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Effectiveness of Online Teaching Methodology on Students' Learning During Pandemic: The Mediating Role of Online Learning Space Design

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Abstract

This study is aimed to analyze the effectiveness of online teaching on students' learning during the current pandemic. The novelty lies in analyzing the mediating role of online learning space design during an unprecedented situation of a pandemic. The effect of online teaching methodology (instructional design, assessment design, and online teaching platform and online learning space design) on student learning (dependent variable) is studied. Furthermore, the mediating role of online learning space design is investigated by correlating factors that influence student learning. A total of 837 student responses and 86 teacher responses have been recorded using two questionnaires. The results fully support the proposed hypotheses.

Keywords: Instructional design; assessment design; online teaching methodology; online teaching platform; online learning space design; student learning

Introduction

The spread of COVID-19 has enormously impacted the socio-economic conditions globally (UNDP, 2020). These effects were felt equally across the education sector as well. As per UNESCO (2020) approximately over 60% of the students, all around the world got affected by the spread of COVID-19. Necessary emergency measures were deliberated and applied globally in all educational institutions in a bid to facilitate

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students and teachers for carrying out educational activities with least disruption. For the transition to be as smooth as possible, this called for changes and reforms in the teaching methodology and curriculum for courses being taught in class or online (Sandars et al., 2020).

Online education is not a term novel to anyone; since past two decades, online education as part of distance education has become a component of higher education system in the form of blended learning and e-learning. Ease of access due to ubiquity of internet and flexibility of course design has allowed online education to give promising results for the future. The popularity of distance or online education is not surprising provided the benefits it offers to both students and educational institutions in terms of low cost and further reach. Its usability and effectiveness have been examined by many empirical studies conducted in the past and such efforts continue as new pedagogical models and learning theories continue to evolve.

Despite much advancement, online education still has a long way to go to get a consensus on its usefulness. In a majority of universities around the globe, the preferred mode of education is face to face. Therefore, the experience of shifting all the education online in days or weeks is a challenge for many. Hodges et al. (2020) terms the sudden shift of emphasis to e-Learning in comparison to the traditional face-to-face learning as emergency remote teaching. Bozkurt and Sharma (2020) emphasize on the importance of identifying and using the correct definition for the prevailing temporary e-Learning solutions as remote emergency measures, which will help in designing efficient long-term policies for increasing effectiveness of distance education. Factors that govern the teaching of online courses successfully involve online learners, instructors, and content development (Kebritchi et al., 2017). Along with the major identified factors, a study conducted by Shaaban and Salman (2020) stresses on the importance of providing technical training focusing on e-Learning for both students and teachers along with emphasis on training for troubleshooting technical errors provided to professional technicians. Nonetheless, it is not wrong to say that measuring the effectiveness of online education in times of emergency is still a task to be done. The rationale of the study conducted is focused on the sudden shift to online learning in Pakistan due to the COVID-19 pandemic.

This paper aims to measure the following objectives:

1. The effectiveness of online education in student learning (SL) based on course design, teaching methodology, and elements of learning space design in times of emergency.

2. The mediating role of online learning space design (OSD) on online teaching methodology (OTM), online teaching platform (OTP), and student learning in times of emergency in a developing country.

Literature Review

Student learning

A. Attainment of Course Learning Outcomes

The use and measurement of course learning outcomes have attained considerable importance as a mean of determining the level of knowledge and skills attained by a student (Keshavarz, 2011). Rahmat (2011) highlights the importance of determining the attainment of learning outcomes and describes it as an important factor that contributes to identifying weakness of, not only of the student, but also that of the department, faculty, and university administrators. The students' attainment of course learning outcomes is often directly measured with formative and summative assignments. Various types of formative assessments are in practice for online learning environment, yet these assessments are found to have little differences in level of difficulty as perceived by students (Ogange et al., 2018). On the other hand, students are more responsive to peer-assessment and computer-marked assessment when compared to teacher-marked assessment.

Apart from the type of assessment, student's' online presence also has an impact on students' performance as analysed by Yang et al. (2016). The results of the study indicated that teaching presence explained 10.2% of the variance of the objective learning outcomes and teaching presence explained 38.5% of the variance of the subjective learning outcomes. Further social presences explained 52.6% of the variance in subjective and 15.8% of the variance in objective learning outcomes in the blog-based course. While study carried out by Islam (2016) shows there is a direct relation between the students' perceived compatibility of the use of a e-learning system and the academic performance. A user-friendly interface for an e-learning system equipped with functions that will aid students' study will have a positive impact on the students' academic performance. Beard (2017) analyzed students' engagement for summative and formative assignments in virtual learning environments. The study revealed that students displayed higher level of engagement in the summative online assessment while displayed lower level of engagement in formative assessments, due to different factors including differences in lower level of students' motivation.

