Rethinking and Revitalizing Learning Spaces in Higher Education Institutions in the Post Pandemic Environment

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2023

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A thesis submitted to the National University of Sciences and Technology,

Islamabad, in partial fulfillment of the requirements for the degree of

Masters of Science in
Urban & Regional
Planning

Thesis Supervisor: Dr. Abdul Waheed

Department of Urban & Regional Planning,

School of Civil and Environmental Engineering

National University of Sciences & Technology

(NUST) Islamabad, Pakistan

Thesis acceptance certificate

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PROF DR MUHAMMAD IRFAN
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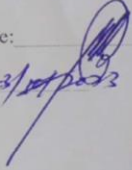SCEE, NUST

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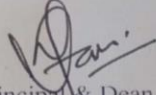
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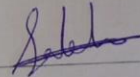
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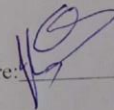
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University of: National University of Sciences & Technology (NUST), Islamabad Pakistan

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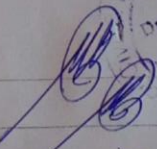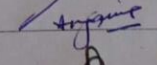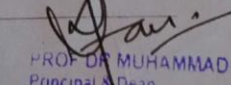
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Dedication

For all the people who lost someone to the COVID-19 pandemic

Acknowledgements

I am thankful to Allah Almighty to have guided me throughout this work at every step.

I would like to express my gratitude to my supervisor *Dr Abdul Waheed* for his help throughout my thesis and also for the courses which he has taught me.

I would also like to pay special thanks to *Dr Irfan Ahmad Rana* for everything he taught me throughout my course of studies here at NUST.

Finally, I would like to express my gratitude to *all friends and family* who have rendered valuable assistance to my master's study.

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Abstract

Online education and distance learning has become the new normal since the pandemic hit in 2019. The effects have brought out adverse changes in educational spaces and teaching pedagogies and mental health especially for learners in college and professional universities. This thesis aims to investigate the barriers to sustainable higher education and the effects of the pandemic on universities and campus life. Findings showed that higher education institutions faced multiple barriers to sustainable growth in the form of lack of ICT infrastructure, supports, expertise and limitations in mobility and accessibility to services and resources. The shift from face-to-face learning to online classroom was not easy and presented challenges for teachers, students, families and even governments due to lack of financial resources to sustain online education at such a huge scale. Results give us a detailed insight on, "who incurred the biggest loses?" And "what were the biggest challenges that we still need to overcome?" All these questions helped strategize new methods that will help revitalize learning in higher educational institutes. The later part of the thesis aims to highlight strategies that help postulate new design parameters to revitalize learning spaces in higher educational institutions. The recommendations made in this study focus on three key areas which include the design of learning spaces, new protocol for communication and pedagogies, and the incorporation of technology into various aspects on the campus. The information provided by the experts provided valuable insight that can help revitalize learning in the post COVID-19 environment.

CHAPTER-1 INTRODUCTION

1.1 Introduction and background

During the pandemic, major lockdowns across the country forced learners and educators participating in an unparalleled distant learning experiment. From administrators and educators to students and parents, all were compelled to communicate, teach and learn through online platforms and tools. For many this was an unchartered territory with a steep learning curve. For some students who did not have access to devices and an internet connection had to halt their studies completely which will have consequences for years to come. Even now as the world enters the year 2022, there is still deep uncertainty around what the landscape of education and educational spaces will look like in the post pandemic era. Though it is unclear when the pandemic will finally be over and if or when things will go back to normal however, it is clear that the COVID-19 pandemic has highlighted the need for new approaches and innovative solutions for higher educational spaces. The COVID-19 pandemic has effected around 210 countries with 250 million confirmed cases and over 5 million death across the globe including Pakistan. Pakistan, a country with high rates of poverty, an inadequate healthcare system and very high population growth also observed over 1 million cases and around 28000 mortalities since November 2021(Basray et al. 2021). The effects of the pandemic were numerous, from industrial shutdowns to economic loses reaching over 1.1 trillion PKR in FY 2021 and a rise in poverty of 33.7%. The education sector of Pakistan also saw huge loses. The COVID-19 pandemic affected learners of all ages. Initial studies show that educational loses at many levels are also linked with increased depression and anxiety, however there is still less known about long-term outcomes of these loses. The use of new pedagogies and delivery modalities for education, under the guidance of various organizations have been quickly adapted. It is also observed that the pandemic has widen the socioeconomic gaps between normal and special learners. Most of the professions including medical profession that teaches by graduated internships has also been severely affected and has had to make drastic changes(Lucey and Johnston 2020).

Online education and distance learning has become the new normal since the pandemic hit in 2019. The effects may bring about adverse changes in educational spaces and teaching pedagogies and mental health for learners in primary schools, high schools, college and professional universities.

The effects and changes will differ by age, gender, socioeconomic wellbeing and even the environment however at this time there is still very less data on the outcomes of these effect(Jodheea-Jutton 2021). At this time, many organizations have only expressed concerns, given guidelines and are still extrapolating from previous experiences. Since early 2020, numerous research studies were carried out to examine the effects of the pandemic on mental and social health. The mental health of learners and educators was also examined during this time to better understand the losses incurred due to the COVID-19 virus and to be prepared for future pandemics. Although there is a paucity of data at this stage, but some researchers have extrapolated from other studies carried out on effects of school closure due to hurricanes and other disasters. Some studies suggest that closure of schools due to inclement weather and natural disasters can decrease overall achievement scores. Data also shows that math scores are affected negatively the most as compared to any other subject(Parolin and Lee 2021).

This paper aims to investigate the effects of the pandemic on higher educational spaces and campus life. It gives a detailed insight on, who incurred the biggest loses? How do we need to rethink our learning spaces? And what will be the future of our educational spaces and what will be the "new normal"? All these questions will help strategize new methods that will help revitalize learning in higher educational institutes.

A global nonprofit association called The Northwest Evaluation Association has provided research based assessments and professional development for educators. These assessments were evaluated by a team of researchers at Stanford University. Their studies they found that the average student has lost 25 percent of a year to a full year's worth of learning in reading and about 75% of a year to more than a year in mathematics since closure of schools since march 2020(Ozkan and Budak 2021). Families are experiencing a new stressor since education has shifted online. With the closure of schools and universities it has also come to light that families and students depend on schools and colleges for much more than reading and learning. Shelter, food, health care and social well-being are all part of what learners and students, as well as their parents and guardians, depend on educational institutes to provide. Further studies also suggest that the pandemic has caused economic instabilities in many families, which has resulted in the loss of wages, food insecurity and housing insecurity(Bukari et al. 2022). Data has shown that many parents had to quit their jobs in order to be at home for younger children who had to be schooled from home. In 1 survey, 37%

parents affirmed that experienced behavioral problems in children which they attributed to virtual schooling. There is also evidence of depression and anxiety in young adults since the closure of schools and colleges due to the pandemic. Studies have also reported that stressors from the pandemic have also led to poor diet choices with increase in consumption of fried food and sweets. Moreover virtual schooling has also decreased exercise opportunities. One research showed that the daily sitting time has increased 5 to 8 hours and binge eating, snacking and the number of meals have all significantly increased owning to lockdown initiatives across the globe. Studies suggest that people are consuming more sugary items than ever and as evidence suggests, high sugar diets have detrimental effects on the health of animals and humans alike. In light of the pandemic, this should be a major concern. It is also imperative to mention here that adverse life experiences at a younger age are associated with higher chances of mental illnesses and mental health issues. There is also some evidence that shows that children from age 6 to age 18 have shown increase in irritability, fear and clinginess during the pandemic lockdowns. These emotions are associated with anxiety and have a negative impact on the wellbeing of families as a unit during the pandemic. Moreover another concern regarding this is that many children are experiencing lengthy periods of isolation which is effecting their ability to socialize in the long term(Pandi-Perumal et al. 2021). Educational institutions are also agents of social connections as well as where social development occurs. Noting that the academic performance in educational institutes is also declining which shows that the pandemic may be creating a snowball effect, setting back learners in various ways from which they may never recover as adults. Extrapolation on data analysis obtained natural disasters, schools absenteeism, summer breaks and other such occurrences is not suitable for the current situation however all indicators suggest the effect on the pandemic on adolescents and young adults is not equal. Although some children and adolescents will not suffer long term effects of the pandemic but young adults in the prime of their education and those suffering from socio-economic differences are expected to suffer more losses than any other(Zemrani et al. 2021).

As a result of COVID-19, Pakistan was also among the first countries in the world to close all educational institutes. Schools in Sindh closed as early as February 2020, while the rest of the schools in the country closed in March 2020. This study is being conducted while all educational institutes are planning to reopen or are already reopen. At this stage, educational institutes are focused on making themselves safe and virus-free. Private and public institutes are observing all

safety protocols. But the question rises, what will be the new normal? What will be level of learning that educators can expect from young adults? What will the class arrangement look like? What will be the protocol in the long term? Should learning be carried out in a hybrid manner? It has been deduced from past data that crises that effect closure of educational spaces such as earthquakes and floods can effect education for many years to come. For example the 2005 earthquake in Pakistan decreased the academic results of students even 4 years after the event despite remediation efforts(Mahmood et al. 2015). This paper aims to investigate the impacts of pandemic on education and educational spaces. It aims to identify the current situation of learning in higher educational institutes and how these educational institutes should move forward in light of the current scenario.

A World Bank report in 2020 predicted that 930,000 children would drop out of primary and secondary education in Pakistan making it the country with the highest dropout rate due to COVID-19(Kurbucz 2020). In a country that is already scarred by huge differences in private and public education and low literacy rates, the pandemic has affected the education of 40 million students across Pakistan. Another World Bank report has claimed that the most optimistic scenario is still an overall loss of learning for every child enrolled. UNICEF has also claimed in its reports that students learn less from home as compared to classrooms. Moreover it says that learning from home was also effected by a lack of understanding the system, lack of internet connectivity, lack of technology and low levels of motivation. A UNICEF report claims that remote learning was not possible for 23% of young adults due to lack of access to digital technologies. It is also imperative to mention here that the pandemic has hit poor and disadvantaged families more severely as they were unable to purchase any digital device at all. Geography has also been a barrier for some learners. In Pakistan around 26% of urban youth did not have access to sufficient technology while that umber rose to 36% in the countryside by mid-2020.

1.2 Problem statement

In the end of 2019 the world was hit by a deadly virus called the COVID-19 virus which rapidly spread across the globe and presented itself as a public health emergency of global concern. This virus got global attention due to its rapid rate of transmission and its deadly nature, killing millions since 2019. The COVID-19 pandemic effected the entire globe and many feared that the entire world would enter its biggest recession. Although this didn't happen but economies around the

world were effected very badly as many industries and service sectors had to shut due to lockdowns observed across the globe. The education sector was one of the sectors most effected by the onset of the pandemic. UNESCO reported (2020) that around 1 billion students were affected due to lockdowns since April 2020 across 188 countries at all levels of education(UNESCO IESALC 2020). Hence as a result, education was shifted online at an unprecedented scale. However due to socio economic challenges, the education sector in Pakistan could not keep up. This thesis aims to review the challenges faced by academic staff and students at higher education level. It seeks to address the effects of the pandemic on learning spaces and campus life at higher educational institutes. There is also a need to discuss future pedagogies and learning modalities in the post pandemic environment. This thesis aims to rationalize the need for change in design parameters which are organically happening during the pandemic. Through research and expert opinion we can create innovative strategies that will help revitalize higher educational spaces in the post pandemic world.

1.3 Research questions

Following are the research questions this thesis aims to answer:

- What are the challenges faced by educational institutes and how was campus life effected during the pandemic?
- How to change the design parameters in response to the pandemic?
- What are the necessary measures required to revitalize higher educational spaces in the post pandemic environment?

1.4 Research objectives

This study aims to achieve the following objectives:

1. To investigate the effects of the pandemic on higher educational spaces and campus life
2. Revisiting the design principles and making modifications to the design of educational spaces
3. To suggest strategies to revitalize higher educational spaces in the post pandemic environment

1.5 Rational of study

It is no doubt that education is crucial for any person living in the 21st century. Irrespective of gender or economic wellbeing, education is important for improving the quality of life in a society, hence no child, whether girl or boy, must be left behind. Moreover education is important because it is one of the key components for the progress of a community or a society and can help reduce global poverty as well. It is also important to mention here that several researches have proven that education is linked with a plethora of social issues such as pay gaps, gender discrimination, domestic abuse and inequalities in the society. To tackle these social issues, education stands at the opening gambit. Not only does every additional year of schooling increases 8-10% of wages but also leaves people less vulnerable to social, economic and physical problems(Martins and Pereira 2004). An education can mean the differences between life and death for some people. COVID-19 however, has impacted education, students and educators in different ways all around the globe. It has put millions of students out of school and has forced many to quit their education midway or freeze their semesters in order to financially help their families. Not only were people forced to look at alternate modes of learning and teaching but also forced to rethink what back to normal will look like at university campuses across the world. This study is important because it brings attention to one of the most crucial problems faced by our global society. It helps us understand the effects of the pandemic on education and how to create learning spaces that are pandemic responsive.

It is no doubt the COVID-19 pandemic is a health crisis but in response to keeping people safe it was also crucial to shut down schools, colleges and universities across the country. The crisis crystalized into a dilemma which forced policy makers and decision makers to keep learning spaces closed(to keep people safe and prevent the pandemic from spreading) or keep them open (for the country's economy and progress). The disruptions in the education system was felt by millions of families in Pakistan(Fouzia Malik, Fouzia Ajmal, and Zohran Jumani 2021). Though some were able to continue their education online, most were not due to lack of access to internet or telecommunication devices. Teaching was moved online at an unprecedented scale. Student's assessments, final board exams and even professional exams were moved online(Rajput et al. 2020). These were untested and unchartered waters for everyone. These changes and interruptions in the learning environment brought about a lot of issues which will have long term consequences for the affected cohorts and will eventually also increase inequality in the years to come.

This thesis is important as it addresses a pressing issue of our time. The global lockdown on educational institutes and learning spaces and its effect on students and educators and their lives. It helps ponder upon the possibilities that can be implied to mitigate the negative impacts of the pandemic and most of all it helps answer the question that, 'what is "back to normal" going to look like?' and will policies support new graduates to enter into the labor market to avoid longer periods of unemployment? All these questions are important as their answers will help revitalize educational spaces in the post-pandemic environment.

CHAPTER-2 LITERATURE REVIEW

2.1 History of pandemics

Since the dawn of times infectious diseases have effected societies throughout the world. These events have had a profound effect on the economic, political and social aspects of civilizations throughout the centuries. Pandemics have also been one of the drivers of modern medicine, pushing the scientific community to develop immunizations and treatments. In this part of the literature we will focus on some of the infectious outbreaks that effected civilizations and changed the course of history. The earliest record of a pandemic ever recorded comes from 430 BC Athens during the Peloponnesian war which passed the disease into Egypt, Ethiopia and Libya(Piret and Boivin 2021). Then in 165 AD comes the antonine plague which is the earliest appearance of small pox which effect the Roman Empire. In 250 AD comes the Cyprian plague, named after the first victim, Christian bishop of Carthage. The plague passed from Ethiopia to northern Africa and into Rome and onwards. There were breakouts of the Cyprian plague for the next three centuries. The plague that changed the course of the Roman Empire came in 541 AD- the Justinian plague. The plague first appeared in Egypt and spread to Palestine and then into the Byzantine Empire and then throughout the Mediterranean(LePan 2020). The plague has recurrences for the next two centuries and killed almost 26 percent of the world creating an apocalyptic atmosphere. After many years came leprosy in the 11 century which spread throughout Europe in the middle-ages. Several superstitions were attached to leprosy due its symptoms, it was thought to be a punishments for moral decay. In 1350 came the largest bubonic plague called the Black Death. This plague was responsible for the death of one-third of the world population. It is believed to have started in Asia and spread to Europe through caravans. After the arrival of Spanish in 1492 several diseases such as smallpox and measles were transferred to the native population of the Caribbean. In 1520, the Aztec empire was also destroyed by smallpox infections from Europe. This also made them weaker to resist the Spanish colonization(Adu-Gyamfi et al. 2021).

The starting of the 20th century saw many changes. The industrial revolution, the First World War and the first true global pandemic- the Spanish influenza that lasted from 1980 to 1920. Within months the influenza virus had spread everywhere, owing to the massive military movement in Europe and overcrowding, the disease soon spread to Asia, Africa and into the Pacific Islands. The

death toll was possibly around 100 million and it killed more individuals in a year than the Black Death did in a century. In the late 1900's around 1980 came the HIV pandemic. This was a slow progressing disease which with time progressed into AIDS and ultimately death(Calderón and Murillo 2021). The initial expansion of HIV was seen in homosexuals which lead to social isolation and stigma. The 21st century has also seen its fair share of diseases. The first was SARS (Severe Acute Respiratory Syndrome) which spread in China and Hong Kong and some other countries including Canada. The 2009 outbreak of swine flu was a reappearance of the Spanish influenza but less devastating. It started in Mexico and reached pandemic proportions within weeks and was over by the mid of 2010(Mari 2020). The swine flu affected 10 percent of the world population. It was also during this time that mental health was studied in relation to pandemics and outbreaks of diseases for the first time. In early 2014, central and western Africa observed Ebola outbreak, starting in a small village in Guinea and spreading throughout Liberia and Sierra Leone. Though it was contained in 2016, it gained worldwide attention when a Liberian died from Ebola in Texas leading to significant public concerns of Ebola outbreak in USA. Zika virus was first discovered in Uganda and then in Brazil in 2015. The disease was a mosquito borne disease but could be transmitted sexually as well. In 2019, SARS-COV2 or COVID-19 first emerged in china and by March 2020 became the COVID-19 pandemic killing more than 5 million people across 240 countries of the world(Liu, Kuo, and Shih 2020).

