study material, document layout, use of videos, learner-instructor interaction as a level of communication between learners and instructor, and self-efficacy of the

students on internet measured as the ability of the students to use the internet were the main factors of student's satisfaction in online education programs.

Online teaching can have challenges such as poor internet connectivity, non-availability of appropriate electronic devices, lack of a teaching environment at home, and less ICT knowledge among students and teachers can result in less engagement of students and teachers in the teaching and learning process. Onyema et al. (2020) found that poor digital skills of teachers and students, lack of electricity facilities, less availability and accessibility of internet, connection issues, inadequate facilities, training, funding, and unacceptability of technology, etc. were the barriers to online education at the time of closure of colleges due to COVID-19 pandemic. The success of online learning depends on various factors. Students can also have a casual attitude, less attendance, feeling of isolation and less interaction can lead to mental distress, and spending more time in front of a computer could be hazardous for health too (Baid et al. 2017; Kang and Sindhu 2015; Ran et al. 2020; Surkhali and Garbuja 2020; Trotter 2002; Gilbert 2001; Wahyu et al. 2020) concluded spending more time in front of a computer could result in health problems and it was difficult for the teacher to ensure participation of students due to less in-person conversation and less socialization and less participation can result in mental distress. They also stated the problem of accessibility and affordability of internet connection was the main problem of virtual learning. They also found that low internet bandwidth and technical disturbance, less interaction, and minimum participation led to less engagement and disturbance during online classes. Although online teaching is helpful to maintain the continuity of the teaching and learning process it also requires various technological and infrastructure facilities for the smooth functioning of online learning and the limited availability of these faculties could affect the quality of education. Various research studies have been done to know the challenges faced by teachers in online teaching. Through online teaching students can interaction with the teacher which could be helpful to provide moral support and reduce the stress level of students during the COVID-19 Pandemic. Yulia (2020) concluded that online teaching is effective during this COVID-19 pandemic time for preventing the students from going away from home.

Moore (1991) observed the emergence of the personal computer industry and related technologies during the 1970s and 80s. He noted that technical innovations are adopted by different market segments in sequence. Online teaching-learning has benefits but various challenges and drawbacks are also associated with it. Various infrastructure and logistical facilities are required for the effectiveness of online teaching and learning. Geoffrey Moore's

concept is the Technology Adoption Life Cycle (Moore 1991, 1995, 2002, 2005). Based on Everett Rogers' observations on the diffusion of innovations specifically, adoption or diffusion of innovation occurs as adoption by a sequence of adopter segments. Online learning has been initiated by various schools and colleges without providing the necessary infrastructure and technical assistance and training for usefulness for online teaching and learning.

Various studies have been done to determine the challenges and drawbacks faced by teachers and students during online classes. Students' participation was less due to the lack of in-person conversations with teachers which could result in mental stress for students and teachers (Surkhali and Garbuja 2020). They also reported that an accessible and affordable internet connection was the main problem faced by students and teachers and less participation, interaction, and technical disturbance led to less engagement and disturbance in online classes. Teachers found technical, logistical, and pedagogical problems during online classes because of an unprepared transition from face-to-face teaching to online teaching. More efforts were required from the teachers' side to ensure that students are studying the correct study material and providing information about the assignment. Students opted for online education because it offered greater flexibility but required more self-discipline by students (Daymont 2011; Squire 2021; Jain et al. 2021; Willermark 2021; Neuwirth et al. 2020; Egielewa et al. 2021). Students' perceptions of vocational studies on online mode stated that as vocational studies require not only knowledge but skills as well, at the same time online learning did not improve student's productivity. The students' experience was not up to expectations (Syauqi et al. 2020).

II.1. *Systematic literature review of COVID-19 and education*

II.1.1. Bibliometric search

The search for articles to be included in the review was guided by a search strategy that we developed consists of four stages: database search, scholarly filtration, language filtration, and subject filtration (Fig. no. 2).

In the Stage one database search. The Scopus database has been selected due to the following reasons: Its coverage of publications that met a stringent set of requirements for indexing (e.g., scientifically and scholarly relevant), and its comprehensiveness of bibliometric information for publications that it indexes. Indeed, Scopus is suitable for endeavors seeking to curate a large corpus for

review (Paul et al. 2021), and it is a scientific database that is often recommended for bibliometric reviews (Donthu et al. 2021). The Scopus database has been recognized as a high-quality source for bibliometric data (Baas et al. 2020), and the correlation of its measures with those available from alternative scientific databases such as Web of Science is "extremely high" (Archambault et al. 2009), though the latter's coverage is less than the former (Paul et al. 2021).
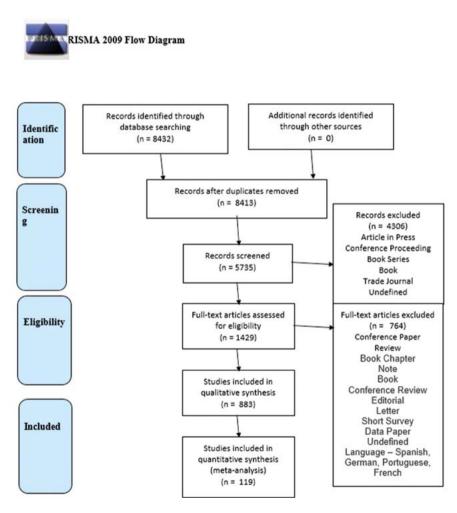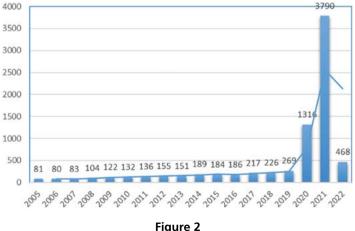