B. Student-Teacher Interaction

Teacher's presence, interaction, and engagement with the students during a class can be regarded as a prime factor that influences student learning. Studies carried out by Richardson et al. (2016), Martin and Bolliger (2018), and Kyei-Blankson et al. (2019) reveal that the interaction between a student and teacher can have important implications on students' learning and performance. The studies show that the teacher-student interaction has a positive impact on students' motivation for learning and removes a sense of isolation from the student. Eom and Ashill (2016) investigated the role of student-teacher interaction in students' satisfaction and achievement of leaning outcomes. By examining motivation, dialogue, teacher, course design, and students' self-regulation as independent variables, the study concluded that dialogue (both teacher-student and student-student), teacher, and course design played major role in achieving learning outcomes while ensuring students' satisfaction.

A recent study conducted by Ouyang et al. (2020) endorses similar outcomes while analysing student-teacher collaborative interaction in higher education context. The study emphasizes the efficacy of learning community approach using participant perception, participation frequency, and engagement move as main variables. The adopted approach facilitated teachers in developing healthy social learning environment through increased communication, mutual interactions, discussions, and active participation to build knowledge. Tsiotakis and Jimoyiannis (2016) characterize online teaching to be complex, requiring a lot of self-organization. They highlight teacher's presence as a crucial variable in creating socially interactive environment that directly affects students' participation, engagement, interaction, and cohesion in online classes.

C. Self-Regulation

Many studies have been carried out to assess teachers' presence and student-teacher interaction being the major factors in online learning. Some results indicate that both extrinsic students' motivation and students' self-regulation have no significant relationship with user satisfaction and learning outcomes (Eom&Ashill, 2016). However, the consensus seems to be due to lack of studies performed to examine self-regulation. Zacharis (2015) highlights the requirement of monitoring and tracking students' online activities besides the content design and online activities by testing 29 different variables. Among those, students' contribution in online classes through content creation, reading and posting messages, number of files reviewed, and quizzes predict 52% of the overall variance in final grading that depicts students' active participation and self-regulation as another important aspect of online education. Using Online Student Engagement (OSE) scale for data of an online course management system, Dixson (2015) has attempted to correlate students' self-report of engagement

with the tracking data of students' behaviors. Selecting some common activities such as posting to discussion forums, taking quizzes, and writing e-mails, the study reports significant positive correlation between OSE and application learning behaviors of the students. The study conducted by Kizilcec et al. (2017) further supports the hypothesis by showing significant effects of Self Regulate Learning (SRL) on course learning outcomes. The students with strong SRL skills (efficient goal setting and strategic planning) have been found to perform better than those with weak SRL skills for taking online course.

Learning Space Design

Design of an online learning space majorly depends upon the compatibility with different tools offered by Information Technology that is essential for instructional flexibility, group collaboration and provides platform for knowledge creation (Thomas et al., 2019). Since the late 1990s, the use of learning management systems has increased exponentially in higher education to facilitate online education and training through effective delivery, tracking, and management of online courses (Limayem& Cheung, 2011). Now, LMS has become vital tool for online education. To understand the efficiency of e-learning system for achieving learning outcomes, it is very important to conduct research that investigates its impact on the academic performance of the students.

In the context of online studies, most of the research has been carried out to measure instructors' acceptance or their intention for LMS usage. However, measuring the instructors' satisfaction with LMS for the online course can give a better indication of the overall preferences as well as the overall benefit of the online system. Instructors seem dissatisfied with online teaching platforms owing to perceived technology acceptance, complexity, and unfamiliarity with these platforms along with other technical issues such as low accessibility and bandwidth issues that increase frustration due to interrupted conduction of online classes (Llewellyn, 2011). Almarashdeh (2016) supports the argument by showing that instructors' perceived usefulness of the system along with service, system, and information quality has a significant effect on user satisfaction. Moreover, system's availability and accessibility paired with instructors' training on usage of such platforms mediates the influence and encourages system's usage in distance education by instructors and students. The integrated platform model proposed by González and Quiroz (2019) for online learning also emphasizes on the services required to ensure operational continuity, such as Cyber security and backup and recovery systems. Such services are one of the challenges of online education models.