2.2 Education systems before the pandemic

The learning theory teaches us that a shift in teaching and learning has been well underway since the early 2000's. In 1900 when education and literacy only included reading writing and calculations, in the 21st century this concept is changing fast. Previously 'knowing' meant the ability to read, remember and repeat which was also practiced in the industrial age. People anticipated only having one sort of profession throughout their working lives while education was based on a 'one-size fits all' model and talent was seen only among those who could not do well in a monochromatic learning environment. Fast forward, postindustrial era showed rapid change in all sectors. Literacy now also included critical thinking, expression and the ability to solve complex problems and perform organizational tasks properly(Krokinskaya 2019). Knowing in this era meant using well organized facts to solve difficult tasks and bring new innovative ideas and solutions. In this era education relied in understanding more than memorizing.

2.2.1 Constructivist theory of learning

Since the early 2000's a shift has emerged partly due to the constructivist theory of learning. According to this theory the one who possess knowledge builds understanding and creates new information based on current facts and expertise. This theory also contradicts the idea that learning is merely the transmission of knowledge to a passive learner. According to constructivist theory of learning knowledge is the assimilation of new information and a learner does not come to a classroom or learning space with an empty mind, there is already preexisting level of understanding of a subject on which a complex understanding is built(Fernando and Marikar 2017). Thus, knowledge exist on multiple levels and it is the sophistication and depth of this knowledge that separates the expert from the beginner. The theory also postulates the importance of context- understanding that a learner is a beginner or expert, then active participation- engaging the learner in activities that employ analysis, debate and criticism that helps enhance understanding of a subject and lastly the social value- engaging the learner in direct interactions with peers and experts and conducting team based projects(Harasim 2018). However, since the pandemic, learning went from a physical space to a virtual space. This compelled us to expand our knowledge of where this learning can occur and how it will occur. It is clear now that virtual spaces are taking a place alongside classrooms and other learning spaces.

2.2.2 Digital transformations in education

Looking back at history we see that crises often reshape and reinvent societies. While it is uncertain how COVID-19 will reshape modern day life but it has encouraged the development and spread of ICT infrastructure and advancements in the digital sphere. Education sector which is a service sector industry has seen several digital transformations even prior to the pandemic. Though transformations in the education industry are slow however, they are happening. COVID-19 on the other hand has accelerated the process for educators, students, policymakers and other players who are actively a part of this sector. Digitalization and educational technologies seem to be the most observed and rapidly changing trends in the education sector, pre and post COVID(Shevchuk, Kondrat, and Stanienda 2020).

2.2.3 Design of the learning spaces

Since learning spaces are also physical spaces, they require certain design principles. The principles of universal design are at the base of any design project. A universal design is a space that can be used by people to the greatest extent possible.

Table 1 The principles of Universal Design (Center for Universal Design, 1997).

PRINCIPLE	DESCRIPTION
Equitable use	The design can serve people with different abilities
Flexible in use	The design can be used by individuals with different preferences for different purposes
Simple and instinctive design	Using the design is easy and can be understood easily by all user regardless of user knowledge, language or experience
Definite information	The design communicates the necessary information to the user regardless of ambient conditions
Forbearance for error	The design minimizes hazards and is ready to accommodate for accidental actions
Less physical effort	The design can be used with minimum fatigue
Size and space for approach and use	The design is such that an appropriate size and space is provided to approach, manipulate and use regardless of user body posture or mobility.

2.3 The global effect of the pandemic on education

Education is a common good and the fundamental right of every human being and according to the SDG of 2030 agenda it is also one of the drivers for just, inclusive and peaceful societies. The COVID-19 pandemic, since its emergence in the end of 2019 and early 2020 has caused, massive disruptions in the education sector all across the globe. Universities across the globe were forced to close down and conduct classes from home. Only places where IT infrastructure was already established, students were able to participate in distant learning mode and maintain learning(Pilav-Velić et al. 2021). According to a study by the international association of universities only two-third of higher educational institutions were able to move teaching online from March to April 2020 while one-third could not. Another problem was the clarity and effectiveness of the

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communication of classes conducted online. Many students and teachers found it really hard to participate in the distant learning program. Since many teachers did not have the appropriate skills to conduct classes suddenly in DL mode, this often resulted in self-study tasks and a lot of miscommunication thus decreasing the quality of education. It is also important to note that a sudden jump from face-to-face to distant learning during a crisis cannot be equal to a well-planned online course(ÖZDEMİR and ÖNAL 2021). Moreover, technical challenges limited senior teachers to conduct classes properly thus leading to a loss in rich educational experience. Students also faced a huge burden as they suddenly had to acquire digital resources and skills that they did not have. These problems affected the mental, emotional and social well-being of students, parents and teachers all across the globe.

The pandemic has definitely brought forth different modes of distance learning in different income level countries during university closures. Around 90% of high-income countries employed online learning strategies and 20% used a combination of broadcast and online learning(Năznean 2021). In addition upper middle income countries provided a 70% combination of broadcast and online learning, while 66% lower-income countries used a combination of broadcast and online learning. Other low income countries are using television and radio education for students. Studies conclude that governments ought to provide ICT training to academic staff in order to fill this gap. In South Asia only 50% countries provided training and guidance to teachers to enter distance learning mode. In Europe and North America this was above 50% however, in East Asia and pacific this was below 40% while most of sub-Saharan Africa did not provide any training or guidance(Özer and Suna 2020). There is no doubt that the COVID-19 pandemic has put the whole world in a corner. The whole world even after two years is still working hard to bring the situation under control and figure out a way to manage life around it. Given the present situation the possibility of the virus completely vanishing seem slim and going back to "life as usual" also seems like a dream. Amidst all this, the education of 600 million students across the world stands in limbo.

2.4 Impact of the pandemic on education sector of Pakistan

The first case of COVID-19 in Pakistan was observed in the month of February 2020 and in March over 300,000 educational institutions including schools, colleges and universities closed down. Students were forced to quarantine and stay and study from home. Although some schools and universities were able to continue education online however most did not have the sufficient ICT

infrastructure to continue education online. Reports show that this has affected 50 million students who are at a risk of falling behind in education(Fouzia Malik, Fouzia Ajmal, and Zohran Jumani 2021). Another PTA Pakistan telecommunication authority report says that only one million school going children have access to internet and digital devices. The government in collaboration with tech-organizations like SABAQ and orenda project launched educational material for grade 1-12 on state owned PTV house to prevent children from completely losing touch with education. Moreover a text message system was developed with 250 thousand user to keep students and teacher in communication(Adnan 2020). Despite all these efforts the learning poverty of Pakistan is at 75% which will continue to rise to 79% because of the pandemic.

We know that education is crucial for the development of any country and is one of the pillars for the nation's progress. It increases efficiency in individuals and creates professional population capable of progressing with the world and creating sustainable economic growth in the country. Reports from 2015 show that higher educational institutions are already struggling in terms of facilities and services, recruitment of teachers, institutional organizations, political pressures, parental participation, financial deficiencies, technical breakthroughs, lack of equipment and the constant need for consistency, up gradations, competition and the evolving nature of research around the globe(Lodhi, Iqbal, and Ayyubi 2021). The pandemic has furthered this struggle and higher educational institutes in Pakistan are facing a plethora of problems. Studies show that it is not teachers and students struggling but also the parents of students who are taking part in the educational process and are struggling with the virtual challenges of online education.

Though this has amplified parental participation in the educational experience however, students are more likely to suffer difficulty in self-regulation, comprehension of learning resources and organizational challenges. Research also shows that in Pakistan, lower income parents are less interested in their children's education as compared to middle or higher income parents(Minhas, Shahid, and Ali 2021). This disparity was due to the fact that lower income parents tend to work longer hours and have several responsibilities and less consistency and security in their jobs as compared to parents from middle or higher income groups. It was also observed that parents from higher income groups tend to have high standard in education. A 2010 study showed that educated parents are more capable of helping their children participate in online learning at home. This

enables their children to comprehend complex tasks, take up advance content and tackle technical issues better than others(Wamala, Kizito, and Jjemba 2013).

2.5 Higher educational spaces and campus life during the pandemic

The disruptive effects of the COVID-19 outbreak have impacted almost all sectors of our society. Higher education is no exception. Anecdotal evidence paints a bleak picture for both students and universities. The effect of the pandemic on the education system goes deep, examinations and evaluation, mental health, physical spaces on campus, access and mobility in universities and even learning and teaching pedagogy was effected drastically. Following are some of the areas of the education system were presented with significant challenges.

2.5.1 Mobility and accessibility

The COVID-19 pandemic has affected students, teachers and parents from schools and universities across the globe and the crisis continues to increase social inequality everywhere. Mobility and the ability to reach certain resources on campus or inside the university was severely affected(Z. H. Khan and Abid 2021). Disadvantaged students already could not avail most of the educational facilities due to poor economic and unsustainable social circumstances, however, during the pandemic their mobility was further hindered. Students who did not have computers at home used to use the computer facilities at the university but after closure of universities they were forced to stay at home and were unable to fully participate in the distant learning mode. In rural areas where the ICT infrastructure was very poor, students were compelled to drop out completely. Most were unable to avail educational resources through phone as well, due to low coverage of mobile networks. Inaccessibility was another major issue during the pandemic. Inaccessibility to not only ICT infrastructure but also to several other services required during a degree. Inaccessibility to labs, experimental tools, workshops and other facilities where practical learning was performed, all became inaccessible to students(Farooq et al. 2021). Moreover, students who were still living in hostels, had to face food shortages. It is no doubt that distant learning has proven itself to be a very vital solution to continue education in the advent of a pandemic however, it is extremely difficult in developing countries with highly disadvantaged social groups(Aziz et al. 2020).

2.5.2 Architectural challenges in the learning space

One of the major challenge faced by the education system was the change required in physical spaces to sustain social distancing. While at home, observing quarantine, many students did not

have a proper desk or chair where they could attend their classes so they made do with whatever space they had, attending classes from bedrooms or living area(Faisal, Khotib, and Zairina 2021). Furthermore, the lack of privacy in small households also further interrupted the learning process which prevents students from fully concentrating on lecture. The architecture of a learning space is very crucial as it helps sustain knowledge and learn better. Uncomfortable spaces can divert attention and decrease learning efficiency. The COVID-19 pandemic forced many students to attend classes in uncomfortable places thus decreasing their ability to sustain that knowledge in the long-term. Another similar problem here is that, once the universities allowed FTF lecture on alternative days, physical space became inadequate to maintain social distancing(Nafees and Khan 2020). Classroom, corridors and all other facilities in the university are not designed to serve during a pandemic or sustain social distancing ques. Once the universities were fully open, this challenge remains candidly.

2.5.3 Effects on mental and physical health

Closure of schools, colleges and universities and lockdowns all over major cities around the globe, forced people to stay indoors for very long periods, causing several people to develop mental health issues. Students were no exemption. Those living in rural areas were forced to give up education and support their family in cattle herding or farming(Iqbal and Younas 2021). Girls in rural areas from lower income families were more prone to sexual violence, forced labor and early marriages. Some studies also indicated a sharp increase in general anxiety since the pandemic began(Dhahri et al. 2020). Students who were subjected to several pressures at home also developed physical health issues. It was also observed that some students had major difficulties while interacting on online learning platforms. Studies indicate that this may have long term effects on career choices and the quality of graduates that will enter the market after finishing school(Ping 2021). Although there is still room for further investigation if these effects will stay long-term in their lives.

2.5.4 Evaluation and assessments

Since the closure of universities online learning platforms like Zoom, TronClass, Google classroom and Microsoft teams saw a boom in their user ship. These tools were very crucial to sustain distance learning. However, shifting from face-to-face learning to online classroom was not easy and presented challenges for teachers, students, families and even governments due to lack of financial resources to sustain online education at such a huge scale. Furthermore, most

universities did not offer training courses to teachers or students to shift to online mode of learning. This was a huge hindrance for a smooth transition and greatly affected the quality of student evaluation and examination. In addition, students who did not have laptops or computers at home, took exams on their phones and those with poor internet access or no internet access, suffered the most. It is also imperative to mention here that some courses cannot be taken online and require in person learning and supervision, such as nursing, lab-work, music, arts and practical learning workshops. Depending on the course type and the nature of assessment required for that course, online assessment decreased the credibility of evaluation and examination conducted. Nevertheless teachers had to adjust their assessments to an online mode and had no way to make sure if the students were cheating during examinations or not. Taking assessments was also difficult for teachers and instructors, particularly due to technical competencies, assessment of practical skills and the practical pedagogy. Some students who did not have access to computers or internet could not participate in the examinations all together. Thus effecting their course of studies for the coming few years. It is important to note that educational inequalities are a threat to the development of a country especially in times of a pandemic.

2.5.5 Quality of education during the pandemic

Since the closure of universities online learning platforms like Zoom, TronClass, Google classroom and Microsoft teams saw a boom in their user ship. These tools were very crucial to sustain distance learning. Furthermore, most universities did not offer training courses to teachers or students to shift to online mode of learning(Adnan 2020). This was a huge hindrance for a smooth transition and greatly affected the quality of student education. In addition, students who did not have laptops or computers at home, took exams on their phones and those with poor internet access or no internet access, suffered the most. It is also imperative to mention here that some courses cannot be taken online and require in person learning and supervision, such as nursing, lab-work, music, arts and practical learning workshops(Akram, Anjum, and Batool 2020). Depending on the course type and the nature of assessment required for that course, online assessment decreased the credibility of evaluation and examination conducted. Taking assessments was also difficult for teachers and instructors, particularly due to technical competencies, assessment of practical skills and the practical pedagogy(Lodhi, Iqbal, and Ayyubi 2021). Some students who did not have access to computers or internet could not participate in the examinations all together. Thus effecting their course of studies for the coming few years. It is

evident that in its third year COVID-19 might become an epidemic from a pandemic, however it is here to stay. This brings us to the question that how should countries plan to continue education and what are the strategies that can make distance learning easier? Several developed countries designed strategies to scale educational technology according to the growing demand, they provided online educational resources free of cost and universal service funds helped keep students in universities. Moreover other strategies like free online learning courses, mobile learning, academic content on radio and television and online coaching also helped in growing the ICT infrastructure(Rafique et al. 2021). It is no doubt that there were different distance learning challenges faced by students and families from middle to lower income households. This was and still is one of the major bottleneck of online teaching and learning. There is no doubt that the COVID-19 pandemic has put the whole world in a corner.

2.5.6 Challenges to adapting to online learning modes during COVID-19

It is no doubt that the pandemic has affected education greatly however some studies also show that with the imposition of social distance strategies in higher educational institutes, the curriculum needs rapid redevelopment to adjust to online learning modes. Several countries report that due to closure of schools and universities, students, their families and academic staff all face difficulties therefore online teaching is a good solution however, it is a huge challenge for the marginalized and poor students and families who cannot participate due to lack of tools and an internet connection. Initial reports of UNESCO suggest that the pandemic has interrupted face-to-face education for 90% of students worldwide. Statistics also revealed that globally, 50% (826 million) students don't own a computer and 43% (706 million) do not have an internet access at home. Moreover 56 million students cannot use mobile phones since their area is not covered by mobile networks. It should also be highlighted here that with the shift in mode of learning a need for trained ICT teachers also came to light. According to UNESCO 2020 reports there is only 1 trained ICT teacher for every 56 students in developing countries. A shortage of trained staff was also one of the major precursors for poor grades and decline in quality of education during the pandemic.

2.6 The future of learning

Classrooms and learning spaces are sometimes used interchangeably but are very different from each other. In the past few decades, classrooms were the prime areas of imparting knowledge. Traditionally a teacher would teach a class in a classroom in a formal manner. However this is

changing and with the pandemic this change has been accelerated. With the advent of the world wide web a great deal has changed. Internet has spawned a wealth of knowledge and information, now easily accessible to everyone around the world(Pouru-Mikkola and Wilenius 2021). Today learning spaces are more flexible and informal. A learning space could be anywhere from a classroom in a university or even a coffee shop. With the developments in IT an entire generation has grown up using phones, laptops and other digital tools. For them these tools are essential and those without it will have a hard time coping in the world since everything is slowly turning digital. Since after the pandemic, learning spaces have shifted online and into the homes of students thus asking education to become more flexible and adaptable to changing environments(Elmore 2019).

