 doi:10.20944/preprints202106.0446.v2

Article

The Latent Digital Divides and Its Drivers in E-Learning: Among Bangladeshi Students During COVID-19 Pandemic

Md Badiuzzaman [1,*], Dr. Md. Rafiquzzaman[2], Md Insiat Islam Rabby[3] and Mohammad Mustaneer Rahman[4]

[1] Faculty of Arts Design and Architecture, UNSW, Sydney, Australia; badiuzzaman@unsw.edu.au
[2] Department of IEM, KUET, Bangladesh; rafiqbitr@yahoo.com
[3] Department of Mechanical Engineering, UPM, Selengor, Malaysia; insiatislam8@gmail.com
[4] School of ICT, UTAS, Hobart, Australia; mustaneer.rahman@gmail.com
* Correspondence: badiuzzaman@unsw.edu.au; Tel.: +8801911788766

Abstract: The devastating COVID-19 pandemic forced academia to go virtual. Educational institutions around the world have stressed online learning programs in the aftermath of the pandemic. However, because of insufficient access to ICT, a substantial number of students failed to harness the opportunity of online learning. This study explores the latent digital divide exhibited during the COVID-19 pandemic while online learning activities are emphasized among Bangladeshi students. It also investigates the digital divide exposure and the significant underlying drivers of the divide. A cross-sectional survey was employed to collect quantitative data mixed with open-ended questions to collect qualitative information from the student community. The findings revealed that despite the majority of students have physical access to ICT but only 32.5% of students could attend online classes seamlessly, 34.1% of the students reported the data prices as the critical barrier, and 39.8% of students identified the poor network infrastructure is the significant barrier for them to participate in online learning activities. Although most students possess physical access to the device and the Internet, they face the first-level digital divide due to the quality of access and maintaining subscriptions. Consequently, they fail to take advantage of physical access, resulting in the third-level digital divide (Utility Gap) and submerging them into a digital divide cycle. This paper aimed to explore the underlying issues of the digital divide among Bangladeshi students to assist relevant stakeholders (e.g., the Bangladesh government, Educational Institutions, Researchers) in providing the necessary insights and theoretical understanding to arrange adequate support for students to undertake conducive online learning activities.

Keywords: COVID-19, Digital Divide, Online Learning, Multi-level Digital Divide

1. Introduction

At the beginning of 2020, the COVID-19 infection has spread worldwide and turned into a global endemic [11, 14]. Still, now many people worldwide are infected daily, and the super infectious characteristic of the virus created a global pandemic. On March 8, 2020, the first COVID-19 infected case in Bangladesh was identified, and till now, 896770 people were infected [12, 59]. However, after detecting the first COVID-19 case, the government has closed all physical activities in the educational institute from the end of March 2020 [17]. Due to the restriction on physical classes, many educational institutes started online teaching and learning activities. However, insufficient access to ICT (information and communication technology) became a significant concern among the student community in Bangladesh. The disparity of ICT access is defined as the digital divide.

The term "Digital-Divide" addresses the uneven distribution of digital technology and ICT regarding usages, access, impact in individuals' lives, organizations, or countries. The digital divide distinguishes the ability to access, usages, and utility of ICT between individuals, organizations, or countries. Between the late 1980s to early 1990s, the digital

 doi:10.20944/preprints202106.0446.v2

divide was a floating gossip as "information-rich" and "information-poor." After the public internet deployment, the gap was visible to access or not have access [2]. Lloyd Morrisett coined the term digital divide to indicate a gap between socioeconomic groups in accessing technology tools [10]. The National Report on Telecommunications and Information Administration, Falling through the Net: Defining the Digital Divide, describes the digital divide as the differences in access to telephones, personal computers (P.C.s), and the Internet among some demographic groups [10]. Nowadays, there is the possibility of a digital divide among any individuals, organizations, or country.

Similarly, there is digital inequality among schools or student communities [21]. The digital divide notion is not limited to having access to and not having access to ICT in the 21st century. For more than two decades, extensive research on the digital divide has established multiple levels of the digital divide concerning access to devices and the Internet, ICT usage abilities, and usage outcomes [1- 23]. During the 1990s, the first digital divide research focused on access to digital technology and the Internet. Earlier, the criterion to define the difference was, having access or not having access. It was a binary term restricted between two states.