Instructional Design

Instruction design (ID) process builds on five core elements: analyze, design, develop, implement, and evaluate. It has been proved as a useful tool in measuring the competencies of educational design models. It helps to identify whether a certain teaching model encompasses all five elements or some of them. The combined criteria including educational model and design process elements then can help specify a model for a particular field (Reiser, 2001). New learning trends have been inevitably influenced by contemporary theories in educational psychology with their focus shifting to student-centered and knowledge-based approaches from the teacher-centered approaches of the past. Intentional learning is supposed to involve multiple and simultaneous interactions between people, places, and things that are in a text over a period. The instructional design process facilitates the use of such active and multifunctional approaches. The progress has further geared by advancements in IT infrastructure that has enhanced the designers' ability to create more engaging and interactive learning environments. Using advance IT tools such as information management systems, performance support systems, and concurrent engineering along with instructional design models have helped greatly in creating high quality teaching and learning environments (Branch & Kopcha, 2014) and many studies have been carried out to measure the effectiveness of these tool till date.

Conducting a systematic review of 20 such studies, Lee, and Jang (2014) has deduced four critical dimensions of instructional design model: function, origin, sources, and analysis. These dimensions describe various theories, practices, and conceptual oriented approaches through E-learning engagement design (ELED) framework. Another bibliographic review conducted by Giraldo (2011) explains the educational models in virtual education through two learning theories, cognitivism, and constructivism, emphasizing the applicability of these theories in online learning. Like information systems and information and communication technologies, a very dynamic world must be updated to quickly and efficiently incorporate new resources into online learning systems. The instructional design must utilize the resources and technological methods of existing and future systems, and this requires recognition, use, and proper use of them to achieve the primary goal of education, student learning (González & Quiroz, 2019). There are many stakeholders involved in student conflicts. Czerkawski and Lyman (2016) has examined trainers, training designers, researchers design training through ELED framework for designing and developing interactive e-learning environment. The designed framework attempts to provide such an approach that emphasizes on interaction, collaboration, facilitation, and feedback strategies with a special focus on online learning design.

Hypotheses

The current study argues that learning space design may be a more substantial factor influencing the quality of online education along with teaching methodology and students' participation. In times, like these, which are clouded by uncertainty and emotional distress, the design of learning environment with state-of-the-art tools and technologies may offer a potential mediating role. After conducting literature review, the questions are designed to test the following hypotheses in order to check the effect of instructional design methodology on students' learning and the role of online space design in facilitating their learning.

H1: Online instructional design (ID) has a positive effect on student learning (SL).

H2: Online assessment design (AD) has a positive effect on student learning (SL).

H3: The use of online teaching platform (OTP)has a positive effect on student learning (SL).

H3: The use of online teaching platform (OTP) has a positive effect on student learning (SL).

H4: The use of online space design (OSD) mediates student learning (SL) and online teaching platform (OTP).

The research model showing the interdependence of selected factors is show in figure 1.

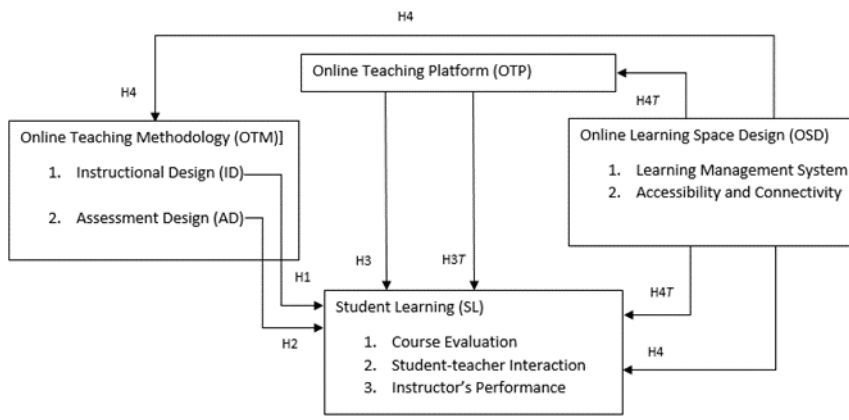

Figure 1 Research Model

Methodology

The aim of the study is to examine the effectiveness of online teaching methodology in students' learning and to investigate the mediating role of learning space design. For this purpose, deductive approach (Johnston, 2014) is used for hypotheses' building, based on existing learning theories. After conducting literature survey of concerned factors, research questions have been developed and examined through survey questions.