2.6.1 New pedagogical approaches in learning spaces

Over the past few years, the higher education sector has invested million into classroom technology. Adding cameras, DVD players, multimedia, projectors, and internet access, all to enhance the functionality of a classroom. However with time and the advent of new technologies a variety of functions have been added thus expanding the idea of a classroom. The classrooms are flexible and allow new pedagogical approaches to be practiced in these spaces. Wireless networking allows synchronous interactions while videoconferencing makes it easier to invite guest lecturers from various parts of the world into the class session(Salas-Rueda et al. 2022). Lectures can be easily recorded and discussion and notes can be captured and distributed easily via digital technologies. In other words technology acts as a lever to implement new pedagogies effectively. Hence the concept of a learning space and the activities taking place in it are constantly changing. Since after the pandemic, learning spaces have shifted online and into the homes of students thus asking education to become more flexible and adaptable to changing environments. With the advent of virtual classrooms the traditional classroom can no longer encompass where learning will happen(Zeivots and Schuck 2018). This is also a good opportunity to enhance the skill-set of educators and help them rethink and redesign their teaching methods and curriculum so learning can occur anytime and anywhere.

2.6.2 Virtual Spaces as learning spaces

With the advent of virtual classrooms the traditional classroom can no longer encompass where learning will happen. Learning spaces are no longer physical places, they are virtual and metaphysical as well. Virtual spaces are spaces where people from different physical locations can

come into the same spaces and meet using digital networks. Virtual spaces not only includes active and synchronized communication such as in chat rooms or video calls but also asynchronous passive modes such as emails and discussion treads(Olivares, Vázquez, and Toledano 2021). Unlike physical spaces, virtual spaces can be updated and changed every day. In the virtual spaces nothing is permanent and everything is flexible. These spaces can be spontaneous as well as deliberate. Relations inside the virtual space also change very fast and participants can multitask in more than one virtual spaces without disturbing their peers. As laptops become more available and internet access and ICT infrastructure grows, the role of virtual spaces in higher education also grows.

2.7 Post COVID developments in the learning spaces

As we adapt to the pandemic, planning, architecture and design are being called upon to help reinvent and redesign the spaces we live in to make them resilient to future pandemics. The ongoing debate on what the future must look like touches all sectors of life that were affected by the COVID-19 pandemic including learning spaces and what the next educational building will look like in this context(Kolhar et al. 2020). A London based studio, the Curl La Tourelle got inspired by outdoor learning environment of Denmark and proposed learning tents that are socially distant. This design got implemented in Manorfield Primary school in tower hamlets and at Fortismere School in Haringey. In the same line another architect from dubai, Pallavi Dean of studio Roar says that this crisis is an opportunity to reshape and revitalize our learning spaces all together(Harsritanto et al. 2021). In his opinion, the pandemic and virtural learning has brough our attention towards the design of learning spaces in school and colleges where all the real magic happens and students gain educational efficiency and personal enrichment. He says that it is important to spend more time designing these spaces rather than wasting real estate on spaces for humdrum tasks(Febrianto, Winarni, and Prihatmi 2021). He suggests that educational spaces need to be clever, efficient and must have a flexible design. Meanwhile at Moscow architecture school M.ARCH, an online series of discussion focusing on "architectural schooling in the age of Quarantine" brings focus to higher educational spaces and how these spaces need to change and provide for students(Iranmanesh and Onur 2021). The discussion took place from June to July 2020 and provided useful insight for architects to design better and more efficient higher educational spaces in the post pandemic environment.

2.7.1 Working in the learning space

Learners are not the only occupants of learning spaces, faculty and staff are also crucial stakeholders in educational spaces and making work easier for them is an important part of revitalizing higher educational institutions. Lockdowns forced people to work from home but has also brought attention to the discussion of returning back to offices and what these work spaces need to look like. London based firm Morey Smith believes several aspects of offices need to change for sure, such as overall density of people present in the same space, to the materials and surfaces that prevent virus transmissions(Llinares, Higuera-Trujillo, and Serra 2021). The firm admits that offices are trying to make work environments more attractive however, in the post pandemic environment they need to be more than that. Returning to a pre pandemic situation is not practical and shouldn't be practiced while radical change can be tricky, however a New York based architectural office FX Collaborative has already started implementing changes to its workspaces. The firm was building 1 Willoughby Square which would include its newly designed office building in downtown Brooklyn when the lockdown happened. Taking this as an opportunity, the architects made a series of changes creating a contactless environment and reflecting the current need for social distancing. They included automatic doors, touch free faucets, large outdoor spaces, additional bicycle provisions and smart ventilation systems. The firm has said that they are proving their design principles by testing it on themselves. The firms also said that the aim is to model new behaviors and become 'tech-savvy, remotely capable and healthy'.

2.7.2 Adaptable Learning Spaces

Universities and colleges around the globe are now observing a full academic year of untraditional learning arrangements, by hybrid or through distant learning methods. One thing that has become clear in the past two years is that place matters to an education, which means that online university classes cannot replace the learning experience that happens in person on campus. A key challenge forward will be the design of learning spaces that allow collective experiences that define campus life while remaining socially distant and contactless(Jordan et al. 2021). Perhaps traditional lecture halls will be reimagined as multivalent venues that accommodate large gatherings or smaller events. Flexibility will be key. Partition able spaces of various scales will need to be organized around central spaces. The smaller spaces can thus act as self-contained classrooms or parts of larger venues. Each space fluid and always adjustable.

2.7.3 The architecture of learning spaces

Several architects, designers, public health experts and engineers are currently engaged in debates about the appropriate design guidelines to provide people safe and healthy spaces as we transition back into the built environment after lockdowns. Finding a balance between optimizing operations, making spaces more interesting and reevaluating designs in the post COVID environment is proving to be difficult. The AIA American institute of architects has also released a set of guidelines and strategies that help reduce the risk of COVID in schools and colleges. The guidelines are a part of the initiative called "Reopening America". Although we cannot see the future we can however, create analogies that are based on the current situation, which will help us produce appropriate designs that are COVID responsive.

2.7.4 SOP's to prevent the spread of COVID in universities

The spread of COVID-19 forced nationwide closures of schools, colleges and universities. After the lockdowns were lifted and education institutes opened a set of standard of procedures were released by WHO and several other authorities to makes educational institutes safe and healthy. Thermal scanning and body temperature measuring, wearing gloves and face masks, maintain social distance, washing hands frequently and using sanitizers, avoiding crowds and large gatherings, restocking of facemasks and hand sanitizers for all departments and offices and installation of electric hand sanitizers and dispensers at crucial junctions were few of mandatory protocol procedures. The following outlines a summary of these standards of procedure.

1- All students and staff should wear masks and gloves while they're on campus at all times.
2- Thermal scanning and body temperature measuring is mandatory for everyone before entering the campus
3- Anyone having a fever or a cough, cold or even sneezing should be restricted from entering the campus.
4- Display boards about social distancing protocol must be placed at prominent locations.
5- Classrooms should be disinfected every day.
6- Wearing masks is mandatory in classrooms as well.
7- A distance of 6 feet must be maintained between all individuals in the classroom.
8- A distance of 6-7 feet must be maintained between the teacher and first bench students.
9- Students should not share stationary or any food items.

10- Contact with switchboards and door handles should be avoided.

11- Laboratories and workshops and all equipment should be disinfected regularly.

12- Automatic sanitizing machines should be installed at the entrance of all laboratories and workshops.

13- Social distance of around 2 meters must be maintained between those performing experiments.

14- Library and sport complex will be functional but access will be limited for only important work.

15- Students and staff should avoid crowding up corridors and common areas.

16- Students and staff are advised to carry personal sanitizers and use them after frequent contact with door handles.

17- Social distance of 2 meter must be maintained between students and staff in corridors and common areas.

18- It is advised to install electric sanitizers in corridors and at important junctions throughout the campus.

19- Restrooms should be cleaned multiple times a day. All students and staff should sanitize their hands at entry and exit from restrooms.

20- University transports should be sanitized regularly. Hand sanitizers should be placed in all vehicles and wearing masks and gloves is also mandatory inside the vehicles.

21- All students and hostel in charge should submit a COVID negative test report before availing hostel accommodation.

22- Hostilities should quarantine for 14 days before starting regular activities in the campus.

23- Hostel mess and all other areas inside the hostel facility should be disinfected regularly.

24- Social distance of 6 feet should be maintained in the hostel mess and other common areas.

25- Hostilities should be thermally scanned twice a day and every time they enter the facility.

CHAPTER-3 METHODOLOGY

3.1 Research design

The research design of this study incorporates a quantitative approach to achieve its objectives. The study also employs a descriptive and correlational analysis to achieve its objectives. A succinct and logical framework is developed that helps tackle the research questions established in the first chapter of this study.

The research design helps answers the following research questions:

- What are the challenges faced by educational institutes and how was campus life effected during the pandemic?
- How to change the design parameters in response to the pandemic?
- What are the necessary measures required to revitalize higher educational spaces in the post pandemic environment?

RESEARCH DESIGN

aims to achieve

OBJECTIVES

To investigate the effects of the pandemic on higher educational spaces and campus life

Revisiting the ergonomics and making modifications in the design parameters of educational spaces

To suggest strategies to revitalize higher educational spaces in the post pandemic environment

TECHNIQUES USED TO ACHIEVE OBJECTIVES

STAKEHOLDERS
students
teachers and academic staff
administration and staff

survey 1- stakeholder survey
sample size 400

survey 2- expert survey+
interview

identifying
stakeholders

surveys and
interviews

analyzing the data
and facts collected

studying existing
ergonomics

studying the changes
observed during the
pandemic

looking at examples and
case studies via literature
review

overlaying it with the
experts survey and
suggesting new design
parameters

literature review and
secondary data sources

existing thories and
relevant research

results and conclusions
from analyzed data from
the first objective of the
study

factors measured in survey 1
financial factors
physical factors
pyscological factors
productivilty factors

factors measured in
survey 2
architectural and planning
dimensions

DATA ANALYSIS

TYPES

Factor analysis

Content analysis and
descripitive analysis

RESULTS

DISCUSSION AND
RECOMMENDATIONS

Figure 1 Reserch design

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3.2 The objective of the survey

The COVID-19 pandemic has severely disrupted education in universities all over Pakistan. From campus life to grades and even mobility on campus has been effected by the pandemic. How students move and interact and how lectures are delivered by educationists in classrooms and lecture halls has all seen unprecedented change. The objective of this survey is to study the impact of these changes and to understand who was effected the most and why.

It is worth mentioning that the classic form of learning in universities in Pakistan is face-to-face mode (FTF). During the pandemic, this changed and students and teachers entered a distant learning program or in some places a hybrid learning program was incorporated. The survey not only helps understand the impact of the changes but also which changes were useful and which were not. Through this survey universities can make their own models and policies about which changes they would prefer to carry on and which changes proved most beneficial. The survey will help us achieve the following:

- Determining the impact of closure of universities on its users
- Evaluating the effect of the pandemic on quality of education in universities
- Identifying the loop holes in the education system during the pandemic and finding remedies that can be practiced in the future as well.

3.3 Study area

The study area of this research includes higher educational institutions. The research was carried out in 4 universities namely national university of science and technology, Islamabad (NUST), COMSATS University, Islamabad, Lahore University of management sciences (LUMS), M.Islam Medical & Dental College Gujranwala (MIMDC). The topic under study is the effects of the pandemic on educational spaces and changes necessary to revitalize them and make them safer for their users. The target group consisted of students from bachelors and masters programs from these four universities. It also included the teachers and academic staff as well as the administrative staff of the university. Data collection was gathered throughout January to March 2022. Around 400 teachers, students and administrative staff from the four universities participated in the study. Key trends in the responses of the survey will be discussed in the results section. The scope of this study is limited to higher educational spaces only, such as universities. The study is also limited by the elements or factor used to measure the effect of the pandemic on educational spaces. Once

the study area was selected a careful structure was designed that would help achieve the objectives of the thesis. The universities chosen in this study are one of the most prominent universities in the country. Diversity was kept in mind during the selection process. Two of the universities, namely NUST and COMSATS are public and semipublic universities while LUMS and MIMDC are private while the latter is a medical university as well. Once the selection was complete, data was collected regarding the elements under investigation. In the first stage surveys were carefully crafted and conducted in all four universities. The first was a stakeholder survey in which the total sample size was 400. The stakeholder survey was conducted to achieve the first objective of the study while the expert survey was conducted to help understand the necessary changes required in the design parameters and ergonomics of educational spaces. Once the data from the surveys was collected, it was sent to SPSS statistics and factor analysis was conducted on it.
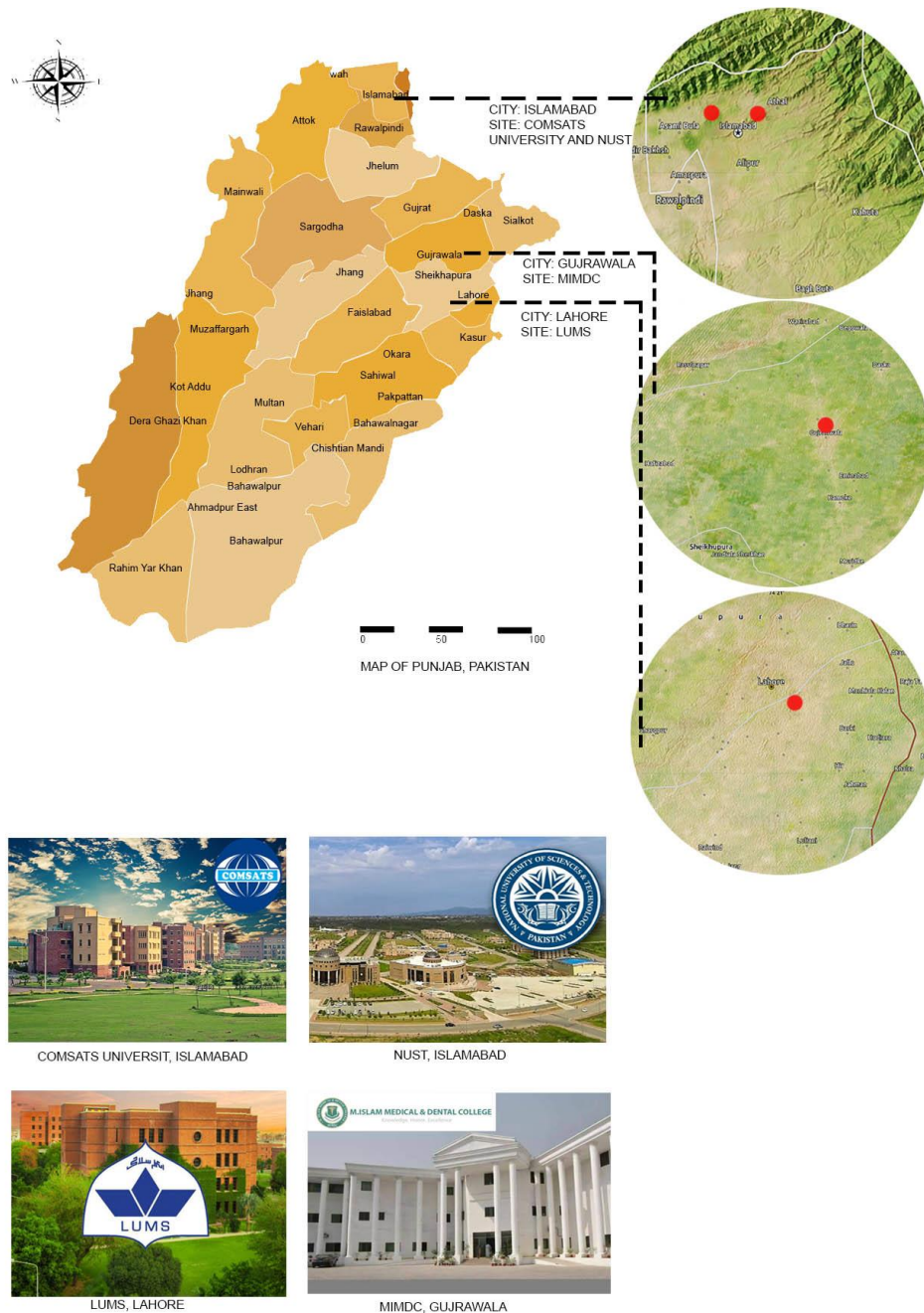
Figure 2 Site map

3.4 Survey design

To understand the impacts of the pandemic and nationwide university closures, it was important to ask those who were most affected by this change. For this purpose a comprehensive survey was designed which was broken down into 3 parts. The first consisted of 20 questions and was aimed at students from the selected universities. The questions included in this part of the survey were

specific to the education and life of students during the pandemic. The second part of the survey was conducted separately and was aimed towards teachers and academia. This part also had 20 questions but the questions were specific to the problems faced by teachers during the pandemic and how they overcame these problems. The third part of the survey was aimed towards the general staff and administration of the university. This part also consisted of 20 questions however, most of these questions required data which only the administrative staff could provide. The survey not only helps understand the impact of the changes but also which changes were useful and which were not. Through this survey universities can make their own models and policies about which changes they would prefer to carry on and which changes proved most beneficial. The survey will help us achieve the following:

- Determining the impact of closure of universities on its users
- Evaluating the effect of the pandemic on quality of education in universities
- Identifying the loop holes in the education system during the pandemic and finding sustainable remedies that can be practiced in the future as well.