Figure 1
PRISMA flow chart for bibliometric review

The second stage is scholarly filtration. We chose to include only journal articles and conference proceedings, as they are usually evaluated on the grounds of novelty, subjected to rigorous peer review, and both. The third stage is language filtration. We chose to include articles written in English that were retained in Stage second only. This filtration was required as we are native English speakers. The Fourth stage is subject filtration. We choose to include articles with keywords. The formula we utilized for it:

> Title-Abs-Key ((("COVID-19" OR "Covid" OR "Pandemic" OR "Epidemic" OR "Disease" OR "Sars-Cov-2") AND ("Education" OR "Teaching" OR "Learning" OR "E-Learning" OR "Virtual Classroom" OR "Virtual" OR "Online" OR "Teaching-Learning") AND ("Faculty" OR "Teacher" OR "Student" OR "Pupil" OR "Learner") AND ("Challenges" OR "Drawbacks" OR "Benefits")))

In the first search of literature total of 8432 papers were found on COVID-19 and Education, after that filters were applied for the search. Further, the search was limited to title-abstract-keywords for more close studies. Then 5735 studies were found. Further, the most important keywords were applied, here we excluded 4306 articles. After that, we again applied filters of language, final publication stage, and journal articles. Here we excluded 764 articles. After that final 119 articles were found usable for extensive literature work which is important based on keywords (figure no. 1).

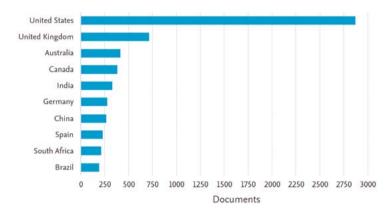## II.1.2. Publication trend of research paper on pandemic and education

Figure 2

Publication trend of pandemic and education

From the bibliometric analysis results for the Scopus database, in 2016 186 research papers were published, then 217 articles in 2017, 226 articles in 2018, 269 articles in 2019, 1316 articles in 2020, 3790 articles in 2021, as on February 26, 2022, 468 articles published in 2022. Now this pandemic and education research has become a trending research area, which is continuously going on (figure no. 2).

II.1.3. COVID-19 and education research across countries

Figure no. 3 is showing the results from the bibliometric analysis. Figure no. 3 is showing major contributing countries in COVID-19 and education research articles. The United States is at the top position by providing 2993 research articles on COVID-19 and education, which is followed by the United Kingdom with 752 articles, Australia with 436 articles, Canada with 398, India with 354, Germany with 283 articles, China with 276, Spain with 235 and South Africa with 210 articles and so on.

Figure 3

Number of articles – COVID-19 and education research across countries.

II.1.4. COVID-19 and education research paper's keywords

Figure no. 4 is showing the most frequent keywords of COVID-19 and education research. These keywords were provided by the authors in their research papers. Which are as follows: COVID-19, human, education, humans, pandemic, teaching, e-learning, online learning, article, medical education, higher education, learning, pandemics, sars-cov-2, education,

distance, curriculum, medical student, coronavirus disease 2019, students, online teaching, distance learning, male, female, procedures, student, students, medical, online education, adult, COVID-19 pandemic, questionnaire, epidemiology, internet, organization and management, emergency remote teaching, university, psychology, controlled study, computer-assisted instruction, education, medical, education, medical, undergraduate, blended learning, coronavirus, cross-sectional study, medical school, perception, distance education, nursing education, clinical competence, and surveys and questionnaires.

Figure 4
Most frequent authors' keywords

II.1.5. Journals contributing to COVID-19 and education research

Table no. 1. is showing the results of bibliometric analysis. Table no. 1 shows the most contributing journals in the field of COVID-19 and education research. sustainability (Switzerland) is the highest contributing journal with 38 papers followed by education sciences journal with 33 papers, bmc medical education with 20 papers, journal of chemical education with 20 papers, and so on.

Table 1

Top 5 Journals contributing to COVID-19 and education research

Sr. No.	Source	Documents	Citations
1	Sustainability (Switzerland)	38	420
2	Education sciences	33	232
3	Bmc medical education	20	361
4	Journal of chemical education	20	178
5	Frontiers in education	15	55

II.1.6. Most cited papers in COVID-19 and education

Table no. 2. is showing the results of bibliometric analysis for studies with the highest citations. Table no. 3 showing the most cited studies in the field of COVID-19 and education research. Daniel (2020) with 334 highest citations followed by Aristovnik (2020) with 273 citations, König (2020) with 178 citations, Watermeyer (2021) with 143 citations, and so on.