Questionnaire Design

The variables included in student survey are assessment design, instructional design, online teaching platform, online space design and students' learning. In teachers' survey, online teaching platform, online space design and student learning are used as variables. Five-point Likert scale ranging from "1" (Strongly Disagree) to "5" (Strongly Agree)"is used in both questionnaires (for teachers and students) for recording answers.
Study's Participants

The target population of this research is divided into 2 parts: students and teachers. To have better assessment, students and teachers of a local university have been selected randomly. The data is taken from different departments of the same university. The participants of the survey include students and teachers engaged in online classes during Covid-19 Pandemic. Purposive sampling method proposed by Hair et al. (1998) is used for the purpose of data collection. To define the sample size Hair et al. (1998) method is used.

Data Collection and Analysis

The data collected and analyzed for the research is primary data. The developed questionnaire was sent to all students and teachers in the university. A total of 837 student and 86 teacher responses have been collected. The data collected was analyzed using Reliability Analysis, Regression, Correlation and Mediation in SPSS 21. The sample size was calculated using the rule of thumb recommended by (Joseph Jr, 2014) that there should be at least 5 respondents per item. There were 20 items in the questionnaire, so ideally the research sample should consist of 100 responses but due to limited availability of targeted population only 86 responses were received.

Many studies have stated that getting high responses is always very challenging and reported low responses of surveys due to different research limitations (Freise & Seuring, 2015; Trkman, De Oliveira, & McCormack, 2016).

Results

Cronbach's Coefficient Alpha was used to check the reliability of each construct for both teacher and student surveys. The statistically significant value of Cronbach's Alpha obtained for data collected through student survey i.e., 0.924 showed internal consistency and reliability of the variables of ID, OTP, AD, OSD and SL. While the Cronbach's Alpha obtained for data collected through teacher survey i.e., 0.763 showed internal consistency and reliability of the variables of OTP-T, OSD-T and SL-T. Further, results in Table 1 and Table 2 show the internal consistency of both student's and teacher's variables are significantly loaded.

Table 1

Reliability, Validity & Descriptive Statistics of Students' Scale

Item	Factor Loading	Mean	SD	Cronbach's Alpha
Online Teaching Methodology (OTM)		29.57	11.49	0.841
Instructional Design (ID)		12.76	4.78	0.83
The course material provided correlation b/w theoretical and real-world examples	0.77			
The teacher adopted a different teaching methodology for the course considering the current pandemic situation	0.66			
The teacher used state-of-the-art educational and technical tools which stimulated my interest into the course	0.77			
The teacher helped me understand the concepts of the course	0.75			
The teacher-maintained a sound learning environment during the online lectures	0.67			
Assessment Design (AD)		16.82	7.32	0.91
The teacher redesigned the course assessments considering the current pandemic situation	0.84			
The online assessments were designed to clear course concepts	0.75			
The online assessments motivated me to self-regulate my studies during the current pandemic situation	0.89			
The online assessments stimulated my interest in the course	0.77			
I am aware of the online assessments policies	0.84			
I found the online assessments evaluation criteria satisfactory	0.79			

I found the time allocated for the online assessments satisfactory	0.89			
Online Teaching Platform (OTP)		10.55	4.23	0.84
Taking into consideration the current pandemic situation, the shift to online teaching platforms was timely	0.788			
The teacher was able to create an online interactive environment using ZOOM (other platform)	0.89			
I had sufficient opportunities to interact with the instructor through different online platforms	0.66			
The online class layout on ZOOM (other platform) helped me to understand the course concepts	0.89			
Online Space Design (OSD)		12.49	5.26	0.82
I had no internet connectivity issues while using on-line teaching platforms	0.73			
I had no power outage issues while using online teaching platforms	0.73			
I had sufficient resources (laptop, mobile, etc.) for accessing online teaching platforms	0.85			
The class layout on the online teaching platform was interactive	0.85			
How would you rate your computer skills before the current pandemic situation?	0.75			
How would you rate your computer skills after the current transition to online teaching platforms?	0.74			
Student Learning (SL)		17.13	6.48	0.85
The teacher provided additional online resources to improve my concepts	0.67			
The teacher was responsive and answered my questions	0.7			
I feel confident that I have effectively attained the course learning outcomes	0.65			
The online assessments helped me to achieve the course learning outcomes	0.79			
I have learned as much from the online classes as I might have learned during the on-campus classes	0.66			
The class layout on the online teaching platform aided the delivery of course learning objectives	0.69			
The design of online activities and assessments complemented the course concepts	0.77			

Table 2
Reliability, Validity, & Descriptive Statistics of Teachers' Scale.