All questions in these 3 parts were closed ended. The following table describes the areas which were under study in the survey.

Table 2 Areas under study in the 3 part survey

Barriers to Mobility and accessibility	Barriers to Coordination and interaction	Psychological barriers	Financial barriers	Barriers education	Barriers to performance
Utilization of classrooms and labs with ease	Interaction with students during pandemic	Feeling safe working in the university during the pandemic	Paid leaves for staff members who contracted the virus	Effect on education and performance during the pandemic	Performance of staff members and teachers during the pandemic
Effect on sports and other activities	Disinfection of classrooms and labs and ease of access	State of mental health during the pandemic	Financial assistance or relief for students in need	Dropout rate in university	Need for more space during the pandemic
Ability to work in labs and workshops and finish work on time	Following and enforcing COVID safety protocol with ease	Provision of counseling and mental healthcare by the university during the pandemic	the departmental budget during to the pandemic	the enrolment rate drop in your university since the start of the pandemic	Staff on regular attendance

Change in seating arrangements	coordination with the academic staff easily during DL mode	feeling safe from the virus on campus or in classrooms	Academic staff or students meeting financial problems during the pandemic	mode of learning which was most comfortable	having laptops and digital tools to participate in DL mode
Mobility on campus during the pandemic?	Contacting students easily when classes were being conducted online	Provision of adequate protection and a safe environment on campus housing	provision with financial assistance to students from the university during the pandemic	mode of learning which was most effective	having good internet access during the pandemic that allowed participation in DL mode
using cafeteria and other services provided on campus during the pandemic	training and workshops for students that helped enter DL mode when the universities entered lockdown for the first time		Fee reduction and compensations	grades during the pandemic the standard of assessments and exams during the pandemic	Ability to deliver lectures properly during DL mode
classroom size sufficient for class strength if the pandemic persists	borrowing laptops or other devices from the university during the pandemic		paid leave for teachers by the university	mode of teaching which was most suitable	students performance in DL mode as compared to FTF
reducing class density to help teachers and students interact more effectively	periodic workshops for teachers and staff by the university that helped transition into DL mode			Teacher student interaction during DL mode	

3.4.1 Sample size

Sample size refer to the number of individuals who participate in the study through survey or interview. This size represents the entire population because including the entire population would be very difficult.

Confidence level: 95%

Total Population size: 20,000

Margin of error: 5%

Sample size: 377

The sample size for this study (individual who participated in the first survey) was set at 380.

3.5 Structured interview

A succinct and logical framework is developed that helps tackle the problem at hand. Various documents and communication artifacts are used in the study to examine the current state of design in higher educational spaces and to present strategies to revitalize them. A survey was designed for experts from various fields related to the education profession. This survey was taken only by experts from the architecture, construction, urban design, academia and policy making field. It asked questions concerning the future of educational spaces and changes in ergonomics and design parameters in university spaces. Around 35 experts took part in the structured interview. These interviews helped achieve a more concrete understanding of why certain changes that happened during the pandemic and nationwide will and should be practiced in the post pandemic environment. Experts were asked questions along the following lines.

Table 3 Areas of query in the structured interview

1	Size of the classroom and its relationship to new social distancing parameters
2	Class density and its relationship to new social distancing parameters
3	The provision of special response teams and response centers in universities
4	Mandate of health screening machines all over campus
5	Visual cues specific to COVID (tapes and signs boards) in all universities to facilitate circulation flow and appropriate distance protocol
6	Movable screens on desks and changing seating orientation to achieve additional shielding
7	University furniture to be made modular, adaptive and flexible
8	Separate modular lounge settings and use of moveable transparent screens in libraries and common areas
9	Administrative spaces and their sizes
10	Implementing hands free experiences and the use of technology
11	Designing for disinfection in campus housing
12	Digital banks for digital tools in universities to facilitate distance learning in universities
13	Modular campus housing designs
14	Materials used in laboratories and workshops
15	The future of learning spaces in higher educational institutes

3.5.1   Criteria for design modifications

In this paper, the design modification in the design parameters of educational spaces are made on the basis of SOP's of COVID-19 for universities by UNESCO, expert opinion from interviews, the Principles of universal design (UD) and Post COVID developments in learning spaces addressed in the literature. The method of collecting responses was manual as well as through Google forms application.

3.6 Types of data

There are two types of data used in this study.

- Primary data
- Secondary data

The primary data consists of the first hand data collected through surveys and questionnaires. The secondary data consists of facts and stats collected from the universities in the study area. It also includes data collected through various literature sources.

3.7 Data Analysis

The method of collecting responses was manual as well as through Google forms application. Data was the imported to excel program for a clearer graphic representation and was later imported to SPSS statistics for analysis and interpretation. The research applies qualitative and quantitative analysis.

The following methods of analysis are used in this study:

- Descriptive analysis
- Content analysis

Descriptive analysis which a type of statistical analysis is the process of using statistical techniques to summarize data sets. Unlike other data analysis the descriptive analysis does not makes predictions about the future, it only draws insight from given data and manipulates it in ways that make it more meaningful. It helps summarize data to provide constructive patterns that make data more useful. In this study descriptive analysis is being used to identify similarities among variables, identify patterns and distribution of data and make it ready for further statistical analysis(Charry et al. 2020).

Content analysis is a research tools that helps determine the presence of certain concepts within qualitative data like text. Using the content analysis, researchers are able to quantify the meaning of certain words and the relationship between words themes and concepts. Sources of data for content analysis can be from interview, open ended questions, field research notes and any communicative language for example books, articles essays and other various documents. A single

study can analyze various forms of texts in its analysis. In this study content analysis is applied to analyze the field interview, the literature and existing design parameters and identify the similar themes and concepts in the various sources of data(Erlingsson and Brysiewicz 2017). This will help us revisit and change design parameters for educational spaces more efficiently. To analyze the data the text will be broken down into codes and then coded categories to summarize the data even further. Nvivo was used to perform the content analysis.

CHAPTER 4 RESULTS AND DISCUSSION

After careful analysis on SPSS, data was manipulated and simplified to provide constructive patterns that made it more useful. In the following section we will discuss the impact of closure of universities on its users and evaluate the effect of the pandemic and the barriers to sustainable higher education in universities. The analysis performed in this study also helps identify the loop holes in the education system during the pandemic and can be used by universities to make sustainable models and policies about the changes that should be carried on for sustainable higher education for the future (Shahzad et al. 2020).

4.1 Profile of participants

The total number of participants in the survey was 380 out of which 51.3% were students, being the major stakeholders of universities. Around 35.5% teachers and 13.2% staff members also participated in the survey. It is also valuable to mention that about 61.8% of the total participants were male while around 38.2% were females. A detail profile of the participants from the four universities is given in the table (2).

Table 4 Profile of participants in the study

VARIABLE	UNIVERISTIES				TOTAL	ASYMPTOTIC SIGNIFICANCE (2-SIDED)
	LUMS	COMSATS	NUST	MIMDC		
AGE						
20-30	47.4%	46.4%	39.4%	68.4%	50.3%	.001
30-40	26.3%	19.1%	25.3%	10.5%	20.0%	
40-50	23.7%	24.5%	24.2%	10.5%	20.8%	
50- ABOVE	2.6%	10.0%	11.1%	10.5%	8.9%	
GENDER						
MALE	57.9%	69.1%	69.7%	48.4%	61.8%	.005
FEMALE	42.1%	30.9%	30.3%	51.6%	38.2%	
STAKEHOLDERS						
STUDENTS	48.7%	54.5%	36.4%	65.3%	51.3%	.005
TEACHERS	36.8%	32.7%	49.5%	23.2%	35.5%	
STAFF	14.5%	12.7%	14.1%	11.6%	13.2%	

4.2 Barriers to education

Barriers to education in this study refers to the physical barriers and physical settings that made learning difficult such as, the mode in while learning took place, the area where learning took place and the mode in which learning was evaluated. Results showed that 67.7% of students were most comfortable in face to face learning in the classroom while 23.6% chose hybrid mode of learning while only 8.7% chose distant

learning mode. The largest percentage of students who were most comfortable in FTF mode were from COMSATS and MIMDC, followed by NUST and then LUMS. It can be concluded that MIMDC students are medical students and perhaps they require more in-class and practical learning and therefore, a vast majority (71.0%) were in favor of FTF education. An anomaly in the results was observed that only 51.4% of students from LUMS wanted to learn through FTF while 35.1% chose a hybrid mode of learning. It can be assumed that LUMS has an efficient distant learning system which motivated students to choose a hybrid system (a combination of distant and face to face learning)(Mahwish Zeeshan, Dr. Abid Ghafoor Chaudhry, and Shaheer Ellahi Khan 2020). In the same line when teachers were asked the same question only 37.0% percent of the total teachers chose FTF while 59.3% chose hybrid mode. The highest percent of teachers who chose hybrid mode were from LUMS (71.4%) thus aligning with the choice of LUMS students. Similarly when student were about the most effective mode of learning, an overwhelming majority of 74.4% answered FTF. However in contrast, when teachers were asked about the most effective mode of teaching, a majority of 56.3% answered hybrid mode of teaching. This shows that teachers were able to be more efficient on the hybrid mode of teaching while students felt that learning was easier only FTF. Another interesting contrast was observed when students were asked about the effect of the lockdowns on their grades and a vast majority agreed that it had a moderate to major effect on their grades while on the other hand when teachers were asked about the performance of students in FTF versus DL they felt that there a minor to neutral difference. However 44.4% teachers agreed that the standard of assessment had fallen in DL mode, the highest being in LUMS and MIMDC. It can be concluded that LUMS has largely always relied on in person and practical assessment of students and therefore was unable to assess its students while MIMDC being a medical university also relied on practical assessment of medical knowledge and was unable to assess students in practical labs and wards(Baqir and Mustansir 2021). Therefore 43.0% teachers from all four universities agreed that exams should only be "sometimes" conducted in DL mode, while 10.4% said "never" while 0.7% answered "always". When the staff and administration offices which are responsible for accumulating data related to exams were asked about the effect of the lockdown on education in their university, their replies were in line with the answers of the teachers. Both agreed that there was a minor to neutral difference on quality of education and the performance of students. This shows that students had a more pessimist view of the lockdown as compared to teachers and staff members(Raza, Haq, and Sajjad 2020).

Table 5 Barriers to education

STAKE HOLDER	VARIABLE	UNIVERISTIES				TOTAL	ASYMPTOTIC SIGNIFICANCE (2-SIDED)
		LUMS	COMSATS	NUST	MIMDC		
STUDENTS	**Most comfortable mode of learning**						.352
	DL	13.5%	5.0%	11.1%	8.1%	8.7%	
	FTF	51.4%	73.3%	69.4%	71.0%	67.7%	
	HYBRID	35.1%	21.7%	19.4%	21.0%	23.6%	
	Most effective mode of learning						.214
	DL	13.5%	3.3%	13.9%	6.5%	8.2%	
	FTF	62.2%	78.3%	77.8%	75.8%	74.4%	
	HYBRID	24.3%	18.3%	8.3%	17.7%	17.4%	
	Effect on grades						.920
	No effect	5.4%	11.7%	13.9%	11.3%	10.8%	
	Minor effect	10.8%	13.3%	19.4%	17.7%	15.4%	
	Neutral effect	13.5%	11.7%	11.1%	11.3%	11.8%	
	Moderate effect	37.8%	25.0%	19.4%	22.6%	25.6%	
	Major effect	32.4%	38.3%	36.1%	37.1%	36.4%	
TEACHERS	**Most comfortable mode of teaching**						.045
	DL	0.0%	0.0%	10.2%	0.0%	3.7%	
	FTF	28.6%	36.1%	34.7%	54.5%	37.0%	
	HYBRID	71.4%	63.9%	55.1%	45.5%	59.3%	
	Most effective mode of teaching						.215
	DL	0.0%	5.6%	10.2%	0.0%	5.2%	
	FTF	35.7%	41.7%	30.6%	54.5%	38.5%	
	HYBRID	64.3%	52.8%	59.2%	45.5%	56.3%	
	Effect on teaching						.482
	No effect	0.0%	5.6%	4.1%	0.0%	3.0%	
	Minor effect	0.0%	0.0%	4.1%	4.5%	2.2%	
	Neutral effect	10.7%	2.8%	6.1%	13.6%	7.4%	
	Moderate effect	39.3%	27.8%	38.8%	45.5%	37.0%	
	Major effect	50.0%	63.9%	46.9%	36.4%	50.4%	
	Students performance in DL vs. FTF						.001
	No difference	17.9%	0.0%	10.2%	0.0%	7.4%	
	Minor difference	35.7%	50.0%	34.7%	4.5%	34.1%	
	Neutral difference	25.0%	25.0%	34.7%	9.1%	25.9%	
	Moderate difference	14.3%	13.9%	18.4%	45.5%	20.7%	
	Major difference	7.1%	11.1%	2.0%	40.9%	11.9%	
	Standard of tests and exams						.186
	No effect	0.0%	0.0%	2.0%	0.0%	0.75	
	Minor effect	0.0%	8.3%	14.3%	9.1%	8.9%	
	Neutral effect	17.9%	30.6%	38.8%	13.6%	28.1%	
	Moderate effect	60.7%	41.7%	30.6%	59.1%	44.4%	
	Major effect	21.4%	19.4%	14.3%	18.2%	17.8%	
	exams and assessments to be conducted in DL mode						.022
	never	7.1%	16.7%	4.1%	18.2%	10.4%	
	rarely	3.6%	19.4%	22.4%	13.6%	16.3%	
	sometimes	60.7%	41.7%	30.6%	50%	43.0%	
	often	28.6%	22.2%	42.9%	13.6%	29.6%	
	always	0.0%	0.0%	0.0%	4.5%	0.7%	

STAFF	Effect on quality of education in university						.414
	No effect	45.5%	35.7%	35.7%	45.5%	40.0%	
	Minor effect	18.2%	35.7%	28.6%	36.4%	30.0%	
	Neutral effect	18.2%	21.4%	35.7%	18.2%	24.0%	
	Moderate effect	18.2%	0.0%	0.0%	0.0%	4.0%	
	Major effect	0.0%	7.1%	0.0%	0.0%	2.0%	

4.3 Psychological barriers

Psychological barriers in this study refers to the barriers or physical conditions that prevented students, teachers and staff members to perform their roles to the best of their abilities. Psychological barriers can change the behavior of people by effecting human emotions by creating doubt and uncertainty, feelings of unsafety and sometimes making people feel like a situation is worse or more dangerous than it actually is. In this section we observe that when students, teachers and staff members were asked the same questions there were variations in their answers. When students were asked if their university followed proper social distancing protocol, 26.7% said 'never' and 23.1% said 'rarely' while only 11.8% answered 'always'. The highest number of those who responded negatively were from COMSATS (38.3%) followed by MIMDC (30.6%), then LUMS (18.9%) and then NUST (8.3%). In the same line when teachers were asked the same question 51.1% replied 'always' and 25.2% replied 'often' while there were none who chose 'never'. In the same line when staff members were asked the same question 58.0% answered 'always'. This shows that students had a negative perception of universities following social distancing protocol(Shahbaz et al. 2021). When students were asked about the provision of safe campus housing 33.8% answered 'never' while 20.0% answered 'rarely'. The highest number of negative responses were from COMSATS (46.7%) followed by MIMDC (35.5%), then LUMS (18.9%) and then NUST (4.6%). In the same line when students were asked about feeling safe from the virus on campus or in classroom, around 31.8% answered 'rarely', 26.7% answered 'sometimes' while 21.0% answered never and only 10.3% answered 'always'. The highest number of negative response were from MIMDC. We assume here that since MIMDC is a medical university, the medical students felt more threatened due to high exposure to the virus in their learning environment (Majeed et al. 2020). Similarly when teachers were asked the same question 32.0% replied 'sometimes' while 26.0% answered 'rarely'. This shows a similarity that students and teachers both, only felt safe rarely or sometimes while working or learning on campus or in classroom regardless if social distancing protocol was being followed or not, or if classrooms were disinfected daily or twice a day. High risk perceptions and fear create negative emotions thus leading to poor mental health and poor performance of roles and duties(M. Mumtaz 2021). Thus when students teachers and staff members were all asked about their mental health during the pandemic, there were similarities in the replies. About 44.6% students replied that the pandemic had a major effect on their mental health while 34.9% replied that it had a moderate

effect. The most effected students were from COMSATS (53.3%) followed by NUST (50.0%), then MIMDC (38.7%) and then LUMS (35.1%). Similarly when teachers were asked the same question, about 45.9% replied that their mental health was moderately effected by the pandemic while 24.7% answered that there was the pandemic had a major effect on their mental health(Sandesh et al. 2020). The most effected teachers were from COMSATS (50.0%) followed by NUST (49.0%), then MIMDC (45.5%) and the LUMS (35.7%). Similarly when staff members were asked this question 56.0% answered that the pandemic had a moderate effect while 36.0% answered that it had a major effect on their mental health. The most effected staff members were from LUMS (72.7%) followed by COMSATS (71.4%), then MIMDC (45.5%) and then NUST (35.7%). It can be conclude that students, teachers and staff members from COMSATS were under more stress as compared to other universities. Despite social distancing protocol and disinfecting of classrooms, students and teachers rarely felt safe on campus(Imran et al. 2021). LUMS performed the best with the exemption of mental health of its staff members. Students and teachers not only felt relatively safer than in other universities but their mental health was also less effected.