Table 2

Top 6 most cited research papers

Sr. No.	Document	Citations
1	Daniel s.j. (2020)	334
2	Aristovnik a. (2020)	273
3	König j. (2020)	178
4	Watermeyer r. (2021)	143
5	Mailizar (2020)	126
6	Webster c.a. (2015)	126

II.1.7. Most frequent keywords

The table no. 3 is showing the most frequent keywords of COVID-19 and education research. These keywords were provided by authors in their research paper which are as follows: COVID-19, human, education, humans, pandemic, teaching, e-learning, online learning, article, medical education, higher education, learning, pandemics, sars-cov-2, education, distance, curriculum,

medical student, coronavirus disease 2019, students, online teaching, distance learning, male, female, procedures, student, students, medical, online education, adult, COVID-19 pandemic, questionnaire, epidemiology, internet, organization and management, emergency remote teaching, university, psychology, controlled study, computer-assisted instruction, education, medical, education, medical, undergraduate, blended learning, coronavirus, cross-sectional study, medical school, perception, distance education, nursing education, clinical competence, surveys, and questionnaires.

Table 3
Top 21 most frequent keywords

Sr. No.	Keyword	Occurrences	Total link strength
1	COVID-19	470	2495
2	human	231	2606
3	education	202	1990
4	humans	192	2249
5	pandemic	186	1864
6	teaching	184	1669
7	e-learning	148	1135
8	online learning	144	456
9	article	119	1403
10	medical education	118	1359
11	higher education	107	409
12	learning	106	904
13	pandemics	98	1267
14	sars-cov-2	95	1185
15	education, distance	94	1260
16	curriculum	85	911
17	medical student	85	1170
18	coronavirus disease 2019	83	1082
19	students	80	572
20	online teaching	73	233
21	distance learning	70	386

II.1.8. Countries with the highest contribution in COVID-19 and education research

Table no. 4 is showing the results from the bibliometric analysis. Table no. 5 is showing major contributing countries to COVID-19 and education research articles. The United States is at the top position by providing 203 research articles on COVID-19 and education, which is followed by the United Kingdom with 85 articles, India with 73, and Australia with 45 articles, and so on.

Table 4

Top 5 contributing countries

Sr. No.	Country	Documents	Citations	Total link strength
1	United States of America	203	1199	15046
2	United Kingdom	85	740	14939
3	India	73	207	9454
4	Australia	45	274	10096
5	South Africa	40	136	5624

II.2. Research questions

- RQ1. What is the publication trend (number of articles by year) of papers focusing on the teaching-learning process through virtual mode during the pandemic time?

- RQ2. Where are the most influential publications (outlets, articles) of papers focusing on the teaching-learning process through virtual mode during the pandemic time?

- RQ3. Who are the most prolific contributors (authors, countries, and institutions) to a paper focusing on the teaching-learning process through virtual mode during the pandemic time?

- RQ4. What does existing research (themes, topics) inform us about the teaching-learning process through virtual mode during the pandemic time?

- RQ5. What can future research (avenues) explore to enrich our understanding of the teaching-learning process through virtual mode during the pandemic time?

The RQ1 to RQ4 have already been explained with the help of systematic literature review results. Further, we have framed objectives and hypotheses to analyze the RQ5. In this study, we have observed what could be the expected benefits of virtual classrooms. What was expected from the virtual classroom by faculty members and students, and whether the expected outcome of the virtual classroom is achieved or not? If not, what could be the possible reasons for the gap between the expected and actual outcomes? This study is conducted to find out benefits received from the virtual classroom and if any gap exists in expected and perceived benefits from the virtual classroom then what could be possible reasons for this gap at the time of the lockdown implemented due to the COVID-19 pandemic.

III. Objectives of the study

This study has the main objective to identify the most contributing authors, countries, and most frequently used keywords during the lockdown time period in studies based on virtual classroom teaching-learning practices. Another objective of this study is to analyze any significant gap between expected benefits and actual benefits perceived from virtual classrooms by teachers and students in higher education. On the basis of systematic literature review support, we also want to analyze the effect of the presence of challenges in achieving the expected benefits from virtual classrooms.

IV. Hypotheses

- H_A1: There are statistically significant differences between expected benefits and actual benefits perceived from virtual classrooms by faculty members in higher education institutions.

- H_A2: There are statistically significant differences between expected benefits and actual benefits perceived from virtual classrooms by students in higher education institutions.

V. Research methodology

We have collected data from the faculty members and students of higher education institutions at the undergraduate level, postgraduate level during the COVID-19 lockdown period. The class mode shifted from face-to-face mode to a virtual classroom. For this study, we have considered the 893 (305 faculty members + 588 students) total responses from faculty members and students of higher education institutes. Two structured questionnaires were shared through

digital platforms like Gmail, and personal messages on mobile, WhatsApp, and Facebook to the faculty members, and students of higher education respectively. Due to the nationwide lockdown face to face interaction was not possible. The structured questionnaire for students was shared with 4978 students of Higher Education Institutes (HEIs) at all Indian levels, 946 responses were received from students with a response rate of 19.5 percent. After the data cleaning process, and removing incomplete responses, only 867 responses from students were considered for this study. Out of the 867 students, only 588 students were using the virtual classroom, so we have considered 588 students for analyzing the benefits of virtual classrooms and the challenges faced by them during the virtual classroom. We have also asked the rest of the 267 students for their reasons for not joining the virtual classrooms. The structured questionnaire for faculty members was shared with 2392 faculty members of Higher Education Institutes (HEIs) at all India levels, 344 responses were received with a response rate of 14.3 percent. After the data cleaning process, and removing incomplete responses, only 335 responses from faculty members were found usable. Out of 335 responses from faculty members, only 305 faculty members were using the virtual classroom for the teaching-learning process, so we have considered only 305 responses from faculty members to analyze the gap between actual and expected benefits. We asked 30 faculty members to provide reasons for not using virtual classrooms.