Nevertheless, the binary notion is no longer condign. In recent years, multiple levels of digital division have been exposed, and each level has different layers. Theoretical experts in the digital divide field have defined three levels of the digital divide. According to recent studies, the first level divide is the difference in physical access to the Internet and device; the second level is the gap in digital skills and motivation (usages gap); the third level is the use gap in the benefits of use [18-20]. Different levels of digital division have been identified and sustain for different periods. Also, contemporary studies have developed complex notions of disparity at each level [53]. The first level divide: physical access was in view from 1995 to 2003, the second level divide: skills and use were centered in 2004, and the third level divide was still under consideration in 2012: outcomes of usages [22]. According to the recent theory, quality of access and the ability to maintain sustainable access is different layers of the first-level digital divide [57].

Many studies have established the level of income as an essential determinant of ICT access opportunities [28-36]. These studies found a link between the amount of income and access to ICT. They asserted that a higher income level increases the ability to access ICT. Similarly, lower-income contributes to less opportunity. Therefore, people from developing countries with lower income levels will have less access to devices that will promote the digital divide at the first level. Consequently, the student community from such countries faces the digital divide during the education system incorporates ICT. Among all the digital divide drivers, income level, educational attainment, and urbanization are the primary drivers [5, 21, 25]. As a result, Bangladesh's student community is vulnerable considering arranging adequate access to ICT, as it has a lower per capita income and lower internet penetration rate with significantly lower Internet speed [38, 40].

A UN policy brief on "EDUCATION DURING COVID-19" stated that the COVID-19 pandemic was the most massive disruption of human history's education system, affecting approximately 1.6 billion learners worldwide [34]. According to the study, an average of 94% of learners worldwide, even 99% of poor and lower-middle-income nations, were affected by the devastating COVID-19 pandemic. Schools went to a sudden shutdown due to health concerns, but governments from several countries responded quicker and switched to online learning. In developed countries, 80-85% of learners gained online learning coverage during the COVID-19 pandemic [34]. Disappointingly, less than 50% of students in low-income countries could access online learning [34]. During the COVID-19 pandemic, Bangladesh declared a long-term shutdown in the education sector. From March 2020 till now, none of its educational institutes has operated in face-to-face mode. Despite the government of Bangladesh initiating online learning activities, there is a high possibility of discrimination to join the online learning activities due to the digital divide. A large number of students seems either beyond ICT access or anyhow excluded from e-learning.

 doi:10.20944/preprints202106.0446.v2

Moreover, no study is available that examined the digital divide's status and drivers of the divides during the COVID-19 pandemic among the Bangladeshi student community. Hence, we focused on the latent digital divide in Bangladesh during emphasized ICT enable learning activities while the pandemic forced institutes to go online. The study revealed notable novel facts that expose the latent digital divide among the Bangladeshi student community. The findings will help the policymakers and respective stakeholders to rethink and redesign their online learning activities. Furthermore, the study will help undertake necessary fundamental initiatives to reduce the digital divide with an intertwined relationship with online learning activities. The COVID-19 pandemic exposed the untold story of the digital divide in Bangladesh, and this study illustrated the nuanced scenario of the multilevel digital divide.

Many Bangladeshi newspapers questioned the efficacy of entirely online-dependent learning during the lengthy closure of educational institutes and anticipated that a substantial number of students are excluded from e-learning [54]. However, no report or study has not appeared explaining the issues considering the theoretical framework of the multilevel and complex digital divide concept. Therefore, we formulated the research questions to address the underlying situation of the digital divide and the significant drivers of the disparity.