Table 6 Psychological Barriers

STAKE HOLDER	VARIABLE	UNIVERISTIES				TOTAL	ASYMPTOTIC SIGNIFICANCE (2-SIDED)
		LUMS	COMSATS	NUST	MIMDC		
STUDENTS	**University enforcing proper social distancing protocol**						.020
	never	18.9%	38.3%	8.3%	30.6%	26.7%	
	rarely	21.6%	28.3%	19.4%	21.0%	23.1%	
	sometimes	13.5%	15.0%	30.6%	16.1%	17.9%	
	often	35.1%	11.7%	27.8%	16.1%	20.5%	
	always	10.8%	6.7%	13.9%	16.1%	11.8%	
	students provided with safe environment on campus housing						.008
	never	18.9%	46.7%	4.6%	35.5%	33.8%	
	rarely	27.0%	15.0%	22.2%	19.4%	20.0%	
	sometimes	13.5%	21.7%	38.9%	11.3%	20.0%	
	often	21.6%	10.0%	5.6%	21.0%	14.9%	
	always	18.9%	6.7%	8.3%	12.9%	11.3%	
	feeling safe from the virus on campus or in classrooms						.000
	never	10.8%	20.0%	22.2%	27.4%	21.0%	
	rarely	16.2%	55.0%	30.6%	19.4%	31.8%	
	sometimes	40.5%	20.0%	38.9%	17.7%	26.7%	
	often	13.5%	3.3%	2.8%	19.4%	10.3%	
	always	18.9%	1.7%	5.6%	16.1%	10.3%	
	mental health affected by the pandemic	8.1%	5.0%	2.8%	8.1%	6.2%	.016

	No effect	5.4%	1.7%	0.0%	17.7%	7.2%	
	Minor effect	10.8%	1.7%	8.3%	9.7%	7.2%	
	Neutral effect	40.5%	38.3%	38.9%	25.8%	34.9%	
	Moderate effect	35.1%	53.3%	50.0%	38.7%	44.6%	
	Major effect						
TEACHERS	**University enforcing proper social distancing protocol**						.067
	never	0.0%	0.0%	0.0%	0.0%	0.0%	
	rarely	3.6%	8.3%	12.2%	4.5%	8.1%	
	sometimes	14.3%	22.2%	12.2%	13.6%	15.6%	
	often	39.3%	8.3%	20.4%	45.5%	25.2%	
	always	42.9%	61.1%	55.1%	36.4%	51.1%	
	Effect of social distancing on teaching						.990
	No effect	32.1%	30.6%	34.7%	27.3%	31.9%	
	Minor effect	25.0%	30.6%	26.5%	27.3%	27.4%	
	Neutral effect	25.0%	22.2%	24.5%	27.3%	24.4%	
	Moderate effect	14.3%	11.1%	8.2%	18.2%	11.9%	
	Major effect	3.6%	5.6%	6.1%	0.0%	4.4%	
	feeling safe working in the university during the pandemic						.440
	never	18.2%	35.7%	14.3%	0.0%	18.0%	
	rarely	18.2%	28.6%	28.6%	27.3%	26.0%	
	sometimes	36.4%	28.6%	35.7%	27.3%	32.0%	
	often	27.3%	7.1%	21.4%	45.5%	24.0%	
	always	0.0%	0.0%	0.0%	0.0%	0.0%	
	mental health affected by the pandemic						.011
	No effect	0.0%	0.0%	0.0%	0.0%	0.0%	
	Minor effect	25.0%	0.0%	8.2%	27.3%	12.6%	
	Neutral effect	21.4%	11.1%	10.2%	18.2%	14.1%	
	Moderate effect	35.7%	50.0%	49.0%	45.5%	45.9%	
	Major effect	17.9%	38.9%	32.7%	9.1%	27.4%	
STAFF	**University enforcing proper social distancing protocol**						.226
	never	0.0%	0.0%	0.0%	0.0%	0.0%	
	rarely	9.1%	0.0%	14.3%	0.0%	12.0%	
	sometimes	27.3%	35.7%	21.4%	9.1%	22.0%	
	often	27.3%	14.3%	0.0%	9.1%	8.0%	
	always	36.4%	50.0%	64.3%	81.8%	58.0%	
	disinfecting classrooms and labs regularly						.285
	never	0.0%	0.0%	0.0%	0.0%	0.0%	
	rarely	0.0%	0.0%	0.0%	0.0%	0.0%	
	sometimes	0.0%	0.0%	0.0%	0.0%	0.0%	
	often	45.5%	64.3%	57.1%	27.3%	50.0%	
	always	54.5%	35.7%	42.9%	72.7%	50.0%	
	mental health affected by the pandemic						.414
	No effect	0.0%	0.0%	0.0%	0.0%	0.0%	
	Minor effect	0.0%	0.0%	0.0%	0.0%	0.0%	
	Neutral effect	0.0%	7.1%	14.3%	9.1%	8.0%	
	Moderate effect	72.7%	71.4%	35.7%	45.5%	56.0%	
	Major effect	27.3%	21.4%	50.0%	45.5%	36.0%	

4.4 Barriers to coordination and interactions

Coordination in this study refers to the process of organizing people or groups so that they work and perform tasks that contribute to the sustainability of the operation of an entire system, in this case the system is education. Interactions in this study refers to the way students teachers and staff members communicate and coordinate to perform certain tasks. Interactions enable coordination and vice versa. In this section we will observe how coordination and interactions were limited due to the lockdown and which stakeholder was most affected by it. When students were asked about their ability to interact with other students during the lockdown a vast majority of 59.0% answered 'rarely'. The highest were from NUST (77.8%) followed by COMSATS (63.3%), then MIMDC (51.6%) and then LUMS (45.9%).similarly when teachers were asked about their ability to coordinate with students, 49.6% answered 'rarely' while 25.9% answered 'sometimes'. The most compromised coordination between students and teachers was from COMSATS (66.7%) followed by NUST (53.1%), then LUMS (39.3%) and then MIMDC (27.3%)(Adnan 2020). In contrast to this when teachers were asked about their ability to coordinate with other teachers and members of the academia the answers were completely different. Around 55.6% of the total teachers from all universities said that they were 'often' able to coordinate with other teachers, the highest from MIMDC (59.1%) followed by LUMS (57.1%), then NUST (57.1%) and then COMSATS (50.0%). Similarly when the administrative staff was asked about their ability to coordinate with student and teachers the answers were quite different. Around 40.0% of the staff from all universities replied that they were only able to contact students 'sometimes'. The least able to contact students were staff members from MIMDC (54.5%) followed by LUMS (36.4%), then COMSATS (35.7%) and then NUST (35.7%). In contrast to this when they were asked about their ability to contact teachers and members of the academic staff then around 56.0% replied that they were 'often' or always (28.0%) able to coordinate with teachers. The highest coordination was observed in COMSATS (71.4%) followed by LUMS (54.5%), then NUST (50.0%) and then MIMDC (45.5%).

These results indicate that interactions among students and the ability to coordinate with students was compromised at all levels(Zheng, Khan, and Hussain 2020). Students were rarely able to interact with peers during the lockdown and in DL mode. Teachers who were able to coordinate with other teachers were also unable to interact with students during DL mode. Similarly administrative staff also found it hard to coordinate with students as compared to teachers and members of the academic staff(U. R. Khan, Khan, and Arbab 2021). This means that students did not have the necessary tools or connections to sustain these coordination and interactions or there was some other factors that prevented their interactions. Moreover when teachers were asked that if reducing class density would help increase interaction with students then 47.4% strongly agreed to the notion(Shah 2021). The highest number of teachers that agreed to this were

from COMSATS (66.7%) followed by NUST (49.0%), then MIMDC (40.9%) and then LUMS (25.0%). This was largely due to the fact that teachers were unable to deliver lectures properly or interact with students through DL mode. This is extremely important for medical students because their learning requires more one-on-one interaction between teachers and students(Sharif et al. 2020).

Table 7 Barriers to Coordination and Interaction

STAKE HOLDER	VARIABLE	UNIVERISTIES				TOTAL	ASYMPTOTIC SIGNIFICANCE (2-SIDED)
		LUMS	COMSATS	NUST	MIMDC		
STUDENTS	interact with other students						.029
	never	0.0%	3.3%	0.0%	6.5%	3.1%	
	rarely	45.9%	63.3%	77.8%	51.6%	59.0%	
	sometimes	27.0%	21.7%	8.3%	27.4%	22.1%	
	often	10.8%	8.3%	13.9%	8.1%	9.7%	
	always	16.2%	3.3%	0.0%	6.5%	6.2%	
TEACHERS	able to coordinate with other teachers during the pandemic						.937
	never	0.0%	0.0%	0.0%	0.0%	0.0%	
	rarely	7.1%	2.8%	4.1%	9.1%	5.2%	
	sometimes	25.0%	38.9%	28.6%	27.3%	30.4%	
	often	57.1%	50.0%	57.1%	59.1%	55.6%	
	always	10.7%	8.3%	10.2%	4.5%	8.9%	
	ability to interact with students properly in DL mode						.000
	never	3.6%	11.1%	22.4%	0.0%	11.9%	
	rarely	39.3%	66.7%	53.1%	27.3%	49.6%	
	sometimes	32.1%	19.4%	20.4%	40.9%	25.9%	
	often	25.0%	2.8%	4.1%	27.3%	11.9%	
	always	0.0%	0.0%	0.0%	4.5%	0.7%	
	deliver lectures properly during DL mode						.013
	never	0.0%	0.0%	0.0%	0.0%	0.0%	
	rarely	7.1%	25.0%	30.6%	0.0%	19.3%	
	sometimes	32.1%	41.7%	34.7%	45.5%	37.8%	
	often	42.9%	25.0%	24.5%	54.5%	33.3%	
	always	17.9%	8.3%	10.2%	0.0%	9.6%	
	reducing class density to aid interaction between students and teachers						.051
	strongly disagree	0.0%	5.6%	4.1%	4.5%	3.7%	
	somewhat disagree	0.0%	2.8%	6.1%	4.5%	3.7%	
	neutral	17.9%	2.8%	6.1%	18.2%	9.6%	
	somewhat agree	57.1%	22.2%	34.7%	31.8%	35.6%	
	strongly agree	25.0%	66.7%	49.0%	40.9%	47.4%	
STAFF	ability to coordinate with the academic staff easily during DL mode	0.0%	0.0%	0.0%	0.0%	0.0%	.878

never	0.0%	0.0%	0.0%	0.0%	0.0%	
rarely	18.2%	7.1%	21.4%	18.2%	16.0%	
sometimes	54.5%	71.4%	50.0%	45.5%	56.0%	
often	27.3%	21.4%	28.6%	36.4%	28.0%	
always						
ability to contact students easily when classes were being conducted online						.712
never	0.0%	0.0%	0.0%	0.0%	0.0%	
rarely	36.4%	14.3%	14.3%	18.2%	20.0%	
sometimes	36.4%	35.7%	35.7%	54.5%	40.0%	
often	27.3%	35.7%	42.9%	27.3%	34.0%	
always	0.0%	14.3%	7.1%	0.0%	6.0%	

4.5 Barriers to mobility and accessibility

Mobility in this study refers to the act of moving physically in a space. Accessibility in this study refers to the ease of access or obtainability or availability of certain activities or spaces. Mobility and accessibility are at the very core of sustainable learning at higher educational institutions. Without the ability to move physically students are unable to use workshops, labs or any other facility available on campus. The lesser the ease of access the lesser mobility on campus. In this section we observe how different facilities were effected and how students were restricted from availing different services. We also try to understand the opinion of teachers and staff about how mobility could have been enhanced. When students were asked about the effect of the pandemic on university sports and their ability to take part in sports then 66.7% of the total students from all universities agreed that it had a major effect on sports. The highest was from MIMDC (69.4%) followed by COMSATS (68.3%), then LUMS (67.6%) and then NUST (58.3%). Looking back at the situation we can confirm these statistics since the pandemic was so widely spread that allowing students to gather in one place and play sports would have only lead to further outbreaks of COVID in the universities(Mohey-Ud-Din, Ullah, and ... 2021). When students were asked about their access to labs and workshops and finish their work on time then a vast majority agreed that it was very rare since the pandemic limited their access. Around 32.8% of the total students answered that it only happened 'sometimes' while 19.5% said 'rarely' and 24.6% answered 'never'. The highest responses of 'never' were from COMSATS (33.3%) followed by LUMS (21.6%), then MIMDC (21.0%) and then NUST (19.4%). The highest responses of 'sometimes' were from NUST (41.7%) followed by COMSATS (35.0%), then LUMS (32.4%) and then MIMDC (25.8%). These statistics tell us why students must have more pessimistic feelings about their grades in the earlier sections(N. Mumtaz, Saqulain, and Mumtaz 2021). Furthermore when the administrative staff was asked about the utilization of classrooms, workshops and laboratories while the university was open during the pandemic then 80.0% of the total staff from all universities agreed that they were 'always' utilized properly. The highest were from NUST (92.9%) followed by MIMDC (81.8%), then

COMSATS (78.6%) and LUMS (63.6%). This dissimilarity in their answers points towards the fact that even though classrooms and labs were open and being utilized, not all students were able to utilize them properly according to their own ease which in turn prevented them to finish their work on time(Masud et al. 2021). Similarly when students were asked about their ability to use cafeteria and other services provided on campus then majority agreed on 'sometimes'. The highest were from COMSATS (46.7%) followed by LUMS (37.8%), then NUST (25.0%) and then MIMDC (19.4%). Moreover, when students were asked about the effect of the pandemic on their mobility on campus then 25.1% answered that it had a moderate effect while 38.5% answered that it had major effect on mobility. The most effected mobility was in NUST (47.2%) followed by LUMS (45.9%), then COMSATS (40.0%) and then MIMDC (27.4%). We think this is because NUST and LUMS allowed higher mobility before the pandemic and students felt more restricted after the pandemic when they were unable to move on campus. These statistics help us conclude that mobility was mostly restricted in all campuses and while classrooms, labs and workshops were open and disinfected regularly, students were unable to access them with ease(Ruqia et al. 2021).

Table 8 Barriers to mobility and accessibility

STAKE HOLDER	VARIABLE	UNIVERISTIES				TOTAL	ASYMPTOTIC SIGNIFICANCE (2-SIDED)
		LUMS	COMSATS	NUST	MIMDC		
STUDENTS	**Effect on university sports**						.678
	No effect	2.7%	5.0%	5.6%	12.9%	7.2%	
	Minor effect	2.7%	3.3%	2.8%	3.2%	3.1%	
	Neutral effect	8.1%	6.7%	11.1%	6.5%	7.7%	
	Moderate effect	18.9%	16.7%	22.2%	8.1%	15.4%	
	Major effect	67.6%	68.3%	58.3%	69.4%	66.7%	
	able to take lab work and workshops and finish work on time						.006
	never	21.6%	33.3%	19.4%	21.0%	24.6%	
	rarely	27.0%	25.0%	13.9%	12.9%	19.5%	
	sometimes	32.4%	35.0%	41.7%	25.8%	32.8%	
	often	18.9%	6.7%	22.2%	30.6%	19.5%	
	always	0.0%	0.0%	2.8%	9.7%	3.6%	
	Effect on mobility on campus						.014
	No effect	13.5%	1.7%	8.3%	21.0%	11.3%	
	Minor effect	5.4%	21.7%	8.3%	12.9%	13.3%	
	Neutral effect	10.8%	5.0%	13.9%	17.7%	11.8%	
	Moderate effect	24.3%	31.7%	22.2%	21.0%	25.1%	
	Major effect	45.9%	40.0%	47.2%	27.4%	38.5%	
	ability to use cafeteria and other services provided on campus						.069
	never	10.8%	10.0%	8.3%	25.8%	14.9%	
	rarely	13.5%	11.7%	13.9%	17.7%	14.4%	
	sometimes	37.8%	46.7%	25.0%	19.4%	32.3%	
	often	24.3%	18.3%	27.8%	17.7%	21.0%	
	always	13.5%	13.3%	25.0%	19.4%	17.4%	

TEACHERS	**change in design of classrooms and labs to revitalize learning spaces and make them safer**						.007
	strongly disagree	3.6%	16.7%	14.3%	0.0%	10.4%	
	somewhat disagree	53.6%	36.1%	34.7%	9.1%	34.8%	
	neutral	7.1%	19.4%	32.7%	31.8%	23.7%	
	somewhat agree	21.4%	16.7%	12.2%	31.8%	18.5%	
	strongly agree	14.3%	11.1%	6.1%	27.3%	12.6%	
STAFF	**utilization of classrooms and labs while the university was open**						.344
	never	0.0%	0.0%	0.0%	0.0%	0.0%	
	rarely	0.0%	0.0%	0.0%	0.0%	0.0%	
	sometimes	0.0%	0.0%	0.0%	0.0%	0.0%	
	often	36.4%	21.4%	7.1%	18.2%	20.0%	
	always	63.6%	78.6%	92.9%	81.8%	80.0%	
	need for more space in the office post pandemic						.440
	No effect	90.9%	78.6%	64.3%	81.8%	78.0%	
	Minor effect	9.1%	21.4%	35.7%	18.2%	22.0%	
	Neutral effect	0.0%	0.0%	0.0%	0.0%	0.0%	
	Moderate effect	0.0%	0.0%	0.0%	0.0%	0.0%	
	Major effect	0.0%	0.0%	0.0%	0.0%	0.0%	