To complete the analysis part of the study, SPSS 20 software has been used to compare the mean of actual benefits and expected benefits. AMOS 16 software was used to check the model fit and moderation analyses for perceived benefits from virtual classrooms.

This study has been done with the help of primary data collected through a questionnaire. To measure the actual and expected benefits from the virtual classroom a standardized questionnaire sun, P.C. et al. (2007), Arora and Srinivasan (2020) have been used. The whole questionnaire consisted of five sections consisting of expected benefits, actual benefits, and demographic information consisting one section for each. To check the internal consistency of the structured questionnaire. The Cronbach Alpha Reliability test has been used for the internal consistency of the questionnaire. Data analysis output is showing the results of internal consistency for each factor. The Cronbach's alpha test of internal consistency giving value $>= 0.7$ is considered to be good. From the teacher's sample of this study Cronbach's alpha value for expected benefits, the actual benefit is 0.927, and 0.939 for each respectively. From the student's sample of this study Cronbach's alpha value for expected benefits, actual benefits, challenges, and drawbacks are 0.953, and 0.960 for each respectively.

VI. Data analysis

VI.1. *Demographics of sample data*

Data analysis results are showing the demographic results of the faculty members and students. Out of 305 faculty members, 51.34 percent belonged to the age group of "up to 30" years, and 48.65 percent of faculty members were from the age group of ">30" years. Out of the total respondents, 68.65 percent of faculty members were female and only 31.34 were male faculty members. Among the total faculty members, 37.61 percent were with teaching experience of "0-3" years, 40 percent of faculty members had teaching experience of "4-10" years, and 20 percent of faculty members had more than 10 years of teaching experience. That means the majority of respondents were young and working as Assistant professors and Associate professors.

The demographic information of the students, out of 588 students, 99.88 percent belonged to the age group of "up to 30" years, and 0.11 percent of students were from the age group of ">30" years. Out of the total respondents, 65.62 percent of students were female and 34.37 percent were male students. Out of the total respondents, 79.12 percent of students were studying at the undergraduate level and 18.10 percent of students were studying at the postgraduate level.

VI.2. *Adoption rate of virtual classroom among teachers and students*

Out of the total 335 faculty members, only 91.04 percent of faculty members were using the virtual classroom to interact with students for the teaching-learning process during the nationwide lockdown due to COVID-19. When this study was conducted, 30 faculty members were not using the virtual classroom to interact with students and out of the total 867 students, only 67.80 percent of students were attending the virtual classroom for the learning process during the nationwide lockdown due to COVID-19, and 32.20 percent of students were not attending the virtual classroom when this study was conducted (Table no. 7). The respondents who were not using the virtual classroom for the teaching-learning process, were also communicated through Gmail to find out reasons for not using the virtual classrooms. Responses were received from 26 faculty members and 254 students, and 17 faculty members have cited the reason that they were thinking that virtual classrooms will not be easy for teaching. so they communicated with students through WhatsApp and Gmail. But after receiving positive reviews from their colleagues, they started using the virtual classrooms. These were conservatives/ late majority who were waiting to adopt until they see a clear

advantage specifically for their own situations and it is easy to use the technology offered (Moore 1991).

9 faculty members have cited the reason that when the lockdown was implemented they were able to complete the major part of the syllabus, and for the remaining part, they were using WhatsApp and Gmail. But in the new semester, there was no option left, so they started using virtual classrooms. These are Skeptics/ laggards who hold out until they have no choice but to adopt. Often they take pride in not adopting. They insist that the "old way" of doing something is good enough (Moore 1991).

103 students have cited the reasons for not attending virtual classrooms as non-availability of better quality internet, network issues, lack of computer/ laptop/Smartphone, etc. these students were facing infrastructural issues in the beginning. But after some time the majority of them made the arrangements when they find that the lockdown may go on for a long time, and 151 students cited the reason that the lockdown was just implemented for a month only in the beginning. Then it was continuously extended by one month again and again. When they realized that it is going long, they felt that it may create academic losses for them. There was no other option for them and then they started attending the virtual classroom. These are Skeptics/ laggards who hold out until they have no choice but to adopt. Often they take pride in not adopting. They insist that the "old way" of doing something is good enough (Moore 1991).

In this study, we are considering virtual classrooms as online live classrooms that can be conducted with the help of Microsoft Team, Google Meet, Zoom, and other live platforms. Those faculty members and students were attending classes on the above-mentioned platforms, and we have considered that those students and faculty members have adopted virtual classrooms for the teaching-learning process.

Those Faculty members and students who were not participating in the live online classrooms, we have considered as they have not adopted the virtual classroom for the teaching-learning process, they were just using online material available on the internet, old YouTube videos, etc. because in India when the lockdown was implemented for the first time, many faculty members were just sharing the study material with students through Gmail and WhatsApp. Because at the beginning of the lockdown there was no proper observation of online classes by the university administration, college principals, and heads of the departments.

VI.3. *Impact of COVID-19 lockdown on virtual classroom*

Out of the total 305 faculty members who were using the virtual classroom for interaction with students, 90.20 percent of faculty members started using

virtual classrooms after the COVID-19 pandemic. Only 30 faculty members were using virtual classrooms before the COVID-19 pandemic. Out of the total of 588 students who were attending a virtual classroom, 87.80 percent of students started using virtual classrooms after the COVID-19 pandemic. Only 12.20 percent of students were using virtual classrooms before the COVID-19 pandemic.