Items	Factor Loading	Mean	SD	Cronbach's Alpha
Online Teaching Platform (OTP)		44.45	6.66	0.87
Taking into consideration the current pandemic situation, the shift to online teaching platforms was timely	0.72			
I was able to transition to the online teaching platforms without difficulty	0.52			
I was provided sufficient technical support and training of online teaching platforms	0.6			
I was able to create a class layout on online teaching platform that helped me to convey the course concepts similar to that of on-campus classes	0.64			
I was able to create an online interactive environment using the online teaching platform	0.74			
I was able to encourage student participation and discussion using the online teaching platform	0.66			
I was able to integrate various audio-visual aides for conducting online classes	0.67			
I found the online teaching platform (ZOOM) to be user-friendly for conducting lectures	0.61			
I found the online teaching platform (LMS) to be user-friendly for conducting assessments	0.7			
I found the online teaching platform (LMS) to be user-friendly for sharing course resources	0.72			
Taking into consideration the current pandemic situation, the shift to online teaching platforms did not affect the course outcomes	0.701			
Online Space Design (OSD - T)		15.18	3.16	0.73
I had no internet connectivity issues while using online teaching platforms	0.83			
I had no power outage issues while using online teaching platforms	0.88			

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I had sufficient resources (laptop, mobile, etc.) for accessing online teaching platforms	0.76			
The class layout on the online teaching platform was interactive	0.81			
Student Learning (SL - T)		7.86	1.54	0.81
The class layout on the online teaching platform aided the delivery of course learning objectives	0.71			
The design of online activities and assessments complemented the course concepts	0.74			

In order to assess the criterion-related validity, bivariate correlations were computed between the dependent and independent variables after summated scores in SPSS. The correlation between the constructs of instructional design assessment design, online teaching platform, online space design and student learning of student data is observed in the Table 3, and they all are significant at 0.01 level. Similar results were observed for correlation between the constructs of online teaching platform, online space design and student learning of teacher data as presented in Table 4.

Table 3
Correlation among Student-Related Variables

Pearson Correlation	ID	OTP	AD	SL	OSD
ID	1				
OTP	0.73**	1			
AD	0.79**	0.741	1		
SL	0.81**	0.77**	0.83**	1	
OSD	0.59**	0.61**	0.66**	0.74**	1

**. Correlation is significant at the 0.01 level (2-tailed)

Table 4
Correlation among Teacher- Related Variables

Pearson Correlation	OTP-T	SL-T	OSD-T
OTP-T	1		
SL-T	0.72**	1	
OSD-T	0.43**	0.45**	1

**. Correlation is significant at the 0.01 level (2-tailed)

To check the mediating effect of online space design, survey questions were sent to students and teachers alike for which results are summarized in Table 5. Using the MACRO of Hayes, the results of both the student and teacher survey show that the relation between independent variable and OSD (mediator) is slightly positive and significant as $p < .05$. From the indirect effect of independent (X) on dependent (Y), the results of student and teacher surveys indicate both the upper and lower limits are positive which shows significant indirect relation between independent variable and dependent variable. Also, the direct relation between independent variable and SL (dependent variable) is positive and significant $p < .05$ in the presence of a mediator for both the teachers' and students' surveys. Therefore, full mediation is seen in this. However, the R2 values for student and teacher results show an increased difference. The value of R2 for students is about twice the value for teachers.