4.6 Barriers to performance

Barriers to performance in this study refers to the variables and factors that acted as hurdles to the process of carrying out and accomplishing actions and tasks to the successful and sustainable functioning of the educational process. These barriers can be economic, social and physical in nature. All stakeholders of the universities (students, teachers and staff members) faced several barriers to their performance. Some were more effected than others. Students remain to be the most effected of all stakeholders in each section. In this section we observe that when students were asked about receiving training workshops to enter into the distant learning programs after lockdown, a majority of 91.8% answered that they didn't(Saaiq and Ullah 2021). The highest responses of not receiving any workshops were from NUST (94.4%) followed by COMSATS (93.3%), then LUMS (91.9%) and then MIMDC (88.7%). This was probably the first setback that decreased the performance and efficiency of students in DL mode(Aqsa Arshad, Madiha Afzal, and Dr. Muhammad Sabboor Hussain 2020). Similarly when teachers were asked the same question, around 76.3% answered that they did in fact receive training workshops that helped them enter the distant learning process. This difference tells us that teachers were accommodated and their performance was less effected than those of the students. This was a huge hindrance for a smooth transition and greatly affected the quality of education (Rafique et al. 2021). In addition, students who did not have laptops or computers at home, took exams on their phones and those with poor internet access or no internet access, suffered the most. In

the survey, when students were asked about the availability of services that would allowed them to borrow laptops and devices from university departments then a majority of 75.4% said that there were no such services available to them. The highest responses of 'never' were from MIMDC (87.1%) followed by NUST (80.6%), then COMSATS (68.3%) and then LUMS (62.2%). We believe that this difference exists because some departments in COMSATS and LUMS did have this service while most of them did not. Similarly when teachers were asked if they were provided with digital tools to participate in the distant learning mode then a vast majority of 76.3% agreed. The provision of ICT infrastructure is crucial to sustain a learning program, without it participant are unable to perform or take part in the learning process. While teachers were accommodated in this regard, students weren't(Wohlfart, Trumler, and Wagner 2021). Furthermore when students were asked about having their own laptops and good internet access to participate in the DL mode of learning then only 50.8% had laptops while only 28.2% always had good internet access. Having internet access on any device at all times is the backbone of distant learning (Hamburg 2021)and this was one of the biggest challenge for those from marginalized groups since, they could not afford laptops and digital tools or had internet coverage in their residential areas. Similarly when teachers were asked if they had good internet connection while participating in the DL mode then 64.4% said 'always' while 22.2% said 'often'. This value was highest in NUST (73.5%) closely followed by LUMS (75.0%) then COMSATS (61.1%) and then MIMDC (36.4%). From these values we can conclude that teachers had laptops and digital tools, as well as good internet access therefore their performance was less affected as compared to the performance of students(Wahid et al. 2020). Furthermore when the administrative staff were asked about the effect of the pandemic on their performance, then about 50.0% agreed that it had major effect on their performance while 30.0% said it had a moderate effect. Comparing this to the attendance of staff shows that despite the effect of the pandemic on their performance 60-80% staff was always on attendance in all universities, the highest starting from MIMDC (72.7%) followed by LUMS (63.6%), then NUST (57.1%) and then COMSATS (57.1%). From this section we conclude, that students faced the most barriers of performance as compared to teachers and staff members. They did not have the proper ICT infrastructure or tools to participate in the DL mode and had no prior training to enter the learning program.

Table 9 Barriers to performance

STAKE HOLDER	VARIABLE	UNIVERISTIES				TOTAL	ASYMPTOTIC SIGNIFICANCE (2-SIDED)
		LUMS	COMSATS	NUST	MIMDC		
STUDENTS	training or workshop that helped enter DL mode Yes No	8.1% 91.9%	6.7% 93.3%	5.6% 94.4%	11.3% 88.7%	8.2% 91.8%	.727
	facilities that allowed to borrow laptops or other devices from the university never rarely sometimes often always	62.2% 8.1% 13.5% 10.8% 5.4%	68.3% 0.0% 8.3% 13.3% 10.0%	80.6% 11.1% 8.3% 0.0% 0.0%	87.1% 3.2% 3.2% 1.6% 4.8%	75.4% 4.6% 7.7% 6.7% 5.6%	.008
	having laptops and digital tools to participate in DL(Distant learning) never rarely sometimes often always	10.8% 0.0% 2.7% 27.0% 59.5%	6.7% 1.7% 3.3% 36.7% 51.7%	8.3% 0.0% 8.3% 33.3% 50.0%	9.7% 8.1% 17.7% 19.4% 45.2%	8.7% 3.1% 8.7% 28.7% 50.8%	.038
	good internet access that allowed participation in DL never rarely sometimes often always	8.1% 8.1% 10.8% 37.8% 35.1%	8.3% 6.7% 28.3% 26.7% 30.0%	0.0% 11.1% 16.7% 33.3% 38.9%	19.4% 11.3% 29.0% 24.2% 16.1%	10.3% 9.2% 23.1% 29.2% 28.2%	.039
TEACHERS	provision of equipment and digital tools by the university to take part in DL mode Yes No	85.7% 14.3%	75.0% 25.0%	77.6% 22.4%	63.6% 36.4%	76.3% 23.7%	.334
	free internet provided by the university to participate and teach during DL mode never rarely sometimes often always	0.0% 0.0% 10.7% 14.3% 75.0%	0.0% 0.0% 25.0% 13.9% 61.1%	0.0% 0.0% 6.1% 20.4% 73.5%	0.0% 0.0% 13.6% 50.0% 36.4%	0.0% 0.0% 13.3% 22.2% 64.4%	.004
	periodic workshops by the university that helped teachers						.028

	transition into DL mode	28.6%	36.1%	42.9%	36.4%	37.0%	
	never	46.4%	50.0%	38.8%	36.4%	43.0%	
	rarely	25.0%	13.9%	18.4%	13.6%	17.8%	
	sometimes	0.0%	0.0%	0.0%	13.6%	2.2%	
	often	0.0%	0.0%	0.0%	0.0%	0.0%	
	always						
STAFF	**Effect on staff performance**						.895
	No effect	0.0%	0.0%	0.0%	0.0%	0.0%	
	Minor effect	0.0%	0.0%	0.0%	0.0%	0.0%	
	Neutral effect	18.2%	21.4%	7.1%	18.2%	16.0%	
	Moderate effect	36.4%	21.4%	28.6%	36.4%	30.0%	
	Major effect	45.5%	57.1%	64.3%	45.5%	54.0%	
	percent of staff on regular attendance						.552
	20%-40%	0.0%	0.0%	0.0%	0.0%	0.0%	
	40%-60%	9.1%	14.3%	28.6%	0.0%	14.0%	
	60%-80%	63.6%	57.1%	57.1%	72.7%	62.0%	
	80%-100%	27.3%	28.6%	14.3%	27.3%	24.0%	

4.7 Financial barriers

Financial barriers in this study refers to the variables that act as hurdles for students, teachers and staff members to properly perform their duties and tasks in the educational system due to low availability of resources and funds. Lesser the financial stability higher are the changes of dropping out of university. It is no doubt that distant learning has proven itself to be a very vital solution to continue education in the advent of a pandemic however, it is extremely difficult in developing countries like Pakistan with highly disadvantaged social groups. When students were asked about meeting financial problems during the lockdown then 35.9% replied that they 'sometimes' did face such problems(Aristovnik et al. 2020). When they were asked about provision of financial assistance from universities then a vast majority of 84.1% answered 'never'. The highest responses of this answer came from MIMDC (91.9%) followed by COMSATS (90.0%) then LUMS (73.0%) and then NUST (72.2%). Moreover when they were asked if the university had reduced any fee from the fee structure to accommodate learners during the lockdowns then 94.4% of the total students from all universities replied that there was no reduction in their university fees. The highest number of responses of this answer were from NUST (97.2%) followed by MIMDC (95.2%), then COMSATS (95.0%) and then LUMS (89.2%). We come to the conclusion that students did face financial hurdles sometimes but they were not accommodated by the university in any manner(Radina and Balakina 2021). When the administrative staff was asked about financial compensations or relief given to students during the pandemic, then 48.0% said that students were 'rarely' compensated by the university. The ability to meet financial deadlines effects the enrollment as well as dropout rate of a university. When the administrative staff was asked about the dropout rate in the university, 40.0% said that it was 'neutral' and 54.0% said it was relatively low. When they were asked about the enrollment rate 50.0% said it was

relatively low while 42.0% said that it remained neutral. We come to the conclusion that though dropout rate was not high in these universities, enrolment rate did remain low during the pandemic(Jacobo-Galicia, Máynez Guaderrama, and Cavazos-Arroyo 2021). Students who were already in the university did not wanted to stop continuing their education but students who were supposed to join universities opted to wait out the pandemic. Similarly when teachers were asked about meeting getting compensations from the university in case of contracting the virus, around 23.7% said that they were 'often' compensated while 21.5% said that they were always compensated. The highest value of positive responses came from LUMS (42.9%) followed by NUST (18.4%), then MIMDC (18.2%) and then COMSATS (11.1%). In the same line when staff members were asked about being financially compensated when they had contracted the virus then, 48.0% said that it only happened 'sometimes' while 24.0% said that they were 'rarely' compensated. This shows that students remained the most effected in terms of financial issues followed by staff members, while teachers were least effected in terms of financial barriers.

Table 10 Financial Barriers

STAKE HOLDER	VARIABLE	UNIVERISTIES				TOTAL	ASYMPTOTIC SIGNIFICANCE (2-SIDED)
		LUMS	COMSATS	NUST	MIMDC		
STUDENTS	**students meeting financial problems during the pandemic**						.003
	never	21.6%	38.3%	5.6%	38.7%	29.2%	
	rarely	13.5%	26.7%	30.6%	12.9%	20.5%	
	sometimes	54.1%	25.0%	47.2%	29.0%	35.9%	
	often	2.7%	6.7%	8.3%	14.5%	8.7%	
	always	8.1%	3.3%	8.3%	4.8%	5.6%	
	provision of financial assistance from the university during the pandemic						.001
	never	73.0%	90.0%	72.2%	91.9%	84.1%	
	rarely	10.8%	8.3%	27.8%	1.6%	10.3%	
	sometimes	8.1%	1.7%	0.0%	3.2%	3.1%	
	often	0.0%	0.0%	0.0%	1.6%	3.1%	
	always	8.1%	0.0%	0.0%	1.6%	0.5%	
	Reduction in university fee	89.2%	95.0%	97.2%	95.2%	94.4%	.214
	No effect	10.8%	1.7%	2.8%	3.2%	4.1%	
	Minor effect	0.0%	0.0%	0.0%	1.6%	0.5%	
	Neutral effect	0.0%	0.0%	0.0%	0.0%	0.0%	
	Moderate effect	0.0%	3.3%	0.0%	0.0%	1.0%	
	Major effect						
TEACHERS	**paid leave or financial compensations by the university for academia who contracted the virus**	10.7%	5.6%	2.0%	22.7%	8.1%	.003
		7.1%	27.8%	34.7%	13.6%	23.7%	
	never	10.7%	36.1%	18.4%	27.3%	23.0%	
	rarely	7.1%	19.4%	26.5%	18.2%	23.7%	

	sometimes	42.9%	11.1%	18.4%	18.2%	21.5%	
	often						
	always						
STAFF	**paid leaves or any financial compensations for staff members who contracted the virus**						.562
	never	0.0%	14.3%	7.1%	0.0%	6.0%	
	rarely	27.3%	7.1%	35.7%	27.3%	24.0%	
	sometimes	54.5%	57.1%	42.9%	36.4%	48.0%	
	often	18.2%	21.4%	14.3%	36.4%	22.0%	
	always	0.0%	0.0%	0.0%	0.0%	0.0%	
	university providing needy students with financial assistance or relief during the pandemic						.266
	never	18.2%	28.6%	21.4%	54.5%	30.0%	
	rarely	72.7%	28.6%	57.1%	36.4%	48.0%	
	sometimes	9.1%	28.6%	14.3%	9.1%	16.0%	
	often	0.0%	14.3%	7.1%	0.0%	6.0%	
	always	0.0%	0.0%	0.0%	0.0%	0.0%	
	the dropout rate mid semester from your university since the pandemic						.320
	Low	0.0%	0.0%	0.0%	0.0%	0.0%	
	Somewhat	63.6%	35.7%	71.4%	45.5%	54.0%	
	Neutral	27.3%	64.3%	21.4%	45.5%	40.0%	
	Moderate	9.1%	0.0%	7.1%	9.1%	6.0%	
	High	0.0%	0.0%	0.0%	0.0%	0.0%	
	Drop in enrolment rate						.374
	Low	0.0%	0.0%	14.3%	0.0%	4.0%	
	Somewhat	54.5%	57.1%	50.0%	36.4%	50.0%	
	Neutral	36.4%	42.9%	28.6%	63.6%	42.0%	
	Moderate	9.1%	0.0%	7.1%	0.0%	4.0%	
	High	0.0%	0.0%	0.0%	0.0%	0.0%	
	effect on departmental budget						.278
	Low	45.5%	57.1%	21.4%	27.3%	38.0%	
	Somewhat	45.5%	21.4%	50.0%	63.6%	44.0%	
	Neutral	9.1%	21.4%	28.6%	9.1%	18.0%	
	Moderate	0.0%	0.0%	0.0%	0.0%	0.0%	
	High	0.0%	0.0%	0.0%	0.0%	0.0%	

4.8 Strategies to revitalize higher educational

The population from which the data is derived is mainly in Pakistan. The literature that was examined in the content analysis also focused on the post COVID-19 developments in learning spaces and the SOP's of COVID-19 for universities followed in Pakistan. The experts that took part in the interviews were from the field of academia, policy making (in education sector), construction, urban planning and architecture. These fields were deliberately selected because of their close relation to learning spaces, higher education institutes and the social and physical

aspects dictating life in universities(Batubara 2021). A large majority of these experts were males (70.0%) while only 30.0% were females. This is because majority of the high offices are occupied by males in these fields of study. The age group of experts was also mainly between the ages of 40-50 (57.0%), with only 28.0% were above 50 and only 13.0% between the age of 20-30. The following image presents a profile of the experts that took part in the structured interview which was used in the content analysis along with other text documents.
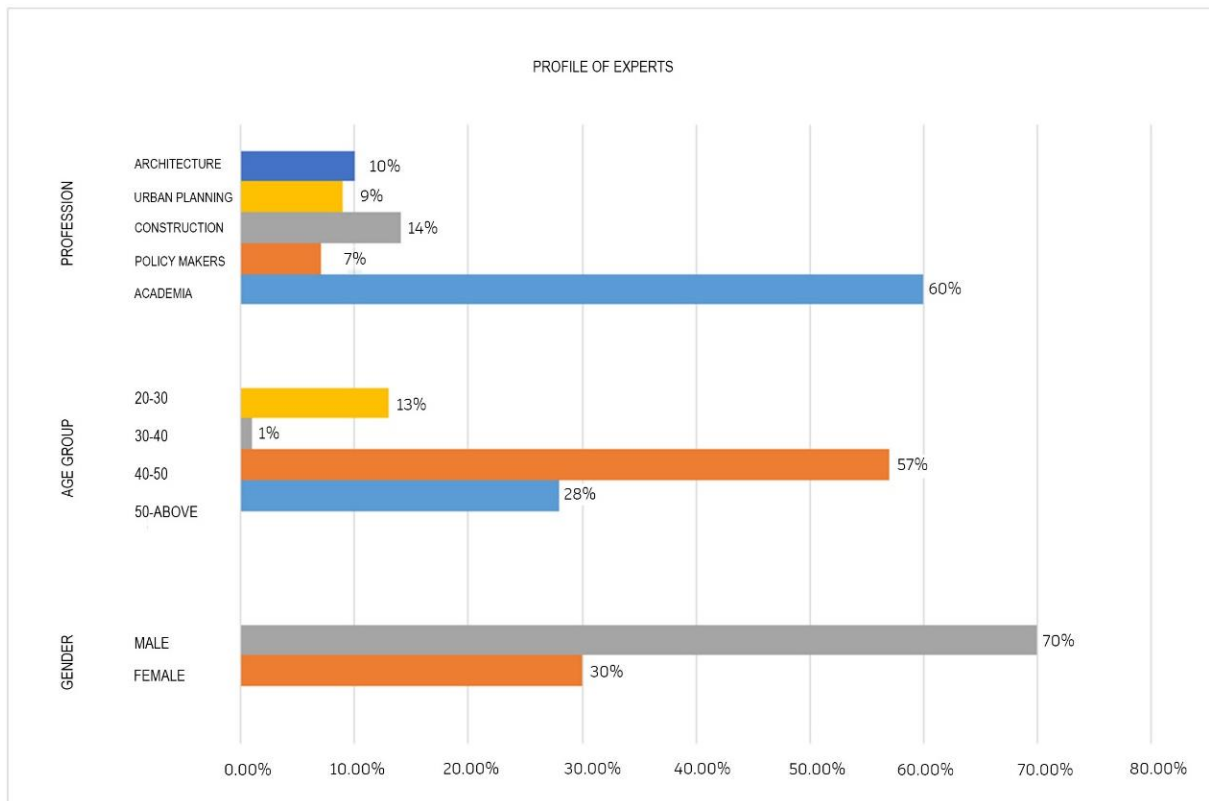
Figure 3 profile of the experts