That shows the majority of teachers and students in Higher Education Institutes (HEIs) were not using virtual classrooms before the COVID-19 pandemic. The results are indicating a significant change in the teaching-learning process due to the COVID-19 pandemic in higher education.

VI.4. *Paired samples test results*

This study has been conducted based on a comparison of the expected benefits of the virtual classroom before attending with the actual benefits of the virtual classroom after attending. This concept has been used for both faculty members as well as students at the higher education level. Table no. 5 indicates the mean value of expected benefits and actual benefits of all 12 pairs for teachers and students respectively. The mean response value of expected benefits is higher than the actual benefits mean value in all 12 pairs for faculty members. That indicates that the actual benefits perceived from the virtual classroom are less than the expected benefits.

The mean response value of expected benefits is higher than the actual benefits mean value in 08 pairs for students. In one pair of students, expected benefits mean values are equal to actual benefits, and in one pair of students' expected benefits mean values are less than the actual benefits mean value. That indicates the major expected benefits of the virtual classroom are not perceived by students from the virtual classroom.

As we can see from table no. 5, the mean value of expected and actual benefits are more than the 3 on the 1 to 5 Likert scale for 11 pairs out of 12 pairs of expected and actual benefits. The mean value of the expected benefit is higher than the mean value of actual benefits for 11 pairs and 08 pairs in the case of teachers and students respectively. The reason behind this gap is network problems, lack of internet facilities, consistent connectivity issues, availability of infrastructure, and lack of classroom environment at home, and the gap in the mean value of expected benefits and actual benefits is higher in the case of students than in comparison to faculty members. Because teachers are having a monthly income, they can afford the expenditure for the development of online classroom infrastructure, laptops, internet connectivity, etc., and students are not supported by any personal

Table 5
Paired Samples Statistics

Pair		Faculty				Students			
		Mean	N	Std. Deviation	Std. Error Mean	Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Convenient to Use -Expected	3.49	305	1.136	.065	3.47	588	1.146	0.047
	Convenient to Use - Actual	3.42	305	1.109	.064	3.09	588	1.267	0.052
Pair 2	Able to Connect with Teachers/students- Expected	3.54	305	1.181	.068	3.38	588	1.129	0.047
	Able to Connect with Teachers/students- Actual	3.46	305	1.141	.065	2.89	588	1.185	0.049
Pair 3	Able to Cover Syllabus Timely-Expected	3.54	305	1.141	.065	3.14	588	1.191	0.049
	Able to Cover Syllabus Timely- Actual	3.49	305	1.139	.065	2.70	588	1.238	0.051
Pair 4	Enhancing personal learning-Expected	3.49	305	1.159	.066	3.14	588	1.179	0.049
	Enhancing personal learning- Actual	3.46	305	1.106	.063	2.78	588	1.207	0.050
Pair 5	Enhance creativity-Expected	3.48	305	1.112	.064	3.00	588	1.201	0.050
	Enhance creativity- Actual	3.41	305	1.178	.067	2.60	588	1.197	0.049
Pair 6	Class attendance will increase-Expected	3.15	305	1.185	.068	3.10	588	1.284	0.053
	Motivate students (more students will join the class) - Actual	2.94	305	1.221	.070	2.61	588	1.239	0.051

		Faculty				Students			
		Mean	N	Std. Deviation	Std. Error Mean	Mean	N	Std. Deviation	Std. Error Mean
Pair 7	Introduces to education technology-Expected	3.61	305	1.071	.061	3.50	588	1.111	0.046
	Introduces to education technology- Actual	3.59	305	1.051	.060	3.19	588	1.207	0.050
Pair 8	Sharpened digital skills-Expected	3.71	305	1.078	.062	3.42	588	1.091	0.045
	Sharpened digital skills- Actual	3.70	305	1.026	.059	3.10	588	1.159	0.048
Pair 9	Schedule Flexibility-Expected	3.78	305	1.041	.060	3.35	588	1.131	0.047
	Schedule Flexibility- Actual	3.70	305	1.100	.063	2.96	588	1.186	0.049
Pair 10	Less Disturbance From Classmates-Expected	2.85	305	1.194	.068	3.15	588	1.228	0.051
	Less Disturbance From Classmates- Actual	2.83	305	1.183	.068	2.75	588	1.263	0.052
Pair 11	Able to Cover Practical Subjects Also- Expected	2.83	305	1.234	.071	2.68	588	1.300	0.054
	Able to Cover Practical subjects Also- Actual	2.79	305	1.345	.077	2.36	588	1.245	0.051
Pair 12	Effective time management-Expected	3.38	305	1.147	.066	3.24	588	1.193	0.049
	Effective time management- Actual	3.34	305	1.192	.068	2.80	588	1.184	0.049