Table 5
Comparison of Survey Results for the Mediation Effect of Online Learning Space Design

Values	Students' Data	Teachers' Data
R	0.68	0.44
R2	0.46	0.19
p	< 0.5	<0.5
Direct relation between OTM& SL	0.11	-
Direct relation between OTP& SL	-	0.02
Indirect relation between OTM & SL	Positive upper & lower limits	-
Indirect relation between OTP & SL	-	Positive upper & lower limits

Discussion

The results support the proposed hypotheses completely as shown in table 6. Survey analysis shows satisfactory results in terms of teachers' and students' perceived usefulness of the platforms in terms of services and quality of education. The availability of online teaching platforms and learning management system helps in timely shift to online education. Teachers' training on use of online teaching platforms

by using state of the art tool to develop interactive classrooms helped them in encouraging students' participation and achieving desired learning outcomes. The training further helped teachers to practice instructional design methodology for maintaining the quality of education despite being new to the online system. The results show that the teachers were able to create a correlation between the theoretical concepts and real-world examples along with adopting new teaching methodologies for teaching the courses. The teachers were also able to create sound learning environment making use of state-of-the-art educational and technical tools which helped students in understanding the course concepts. The survey results show that the teachers redesigned course assessments as per the need of the hour due to the disruption caused by the sudden shift to online platforms which helped students in attaining the course outcomes. It is also seen through the results that usage of LMS, and ZOOM were quite user-friendly, and it helped the teachers in conducting their lectures and taking assessments. This highlights the importance of paying attention to the creation of an online learning community by means of promoting social presence, interactive learning environment, and collaboration between the instructor and students and among students. The results further show that the students understood the assessment policies and were satisfied with the time allocation for completing course assessments along with the marking criteria. The students also found the assessments to be helpful in clearing concepts related to the various undertaken courses. The results also show full mediation between independent variable (online teaching methodology) and dependent variable (student learning).

Furthermore, the results' analysis shows that the students are more impacted by the online space design compared to teachers. The factors such as internet connectivity, power outage, and resources such as laptops, mobiles, etc.to access online teaching platform have a greater effect on students when this emergent shift to online classes was enforced. With university being situated in a metropolitan city, there existed significant inequity of resources among students residing in rural, urban, and remote settings. Emergency shift to online teaching left students of remote areas in an unprecedented challenging situation, consequently hindering their academic activities online. Connectivity and accessibility were also a challenge faced by students of urban areas due to increased traffic and poor internet management due to lack of readiness of country's telecommunication sector.

It may be concluded that the online learning space design acts as a bridge in narrowing down the gap between the online teaching platform, teaching methodology and student' learning, the more this mediator is technically enhanced, ready and scalable, the easier is the shift to online education, especially in emergency situations.

Analyzing the responses in more detail brings onto the requirement to investigate the responses and further quantify them as to how much positive effect on student learning has been achieved during the initial days of the lock down. Also, it would be interesting to study how the students' and faculty's responses evolved as they became adapted to the online platform and the initial difficulties of the online space design have been rectified to some extent or completely.

Table 6
Summary of Hypotheses Test

Hypotheses	Results	Outcome
Online instructional design has a positive effect on student learning	p=0.000 < 0.05	Supported
Online assessment design has a positive effect on student learning	p=0.000 < 0.05	Supported
The use of online teaching platform has a positive effect on student learning	p=0.000 < 0.05	Supported
The use of online teaching platform has a positive effect on student learning	p=0.000 < 0.05	Supported
The use of online space design mediates student learning and online teaching platform	p=0.000 < 0.05	Supported
The use of online space design mediates student learning and online teaching methodology	p=0.000 < 0.05	Supported

Conclusion

This study provides a major theoretical contribution on how the online learning space design mediates the relationship of student learning, online teaching platform and online teaching methodology. Most of the previous studies have analyzed the uses of e-learning systems, distance education, student engagement in online courses and moderating effect of perceived compatibility. This study attempted to analyze the mediating role of online learning space design during an unprecedented situation of a pandemic.

The practical implications of the current study are for educators and administrators of higher education institutions. The availability of suitable hardware along with stable connectivity to internet and power sources is imperative for effective student learning in an e-learning environment. Further, the timely technical training provision for both teachers and students are of utmost importance. The access and use of state-of-art teaching resources along with suitable teaching platforms, such as LMS and ZOOM, helps in creating an effective online learning space for students.

Limitations and Future Research

Although the current study provides a novel view of effectiveness of online teaching during a pandemic, it has some limitations as well. The first major limitation is in relation to data collection from higher education institutions. The current study is limited to data collected from a private university of Pakistan. Due to the selected single source of data collection, a variety of online teaching platforms could not be covered which is the second limitation for the current study. Future research may be conducted by collecting data from both public and private sector universities for a comprehensive insight regarding the shift from traditional face to face teaching to online education during a pandemic. Further, an analysis of the user-friendliness and efficacy of various online teaching platforms may also form the basis of future research for the selection of the most suitable platform.

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