4.9 Areas of design intervention

In this study content analysis is used to study documents and communicative text forms which were in various formats such audios and video. The analysis helped us to observe the patterns in communication into a replicable and systematic manner(Elo and Kyngäs 2008). This is one of the advantages of using this type of analysis in this study as it helps evaluate the various social aspects effecting learning spaces in the post COVID-19 environment in a non-intrusive nature, in contrast

to artificially simulating a social experiment to collect the data. In this content analysis systematic readings of texts and artifacts was made in which labels called codes were assigned to meaningful pieces of the content. This in turn helped label the content into sets of texts to analyze repeated patterns, themes and meanings(Kleinheksel et al. 2020). The first task achieved in this content analysis was the consideration of unambiguous characteristics in the texts through a word frequency diagram. Although this might be limited but the word frequency diagram helps us find important words, the ones that are most repeated and the place of words in their textual context. It also helped us remove uncertainties such as those introduced by synonyms and homonyms(Brysbaert, Mandera, and Keuleers 2018). It is important to mention that word frequency is the quantification of the qualitative data presenting the count of words and the number of times they appear. Despite this, the word frequency diagram is a good starting point to understand and trigger questions like, *why do these words or phrases appear more in the documents?*

Figure 4 Word frequency diagram

We already know that content analysis helps process data by arranging it into groups or clusters on the basis of their closeness or association. Similarly in this study variables were not partitioned beforehand into subsets. The analysis enabled us to find groups of subjects where similarity between each pair showed some resemblance in the whole set of subjects. Since content analysis is a learning algorithm, it is never possible to know how many clusters are present in the data set before the analysis is performed(Vaismoradi and Snelgrove 2019). In this study cluster diagram helped develop a simpler classification of the data. Subjects were divided into groups such as each subject was more similar to the other subjects in its group rather than those outside the group. The cluster diagram seen below provides information regarding the relationship between different subjects in the study. The subjects are then automatically classified into groups, some groups have more subjects than others. For example subjects such as 'technology' 'future' and 'virtual' have commonalties with 'learning' and 'pandemic' however they have more similarities with other subjects under IT and are thus classified in one group. Similarly 'geometry' has relations to 'social' and 'distancing' however it has more similarities with other subjects in the design group. These groups are important as they help categorize variable and identify key areas of concern in the study. For the purpose of this study these groups are areas that require focus while making design decisions and modifications to spaces inside higher educational institutions(Serafini and Reid 2019).
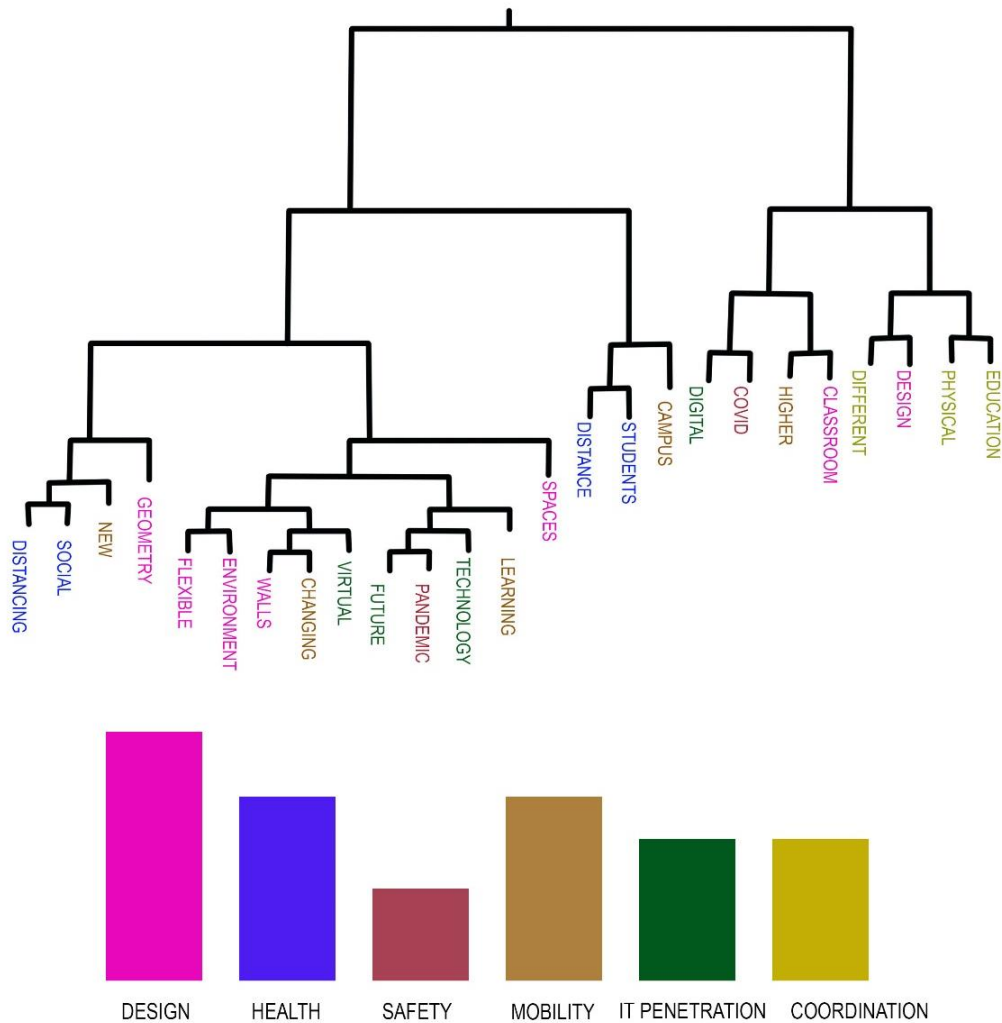
Figure 5 Key areas of design intervention

4.10 Modifications to the design of higher education spaces

4.10.1 The architecture of learning spaces

The content analysis gave valuable insight on the architecture of learning spaces. It showed that physical spaces and their design is critical to the learning paradigm in the post COVID scenario. When experts and stakeholders were asked if making classrooms smaller and decreasing class density would encourage interactions between students and teachers, an overwhelming majority agreed(Su et al. 2021). One expert from the architecture profession said, "*Probably the*

curriculums needs to be designed in a way that it encourages new technology aiding the pupil and the tutor conduct their academic interactions/activities in a virtual/semi virtual environment. E.g. a typical 30 X 40 classroom may or may not become a 4X4 personal, pop up, tech enabled cardboard box open-able in some place like a lush green park or some noisy spice market or a cozy coffee shop. Who knows this pandemic might be an instigator of change in the ways we learn and the content we get to learn in the higher education institutions." Similarly other experts also presented some bold ideas about changing learning spaces in the post COVID scenario. Some of these ideas included reducing class density, changing class geometry or assigning seating in specific environments or adding transparent vertical screens as divisions especially in labs or where minimum interaction is required(Zhang et al. 2020). Vertical screens are also recommended in large open spaces and seminar halls which could be repurposed into new classrooms according to the density of people occupying the space. One expert from the construction industry said, "*Moveable walls, like in old Japanese homes, every space is flexible*." This sort of a flexibility will make a room into a multipurpose space. These sort of spaces lend themselves to a variety of activities depending on the density of users and the type of learning. It could be a community group discussion room, a conference room or a presentation or performance area(Byun 2020). Since furniture is the core element used in lecture rooms and classes, it is of utmost importance. Flexible and modular furniture gives users power to change, move and reconfigure(Ali, Khamis, and Fahmy 2020). It will allow students and educators to easily distance themselves from one another when needed. In the opinion of one expert, *"Modular formation in terms of furniture for on campus session with distance protocols along with distance learning, online zoom sessions and e books would become a new norm for education in universities post pandemic."*
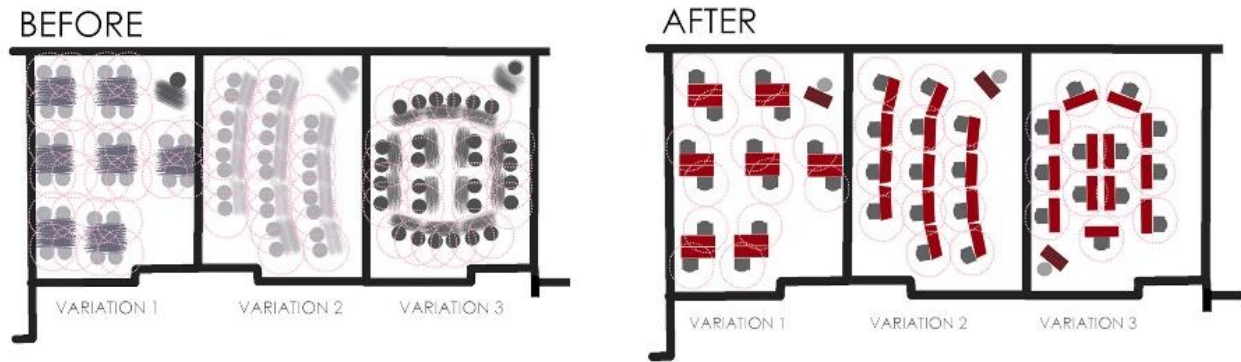
Figure 6 Changes necessary in the new learning space aligned with the expert suggestions

4.10.2 A holistic approach to mental and physical health and safety

Since the pandemic started there has been an urgency to return to life as it was however, that has simply not been completely possible due to mutations in the corona virus, new diseases, global inflation and major events of climate change. Engagement and creativity in learning spaces cannot be reignited and accelerated without remodeling our learning spaces for the well-being of people and making them responsive in times of disruptions(Hughes and Morrison 2020). Covid-19 has presented us with the opportunity to reinvent learning spaces and make them adaptable based on new conditions or for the next pandemic. This means that planning paradigms need to shift from cost and density to flexibility and safety, thus being more fluid and less permanent. In the expert survey when professionals were asked about their opinion on germ repellant surfaces or the use of new materials, many were favor of using germ repellant surfaces like cork, linoleum and copper in educational space(Incekara 2021). In their opinion materials that allow cleaning and disinfecting without degrading overtime should become the new standard. Some experts said that we should use smooth surfaces that are easy to clean and use protective coating or use furniture made from materials that do not degrade quickly(LECTRA 2020). Experts also agreed that universities ought to have a special pandemic response team and isolation center. These response teams will also control various sensors that will measure different aspects of well-being, possibly behavior and actions that indicate illness. One expert from the construction profession said, *"In my opinion implementing hands free experiences wherever possible, such as leaving doors open or door free rooms or opening sensors, automatic lighting based on occupancy or voice activated occupancy should be the new norm in universities. University campuses are going to be much more related to the medical suggestions in post pandemic time."* Contact tracing is another major strategy

that ought to be applied on campuses(O'Connell and O'Keeffe 2021). Should someone become ill, smart phone technology, linked to university serves can anonymously communicate this to those who were near the ill person and suggest them to get tested or self-isolate. Experts also agreed that since on campus housing and commute was also effected by the corona virus, UV disinfecting lighting should be incorporated into campus housing(Kleinman and Merkel 2020). In this regard an expert from the policy making profession said, *"Health screening machines and illness protocols should be made mandatory in universities and similar protocols should be in place when returning to campus. Also there should be less physical interactions, perhaps overhead sprinklers for sanitization after every class, allotted seats for students for the entire semester, glass partitions where necessary and a hybrid learning system, better ventilation, and more open spaces."*

Figure 7 AI software Midjourney generated image showing a holistic learning space

The images above are a product of AI based software called Midjourney which uses texual descriptions to generate images. The words used to generate these images were from the word frequency diagram and cluster diagram obtained in the content analysis. The specefic prompt used in Midjourney was "post COVID design of architectural spaces in universities, higher education physical learning social distancing new geometry student environment flexible walls online classroom virtual technology changing spaces digital future campus life". If we look closely at the images (figure 5), the structural frame shown on the left shows an open layout with lots of frames in between which we assume could be flexible or moveable in design depending on the density of

people present in the lecture room or hall. The use of skylights is also an important element because it allows the flow of natural light and air for ventilation into the building in at all times. Moreover the right most section shows some trees and plants in the background behind the glass frame thus, an attempt to bring nature back into the built environment.

Mental health is just as important as well-being and safety of the people. For this purpose experts suggest various strategies such as bright spaces with plenty of light and air. Research shows that students prefer spaces with color, nature and good ventilation(Uzgör and Caymaz 2021). It is also suggested that in some cases, some classes related to arts and media can be taken shoeless thus creating a reminder of a more comfortable learning environment such as home. One expert from the academia said, *"The post pandemic 'designed' environment should not feel like a prison ... also remember we are learning to co-exist with such situations with new innovations in medicine and vaccines etc. ...so the situation may not be that bad ... safety and security in all forms must be a top priority for all institutions but not at the expense of pleasant, congenial, free learning environment."* Another expert (architect) said, *"The future will be what the present and past should have been; the way spaces should always be designed, i.e.; with ample natural light and ventilation and a seamless boundary between the outdoors and indoors"*

4.10.3 Reconfiguring new protocols for coordination and interactions

It is no doubt that the amalgamation of education with IT for the Net Generation is already happening in colleges in universities around the world but COVID-19 has forced everyone to make current and future plans encompassing and encouraging this convergence at a much rapid pace(Daniel 2020). It has left us no option but to address the formal as well as informal interactions in the virtual space. To enhance coordination and interactions in universities and higher educational institutions it is imperative to rethink their working models on their systems work(Alea et al. 2020). Staff, academia and students are at the center of all coordination and interactions happening in universities. In this regard one expert (urban planner) said, *"The pandemic has opened vast vistas for the mankind imagination. Organizations have opted to variable work environments and they are benefiting from it exponentially. However when it comes to educational spaces, the issues remain debatable, because limiting human interaction in institutes can be a tricky area."* Traditionally, after the industrial revolution spaces were designed

to maximize efficiency but the post pandemic environments need to be different, where people can work organically and in collaboration to solve problems(Lizana et al. 2021). These spaces can be a hybrid of face-to-face and distance based and should foster creativity rather than just productivity(Alsarayreh 2020). Blended learning and blended interactions are at the center of all coordination that will happen in the future. It would also make sense to structure our interactions in universities and higher learning spaces according to the needs of the global economy(Devi, Sharma, and Lepcha 2021).