Table 6
Paired Samples Test - Individual Effect for Faculty

		Paired Differences							
		Mean	Std. Deviation	Std. error Mean	95% Confidence Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Convenient to Use – Expected / Convenient to Use- Actual	-0.125	1.050	0.060	-0.243	-0.006	-2.072	304	0.039
Pair 2	Able to connect with Students - Expected / Able to Connect with Students- Actual	0.089	1.071	0.061	-0.032	0.209	1.444	304	0.005
Pair 3	Able to Cover Syllabus Timely – Expected / Able to Cover Syllabus Timely- Actual	-0.075	0.898	0.051	-0.177	0.026	-1.466	304	0.144
Pair 4	Enhancing Personal Learning – Expected / Enhancing Personal Learning- Actual	-0.131	0.951	0.054	-0.238	-0.024	-2.409	304	0.017
Pair 5	Enhance Creativity – Expected / Enhance Creativity- Actual	-0.043	0.926	0.053	-0.147	0.062	-0.804	304	0.422
Pair 6	Class Attendance Will Increase – Expected / Class Attendance Will Increase - Actual	0.210	1.193	0.068	0.075	0.344	3.072	304	0.002
Pair 7	Introduces to Education Technology – Expected / Introduces to Education- Actual	0.013	0.899	0.052	-0.088	0.114	0.255	304	0.799
Pair 8	Sharpened My Digital Skills – Expected / Sharpened Digital Skills- Actual	0.007	0.874	0.050	-0.092	0.105	0.131	304	0.896

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. error Mean	Std. Error Mean 95% Confidence				
				Lower	Upper			
Pair 9 Schedule Flexibility – Expected Schedule Flexibility- Actual	0.082	0.912	0.052	-0.021	0.185	1.569	304	0.118
Pair 10 Less Disturbance From Students – Expected Less Disturbance From Students- Actual	0.023	1.212	0.069	-0.114	0.160	0.331	304	0.023
Pair 11 Able to Cover Practical Subjects Also – Expected Able to Cover Practical subjects- Actual	-0.052	1.025	0.059	-0.168	0.063	-0.894	304	0.012
Pair 12 Effective Time Management - Expected Effective Time Management- Actual	0.046	1.053	0.060	-0.073	0.165	0.761	304	0.042

Table 07

Paired Samples Test - Individual Effect for Students

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. error Mean	Std. Error Mean 95% Confidence				
				Lower	Upper			
Pair 1 Convenient to Use – Expected Convenient to Use- Actual	0.381	1.165	0.048	0.287	0.475	7.929	587	0.000

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. error Mean	95% Confidence Lower	95% Confidence Upper			
Pair 2	Able to connect with Students - Expected / Able to Connect with Students- Actual	0.488	1.178	0.049	0.393	0.584	10.045	587	0.000
Pair 3	Able to Cover Syllabus Timely – Expected / Able to Cover Syllabus Timely- Actual	0.447	1.276	0.053	0.344	0.551	8.502	587	0.000
Pair 4	Enhancing Personal Learning – Expected / Enhancing Personal Learning- Actual	0.357	1.215	0.05	0.259	0.456	7.126	587	0.000
Pair 5	Enhance Creativity – Expected / Enhance Creativity- Actual	0.401	1.196	0.049	0.305	0.498	8.139	587	0.000
Pair 6	Class Attendance Will Increase – Expected / Class Attendance Will Increase - Actual	0.495	1.383	0.057	0.383	0.607	8.676	587	0.000
Pair 7	Introduces to Education Technology – Expected / Introduces to Education- Actual	0.308	1.029	0.042	0.224	0.391	7.255	587	0.000
Pair 8	Sharpened My Digital Skills – Expected / Sharpened Digital Skills- Actual	0.323	1.03	0.042	0.24	0.407	7.608	587	0.000
Pair 9	Schedule Flexibility – Expected / Schedule Flexibility- Actual	0.388	1.138	0.047	0.296	0.48	8.266	587	0.000
Pair 10	Less Disturbance From Students – Expected / Less Disturbance From Students- Actual	0.405	1.221	0.05	0.306	0.504	8.036	587	0.000

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. error Mean	Std. Error Mean 95% Confidence				
					Lower	Upper			
Pair 11	Able to Cover Practical Subjects Also – Expected / Able to Cover Practical subjects- Actual	0.318	1.256	0.052	0.216	0.42	6.142	587	0.000
Pair 12	Effective Time Management - Expected / Effective Time Management- Actual	0.439	1.214	0.05	0.34	0.537	8.766	587	0.000

Table 08
Paired Samples Test - Total Effect

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Faculty	Expected Benefits – Actual Benefits	0.250055	1.490276	0.028073	-0.005188	0.105297	2.783	304	0.036
Students	Expected Benefits – Actual Benefits	0.3872827	0.8126641	0.0335137	0.3214613	0.4531041	11.556	587	0.000

income. They were dependent on the family income only. During the pandemic time, even the university and colleges have not launched any financial support for students to develop the infrastructure for virtual classrooms.

Table no. 6. is showing individual statistics of the teacher's expected benefits and actual benefits differences for all 12 pairs. The difference between expected benefits and actual benefits is significant (<0.05) for 7 pairs out of 12 pairs, and the difference is not significant for 5 pairs.

From table no. 07, we can conclude that the student's expected benefits and actual benefits pair differences are significant (<0.05) for all 12 pairs.

In this study, the paired sample t-test has been conducted in SPSS software to know whether there is any significant difference between expected benefit and actual benefits from the adoption of the virtual classroom during the COVID-19 pandemic to interact with students. The results of the paired-sample t-test have shown in tables no. 6, 7, and 8.

The mean difference between expected benefits from the virtual classroom and actual benefits from the classroom is positive for faculty members. That indicates the overall mean of expected benefits is higher than the overall mean of actual benefits, and that difference value is 0.250055, with a Sig. (2-tailed) value of 0.036 which is less than 0.05. That indicates the statistically significant difference between means of actual benefits and expected benefits. (Table no. 8)

So here we reject the null hypothesis "H_O1: There are not any statistically significant differences between expected benefits and actual benefits perceived from virtual classrooms by faculty members in higher education institutions", that is the true mean difference is equal to zero. We have sufficient evidence to reject the null hypothesis and accept the alternative hypothesis "H_A1: There are statistically significant differences between expected benefits and actual benefits perceived from virtual classrooms by faculty members in higher education institutions". From the above results, we can conclude that there is a significant difference between the means of expected benefits and actual benefits.

The common reason for this can be less attendance among students, the casual attitude among students, the possibility of proxy attendance, no strict monitoring of students in a virtual classroom, network connectivity, and lack of a professional environment at home. Network connectivity was the major challenge faced by the faculty members (mean value of 3.68) followed by 3.17 mean value for lack of professional environment at home, 3.03 for lack of teaching material at home, 2.92 for lack of personal computer/laptop (Singh and Meena 2022).

To know exactly out of 12 pairs of individuals which pair has a significant difference, further we have conducted t statistics for individual pairs. As per the output results shown in table no. 11, out of 12 pairs of benefits, seven pairs have a statistically significant difference in the mean score of expected benefits and actual benefits. The seven pairs of expected benefits are as follows: convenient to use, connect with students, increase in class strength, effective time management, less disturbance from the student, ability to cover practical subjects, and effective time management. We do not find any significant differences in the mean score of expected benefits and actual benefits for the remaining five pairs.

The mean difference between the expected benefit of attending the virtual classroom and actual benefits from the virtual classroom is positive for students. That indicates the overall mean of expected benefit is higher than the overall mean of actual benefits, and that difference value is 0.3872827, with a Sig. (2-tailed) value of 0.000 which is less than 0.05. That indicates the statistically significant difference between means of actual benefits and expected benefits. (Table no. 8)

So here we reject the null hypothesis "H_O2: There are not any statistically significant differences between expected benefits and actual benefits perceived from virtual classrooms by students in higher education institutions.", that is the true mean difference is equal to zero. We have sufficient evidence to reject the null hypothesis and accept the alternative hypothesis "H_A2: There are statistically significant differences between expected benefits and actual benefits perceived from virtual classrooms by students in higher education institutions." From the above results, we can conclude that there is a significant difference between the means of expected benefits and actual benefits.

The common reason for this may be less attendance among students, the casual attitude among students, the possibility of proxy attendance, no strict monitoring of students in a virtual classroom, network connectivity, and lack of a professional environment at home. Lack of professional environment at home (mean value of 3.59) was the major challenge faced by the students followed by 3.57 for lack of teaching material at home, 3.35 for network connectivity, and 3.31 for lack of personal computer/laptop (Singh and Meena 2022).

To know exactly out of 12 pairs individually which pair has a significant difference, further, we have conducted t statistics for individual pairs. As per the output results shown in table 8, out of 12 pairs of benefits, all 12 pairs have a statistically significant difference in the mean score of expected benefits and actual benefits.

VII. Conclusions, discussion, and recommendations

The difference between the mean value of expected benefits and actual benefits is found to be statistically significant in the case of faculty members as well as students. For the faculty members, the mean difference between expected benefits from the virtual classroom and actual benefits from the classroom is positive. That indicates the overall mean of expected benefits is higher than the overall mean of actual benefits, and that difference value is 0.250055, with a Sig. (2-tailed) value of 0.036 which is less than 0.05. That indicates the statistically significant difference between means of actual benefits and expected benefits. The mean difference between the expected benefit of attending the virtual classroom and actual benefits from the virtual classroom is positive for students. That indicates the overall mean of expected benefit is higher than the overall mean of actual benefits, and that difference value is 0.3872827, with a Sig. (2-tailed) value of 0.000 which is less than 0.05. That indicates the statistically significant difference between means of actual benefits and expected benefits.

Virtual classroom teaching and learning can be fruitful for students as well as teachers to complete their syllabus and assessment, provide moral support, and reduce stress levels during the COVID-19 pandemic. it would also enable the interaction between the teachers and learners. But for effective learning and teaching, infrastructure and technological support are required. Online teaching and learning could be advantageous as through which teachers can motivate students, complete syllabus, provide accessibility to learning and teaching from any time and any place, etc. Stated that Online learning is more flexible in access as it can provide content and instruction at any time, from any place. However, technological and infrastructure support is required for the successful implementation of online teaching and learning through virtual classrooms (Castro and Tumibay 2019). Through virtual classroom teaching students can interaction with the teacher which could be helpful to provide moral support and reduce the stress level of students during the COVID-19 Pandemic. Online teaching is effective during this COVID-19 pandemic time for preventing the students from going away from home. Online teaching can have challenges such as poor internet connectivity, non-availability of appropriate electronic devices, lack of a teaching environment at home, and less ICT knowledge among students and teachers can result in less engagement of students and teachers in the teaching and learning process (Yulia 2020).

The mean value of the expected benefit is higher than the mean value of actual benefits for 11 pairs and 08 pairs in the case of teachers and students respectively. Technical barriers are the reasons for not being able to attend

the expected benefits from virtual classrooms in full capacity by students as well as by faculty members. poor digital skills of teachers and students, lack of electricity facilities, less availability and accessibility of internet, connection issues, inadequate facilities, training, funding, and unacceptability of technology, etc. were the barriers to online education at the time of closure of colleges due to COVID-19 pandemic (Onyema et al. 2020). Students can also have a casual attitude, less attendance, feeling of isolation and less interaction can lead to mental distress, spending more time in front of a computer could be hazardous for health too (Surkhali and Garbuja 2020).