It is also important to note that interactions do not end once the educator leaves the lecture or teaching room. Instead the end of a lecture in a classroom marks a very important transition from formal to informal form of learning. Therefore it is imperative for institutions to plan the virtual learning environment with its real spaces to encourage informal learning(Cha and So 2020). For example allowing access to digital libraries, digital book banks, tool banks, and free internet. Moreover, during the pandemic, recording lectures and giving access has also shown to be a productive method that encourage students to study and learn on their own. In addition to this, the design of neutral spaces is also very important. Many experts believed that spaces like hallways, corridors and transition spaces need to be redesigned according to the SOPs of the pandemic(Farah et al. 2021). One expert (architect) said, "*If we prepare ourselves for the next pandemic I think educational spaces will be resilient. We cannot live without interacting with one another but we can provide hands free experience everywhere, make more flexible spaces, smaller classes, being able to take classes from home and creating openings informal spaces that all encourage the learning process,*" It is imperative to mention that informal learning spaces outside the standard classrooms present a core opportunity to cultivate new teaching pedagogies in higher education institutions because students spend more time in these space than they do in formal spaces(Chang-Tik and Goh 2020). Research, web browsing, report writing, performing analysis and compiling lab reports all happens in places like libraries, common rooms, study halls, media centers, cafes, dorms and learning commons. Making these spaces more comfortable, safer, accessible and enhancing interaction in them will be dogmatic to regain productivity and creativity in the future(Venter 2020).
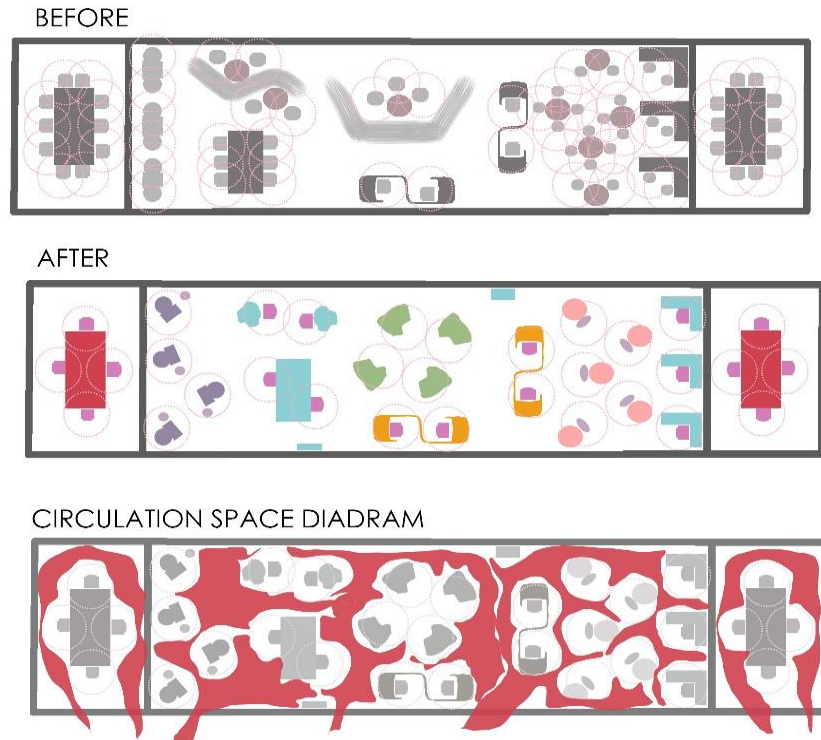
BEFORE

AFTER

CIRCULATION SPACE DIADRAM

Figure 8 The multifaceted options available for the post COVID social space

4.10.4 Increasing accessibility and mobility on campus

Accessibility to services and facilities was greatly reduced during the lockdowns, therefore mobility on campus was also effected and student access was limited. The analysis performed helped us highlight some modifications that may help increase accessibility and mobility back to the way it was, while maintaining social distancing(Yıldırım et al. 2021). These strategies include provision of visual cues, separate lounge settings in common areas and the provision of hands-free experience where possible. We know that small details or visual aids are very important and can be standardized throughout a country. This can be done for universities as well(Popel 2021). It is imperative to mention that these visual cues must include positive reinforcements as students are more likely to follow positive visual cues. Moreover, visual cues and sign boards can also be used to direct circulation flow in the corridors. It must also be noted that when the experts were asked about this strategy in this study more than 60 percent were strongly in favor(Thibodeau et al. 2021). While discussing common spaces experts agreed that maintaining key zones and circulation with physical distancing restriction is very important. For this they suggested separate modular lounge settings and use of moveable transparent screens. One expert from the academia said, *"We need*

to realize that more pandemics like this can happen and they probably will. So if we are to be prepared for them we must design efficiently. Disinfecting periodically if not on regular basis, using transparent screens where necessary, providing visual cues and creating more distance and smart design in seating for common areas to maintain social distancing". Another key strategy that will help enhance mobility and accessibility while maintaining social distancing protocols is the provision of hands free experience or automation of certain doors, entrances, digital devices and services(Nayyar, Pramankit, and Mohana 2020). We know that a lot of shopping malls and big corporate building already have automatic door entrances that provide hands free experience for efficiency and cleanliness. This strategy must also be incorporated into university campuses where possible. Another key area that requires higher accessibility is toilets and water coolers. Previous research has shown that students avoid using toilet in schools as much as possible. Having bathrooms attached to lecture rooms can also enhance access to toilets and might help health as well(Anugrah, Ibrahim, and Sukardjo 2021).

4.10.5 Creating financial safety in higher education institutes through IT

Financial safety nets were one of the biggest factors effecting the continuation of education for most students during the pandemic. Those who could not afford education any longer did not opt to continue their education. Previous surveys showed that students and staff members were not financially compensated by universities during the pandemic(Wahab Ali 2020). When experts were asked, an overwhelming majority of 95.0% agreed that like book banks in libraries there should be digital banks in universities to help students borrow digital tools (like laptops and digital notepads) from the university during DL mode. This will help them continue their education from home wherever that maybe(Jehi et al. 2022). One expert (policy maker) also said, "*Sometimes dictating the user forcefully can affect design approaches. The new normal should try to integrate passive ways of design solutions. For e.g. audio visual class room space and strong virtual infrastructure (such as AIOU in Pakistan) can reduce the pressure of challenges in such pandemic circumstances. Remote learning ways with efficient means of virtual connectivity can be a solution for the new normal.*" Another important change that will help bring frugality is cloud technologies. Cloud technologies allows multiple devices to be connected to one central computer over the internet(Samyan and St Flour 2021). Recently LG in partnership with Microsoft and KIE (Kenya institute of education) has said that they will introduce a model classroom using windows Multipoint Server 2011. Though creating scholarships and financial

support programs are the conventional way of creating financial safety in higher educational institutions, it is not always sustainable due to growing cost of materials and inflation. We know that the future of everything lies in the adaptive amalgamation of technology and design(Singh et al. 2021). When experts were asked what will be the new normal in the post pandemic environment, one expert from the construction profession said *"a mix of off station and in station studies"* while another from academia said, *"Distance learning will be more common in educational institutes. Some SOPs should always be followed. Virtual learning will be the new norm."* These views resonate with the current treads happening in the education sector since the pandemic has come somewhat under control with the advent of modern vaccinations. The question however still remains on how to incorporate IT infrastructure intelligently into our learning spaces(Al-Hajri et al. 2021). For that purpose, the following table illustrates how IT application strategies can be applied to learning spaces in higher educational institutions.

Table 11 Aligning learning principles and strategies to IT applications

Principle of learning space	Strategy applied in learning space	IT application
Numerous learning resources	IT highly assimilated into all aspects of learning spaces	IT infrastructure that fully supports learning space functions
Multiple learning pathways	Providing space for a variety of tools	Provision of free Wireless connections
Explorative learning	Accessibility to labs and equipment, and availability of primary resources and tools	Digital tool banks
Encourage discovery Financial freedom	Accessible facilities Access to financial assistance programs	Open online resources Variety of resources; no "one size fits all"

CHAPTER 5- CONCLUSIONS

In the end of 2019 the world was hit by a deadly virus called the COVID-19 virus which rapidly spread across the globe and presented itself as a public health emergency of global concern. This virus got global attention due to its rapid rate of transmission and its deadly nature, killing millions since 2019. The education sector was one of the sectors most effected by the onset of the pandemic(Cardoso, Fuhr, and Dias 2020). UNESCO reported (2020) that around 1 billion students were affected due to lockdowns since April 2020 across 188 countries at all levels of education(UNESCO 2020). Hence as a result, education was shifted online at an unprecedented scale. However due to socio economic challenges, the education sector in Pakistan could not keep up. This paper aimed to review the challenges faced by academic staff and students at higher education level. From this study we come to conclude that students were the most effected stakeholders, followed by administrative staff and then teachers. Students had a higher risk perception of their grades and performance than anyone else(Baloran 2020). They were also the most stress as compared to teachers and staff members. Students from COMSATS and MIMDC were the most effected of all the students in the study. Students from LUMS were the least effected. We conclude that this was because LUMS has one of the best management systems in the country and was managing itself more effectively. We also come to see that usually teachers agreed on a hybrid mode of teaching and believed it was most effective for students (Tick and Beke 2021). From this study we also come to realize, virtual learning still remains an uncharted territory for most students as they feel more at ease in the FTF learning mode. Sudden changes and interruptions in the learning environment have brought about a lot of issues which will have long term consequences for the affected cohorts and will eventually also increase inequality in the years to come(Sheik Abdullah et al. 2021). Mobility and accessibility were also affected, despite when campuses were open and regularly disinfected and in use, students were unable to access facilities and amenities with ease. While participating in the online learning module, more than half of the students did not have good internet access despite having laptops, whereas, less than half did not have laptops at all. It is suggested that digital banks should be setup on all campuses that allow students to borrow digital devices. Moreover, ICT infrastructure needs to become more sustainable and reliable in the long-term(Yang et al. 2020). It was also noted in this study that, only the academic staff was financially compensated sometimes while students who were the most effected

in terms of learning, mental health, mobility, coordination and interactions as well as performance were never financially compensated by the university. It is suggested that some sort of new funding should be set up for those effected most by the pandemic to help overcome the socio-economic differences that might affect these cohorts in the years to come(Davitt et al. 2021). This study is important as it addresses a pressing issue of our time. The global lockdown on educational institutes and learning spaces and its effect on students and educators and their lives. It also helps us ponder upon the possibilities that can be implied to mitigate the negative impacts of the pandemic and build upon a more sustainable future.

From this study we know that student, educator, administrator and institutional needs are going to evolve with time as the COVID-19 pandemic persists. A holistic approach is required that allows people to feel safe and healthy while returning to campuses and learning institutions. These strategies also align with SOPs for COVID-19 provided by the UNESCO to the greatest extent possible. There may be some unique circumstances that may prevent institutions from adapting to these recommendations, such as bi-laws or the lack of physical space. Though there is an urgency to return to where we were however, we need to become resilient as we move forward and thrive. Engagement and creativity can only be ignited and enhanced in higher educational institutions when they are designed to balance diverse teaching pedagogies and ways of learning, all the while supporting the well-being of all people present on campus(Megahed and Hassan 2022). To thrive in the post pandemic environments institutes need to be designed in a way that they can respond quickly and easily when faced with disruptions. It is imperative to mention that pre-COVID spaces were not made to mitigate diseases however, now designers, planners and those involved in the making of learning spaces will have to make conscious decisions to incorporate furniture and technology choices that adapt to existing spaces and meet the new challenges that lie ahead. One of the strategies suggested in the discussion section of this paper includes reducing density, change in geometry and the division of physical spaces to achieve social distancing without distancing people completely from one another. Moreover, as time passes, the need to introduce modular furniture and video technologies that can accommodate hybrid learning and flexibility in learning modes is more evident than ever. The opportunity ahead is to reinvent learning spaces so that they are adaptable to future calamities or the next pandemic(Hurria 2021). It is also imperative to mention that, the planning paradigm of the past that was cost centric needs to shift to a more flexible and fluid model with less permanent spaces. The learning spaces of the future will need to

support the well-being of people which may include their physical, emotional and cognitive safety. Science based and data driven solutions will be at the center of all strategies and the incorporation of technology into everything will be dogmatic(Landa, Zhou, and Marongwe 2021). This study has shown that as the pandemic persists, the need for revitalization of our higher educational spaces is clearly evident and very important for the future of learning.

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Appendix

Questionnaire Survey
Stakeholder 1- Students

1- Which mode of learning are you most comfortable in?
A. DL mode
B. FTF mode
C. Hybrid

2- Which mode of learning was most effective for you?
A. DL mode
B. FTF mode
C. Hybrid

3- How badly were your grades effected by the pandemic?
A. No affect
B. Minor affect
C. Neutral affect
D. Moderate affect
E. Major affect

4- Do you feel like your university administers proper social distancing protocol?
A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

5- Was your interaction with other students limited or poorly effected during the pandemic?
A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

6- If you play sports, how badly do you think university sports was effected due to the pandemic?
A. No affect
B. Minor affect
C. Neutral affect
D. Moderate affect
E. Major affect

7- How often were you able to take lab work and workshops and finish your work on time?
A. Never
B. Rarely

C. Sometimes
D. Often
E. Always

8- Were you given any training or workshop that helped you enter DL mode when the universities entered lockdown for the first time?
A. No
B. yes

9- Did you meet financial problems during the pandemic?
A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

10- Were you provided with financial assistance from the university during the pandemic?
A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

11- The Supreme Court ordered a 20 percent reduction of fee in primary schools during the pandemic to keep children in schools. Did your university reduce your fee?
A. No effect
B. Minor effect
C. Neutral effect
D. Moderate effect
E. Major effect

12- Were there any facilities that allowed you to borrow laptops or other devices from the university during the pandemic?
A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

13- Did you have laptops and digital tools to participate in DL mode?
A. Never
B. Rarely
C. Sometimes
D. Often
E. always

14- Did you have good internet access during the pandemic that allowed you to participate in DL mode?
A. Never
B. Rarely

C. Sometimes

D. Often

E. always

15- Were you or your friends living in campus accommodations provided with adequate protection and a safe environment on campus housing?

A. Never

B. Rarely

C. Sometimes

D. Often

E. Always

16- How badly was your mobility on campus effected due to the pandemic?

A. No affect

B. Minor affect

C. Neutral affect

D. Moderate affect

E. Major affect

17- Were you able to use cafeteria and other services provided on campus during the pandemic?

A. Never

B. Rarely

C. Sometimes

D. Often

E. Always

18- How baldy was your mental health effected by the pandemic?

A. No affect

B. Minor affect

C. Neutral affect

D. Moderate affect

E. Major affect

19- Were you provided by counseling and mental healthcare by the university during the pandemic?

A. Never

B. Rarely

C. Sometimes

D. Often

E. Always

20- Did you feel safe from the virus on campus or in classrooms?

A. Never

B. Rarely

C. Sometimes

D. Often

E. Always

Stakeholder 3- academic staff/educators

1- **Which mode of teaching was most suitable for you?**
A. DL mode
B. FTF mode
C. Hybrid

2- **Which mode of teaching do you think serves the need of students the most?**
A. DL mode
B. FTF mode
C. Hybrid

3- **Were you able to coordinate with other teachers effectively during the pandemic?**
A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

4- **Were you able to interact with students properly in DL mode?**
A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

5- **Were you able to deliver lectures properly during DL mode?**
A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

6- **Were you provided with equipment and digital tools by the university to take part in DL mode?**
A. Yes
B. No

7- **Did you have free internet provided by the university to participate and teach during DL mode?**
A. Never
B. Rarely
C. Sometimes
D. Often
E. always

8- Were there any periodic workshops by the university that helped you transition into DL mode?

A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

9- How badly do you think learning was effected due to the pandemic?

A. No affect
B. Minor affect
C. Neutral affect
D. Moderate affect
E. Major affect

10- How badly do you think students performed in DL mode as compared to FTF?

A. No difference
B. Minor difference
C. Neutral difference
D. Moderate difference
E. Major difference

11- How severely was the standard of assessments and exams effected by the pandemic?

A. No affect
B. Minor affect
C. Neutral affect
D. Moderate affect
E. Major affect

12- Should exams and other assessments be conducted in DL mode?

A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

13- Keeping social distancing in mind, do you think the classroom size will be sufficient for class strength if the pandemic persists?

A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

14- Do you think reducing class density will help teachers and students interact more and effectively?

A. Strongly disagree
B. Somewhat disagree
C. Neutral
D. Somewhat agree
E. Strongly agree

15- Change in seating and keeping social distance in class is the new norm in universities. Did this effected your teaching in a negative manner?

A. No affect
B. Minor affect
C. Neutral affect
D. Moderate affect
E. Major affect

16- How severely was your mental health effected by the pandemic?

A. No affect
B. Minor affect
C. Neutral affect
D. Moderate affect
E. Major affect

17- Did the university staff enforce COVID protocol/SOPs during the pandemic?

A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

18- If any member of the academia had contracted the virus, were they given paid leave or any financial compensations by the university?

A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

19- Do you think change in design of classrooms and labs can help revitalize learning spaces and make them safer for everyone?

A. Strongly disagree
B. Somewhat disagree
C. Neutral
D. Somewhat agree
E. Strongly agree

Stakeholder 3- administration and staff

1- University
A. LUMS
B. COMSATS
C. NUST
D. MIMDC

2- Age group

A. 20-30
B. 30-40
C. 40-50
D. 50-above

3- Gender

A. male
B. female
C. others

4- How badly do you think education was affected by the pandemic?

A. No affect
B. Minor affect
C. Neutral affect
D. Moderate affect
E. Major affect

5- How severely was staff performance effected by the pandemic?

A. No affect
B. Minor affect
C. Neutral affect
D. Moderate affect
E. Major affect

6- Did you feel safe working in the university during the pandemic?

A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

7- How severely was your mental health affected by the pandemic?

A. No affect
B. Minor affect
C. Neutral affect
D. Moderate affect
E. Major affect

8- If any staff member had contracted the virus, were they given paid leaves or any financial compensations?

A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

9- Did the university provide needy students with financial assistance or relief during the pandemic?

A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

10- During the pandemic when the university was open, were classrooms and labs properly utilized?

A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

11- Were classrooms and labs regularly disinfected during the pandemic?

A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

12- Has the pandemic effected your need for more space in the office?

A. No affect
B. Minor affect
C. Neutral affect
D. Moderate affect
E. Major affect

13- The dropout rate all over the world is very high since mid-2020. How would you describe the dropout rate mid semester from your university since the pandemic?

A. Low
B. Somewhat
C. Neutral
D. Moderate
E. High

14- Did the administration and staff follow and enforce COVID safety protocol properly?

A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

15- Were you able to coordinate with the academic staff easily during DL mode?

A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

16- Were you able to contact students easily when classes were being conducted online?

A. Never
B. Rarely
C. Sometimes
D. Often
E. Always

17- How severely did the enrolment rate drop in your university since the start of the pandemic?

A. Low
B. Somewhat
C. Neutral
D. Moderate
E. High

18- How baldy was the departmental budget effected due to the pandemic?

A. Low
B. Somewhat
C. Neutral
D. Moderate
E. High

19- What percent of staff were on regular attendance?

A. 20-40%
B. 40-60%
C. 60-80%
D. 80-100%