The reasons behind this gap in perceived benefits are network problems, lack of internet facilities, consistent connectivity issues, availability of infrastructure, and lack of classroom environment at home. The gap in the mean value of expected benefits and actual benefits is higher in the case of students than the faculty members. Because teachers are having a monthly income, they can afford the expenditure for the development of online classroom infrastructure, laptops, internet connectivity, etc., and students are not supported by any personal income. During the pandemic time, even the university and colleges have not launched any financial support for students to develop the infrastructure for virtual classrooms.

Higher Education Institutes (HEIs) faculty members, as well as students, were not able to perceive actual benefits in full in comparison to expected benefits due to the presence of challenges in the virtual classroom as moderators. Network connectivity was the major challenge faced by the faculty members with a mean value of 3.68 followed by a 3.17 mean value for lack of professional environment at home, 3.03 for lack of teaching material at home, and 2.92 for lack of personal computer/laptop. Lack of professional environment at home with a mean value of 3.59 was the major challenge faced by the students followed by 3.57 for lack of teaching material at home, 3.35 for network connectivity, and 3.31 for lack of personal computer/laptop. Virtual classrooms have challenges such as poor internet connectivity, non-availability of appropriate electronic devices, lack of a teaching environment at home, and less ICT knowledge among students and teachers can result in less engagement of students and teachers in the teaching and learning process. The findings of this study will help Higher Education Institutes (HEIs), the Ministry of Education, the University Grant Commission, and the teacher in effectively implementing the virtual classrooms during this pandemic. This study will help Higher Education Institutes to reduce the challenges of the virtual classroom. Students' participation was less due to the lack of in-person conversations with teachers which could result in mental stress for students and teachers

(Surkhali and Garbuja 2020). They also reported that an accessible and affordable internet connection was the main problem faced by students and teachers and less participation, interaction, and technical disturbance led to less engagement and disturbance in online classes. Teachers found technical, logistical, and pedagogical problems during online classes because of an unprepared transition from face-to-face teaching to online teaching. More efforts were required from the teachers' side to ensure that students are studying the correct study material and providing information about the assignment. Students opted for online education because it offered greater flexibility but required more self-discipline by students (Daymont 2011). Students' perceptions of vocational studies in online mode stated that as vocational studies require not only knowledge but skills as well, online learning did not improve student's productivity, and also the experience was not up to expectation (Syauqi et al. 2020).

The common reasons for the difference in expected benefits and actual benefits of the virtual classroom may be less attendance among students, the casual attitude among students, the possibility of proxy attendance, no strict monitoring of students in a virtual classroom, network connectivity, and lack of a professional environment at home. Network connectivity was the major challenge faced by the faculty members (mean value of 3.68) followed by 3.17 mean value for lack of professional environment at home, 3.03 for lack of teaching material at home, and 2.92 for lack of personal computer/laptop. Lack of professional environment at home (mean value of 3.59) was the major challenge faced by the students followed by 3.57 for lack of teaching material at home, 3.35 for network connectivity, and 3.31 for lack of personal computer/laptop. Virtual classrooms have challenges such as poor internet connectivity, non-availability of appropriate electronic devices, lack of a teaching environment at home, and less information and communication technology (ICT) knowledge among students and teachers. It implied less engagement of students and teachers in the teaching and learning process (Singh and Meena 2022).

The higher education authorities, colleges/institutes/universities need to fix the above issues to enhance the teaching-learning process. The higher education authorities, institutes/colleges/universities must work together to resolve the issues and challenges of virtual classrooms to improve their effectiveness of the virtual classroom. Higher Education Institutes (HEIs) may provide technical support, and training to the faculty members as well as students for a better experience in the virtual classroom. Students who are lacking technical infrastructures like computers/laptops, and internet connectivity. Higher education institutes (HEIs) may provide financial and

technical support to students, so the students can use the infrastructure for learning. Higher education institutes (HEIs) can also provide digital libraries, and journals access to the students at home, so they can improve their learning in the lockdown.

Whenever the higher education authorities are introducing new technology in ICT, the student and faculty members must be provided with practical training for the better implementation of that technology. Because as per the cycle of the technology adoption life cycle there are conservatives/ late majority and ladders/ Skeptics (Moore 1991). The delayed adoption of technology is going to affect the consistent implementation of the technology.

VIII. Limitations further scope of the study

This study has been conducted taking teachers and students of higher education institutes (HEIs) as the target population. The semi-urban and rural higher education institutes (HEIs) may have faced a higher impact of COVID-19 than urban Higher Education Institutes (HEIs) due to infrastructure limitations. This will provide a more in-depth analysis of the impact of COVID-19 on the higher education teaching-learning process. The higher education institutes (HEIs) having good IT infrastructure have faced less impact of COVID-19 on the teaching-learning process. Possible reasons for high expectations are not fulfilled either for teachers or students, answers could be analyzed further. Further studies can also focus on higher education institutes (HEIs) operating in rural and semi-urban areas. Further studies can also include school-level students and teachers. A comparative study can be presented in the context of comparing the situation in another developing country.

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