2. Research Question

Although ICT incorporation has introduced an unprecedented way to interact in education, there is a high possibility that ICT-enabled learning activities will introduce barriers to many students in Bangladesh due to the disparity in access to ICT. Nonetheless, the digital divide exists in almost all world regions, regardless of their economic status. Consequently, students may face a digital divide during the exacerbated online learning activities during the COVID-19 pandemic. The study formulated two research questions to address the issue as

- RQ1: What is the scenario of the digital divide among Bangladeshi students during the COVID-19 pandemic while they need to participate in online learning activities?
- RQ2: If the digital divide found in RQ1, then what are the key drivers?

3. Literature Review

The term digital divide has become an indicator to measure ICT access status in developing countries [48]. Empirical evidence exhibits that developing countries are confronting severe inequalities accessing ICT. Pick et al. examines the geographical and socioeconomic pattern of adaptation, diffusion, and ICT utilization in 36 nations of LAC (Latin American and the Caribbean) [52]. The LAC has 10.5 % of world internet users, and the internet penetration has reached 71.5% in 2020, which seems progressive. Nonetheless, inequality still exists, considering the adaptation and utilization of ICT in LAC [52]. Authors claimed that prosperous LAC nations had two times more internet penetration than impoverished nations. Another comprehensive study from 2006 on a data set of 161 countries found the region-specific explanation for the divide in ICT penetration [45]. The study identified digital divides accounted primarily by income differential. Income level has been one of the critical drivers of the digital divide that remains stable.

In Africa, rising inequality like algorithmic capitalism has become a significant concern [46]. Algorithmic capitalism refers to cyber capitalism or the spectacular growth of information ventures (e.g., Google, Microsoft, Amazon). Karar states that information capitalism was the third generation of capitalism after mercantilism and the Industrial Revolution [46]. Developing countries with lower incomes may likely face emerging inequalities while ICT application increases. For instance, Tewathia et al. provided recent insight into the relation between India's digital disparity and social inequalities after analyzing a sizable national quantitative dataset [50]. They applied Marxian perspectives and revealed the influence of ICT ownership and skill to hold higher labor class status. The

 doi:10.20944/preprints202106.0446.v2

study also applied Weberian perspectives to examine how ICT assets exclude others by creating an ICT wealthy class. Tewathia et al. concluded that ICT might amplify the digital divide in India due to socioeconomic inequalities [50]. Likewise, another recent research explored Thailand's first digital divide by examining a household ICT use survey of 217,217 people [47]. The authors came to the conclusion that affordability is the primary reason for the disparity in internet use in Thailand, followed by gadget ownership.

South Asian least-developed countries like Bangladesh, Nepal, and Sri Lanka are confronting the digital divide due to lower educational attainment, lower socioeconomic status, lack of motivation, lack of digital literacy, which drive a vicious cycle of inequality. Zhou et al. analyzed survey data from nearly 500 individuals in Bangladesh, Nepal, and Sri Lanka to investigate determinants of ICT use in rural areas [51]. The result of the study indicates that higher levels of education are linked to higher computer use, and South Asian countries are found to fall behind in terms of necessary education and digital literacy.

Socioeconomic status plays a key role in gaining ICT access. Though Bangladesh has recently emerged as a growing economy, people's access to ICT seeming progressive. However, according to the most recent statistics, Bangladesh's Internet quality and speed rank poorest among the world's nations. [55-56]. Overall, it is conceivable that Bangladeshi students are experiencing digital disparities during e-learning resulting in further educational inequalities.

4. Materials and Methods

The research has been conducted employing mixed methods research where a quantitative survey yields the primary data. Initially, desk research and literature review were conducted to get the existing known facts on digital inequalities in Bangladesh and get a comprehensive idea of the digital divide concept. Then, a structured survey was used to collect quantitative data mixed with open-ended questions to collect qualitative information from the student community. The survey was conducted, excluding the identification of respondents to ensure privacy and ethics. The student community engaged in higher education (post-secondary) was the target population, regardless of gender. The research tried to find the critical factors driving the digital divide among the student community while online learning during the COVID-19 pandemic. There were 25 questions designed to get specific data regarding internet access and access to digital devices like personal computers and smartphones—some of the questions designed to collect data about their engagement focus on different purposes. In addition, some questions had open-ended answer options to collect some qualitative data. Both English and Bengali were used amalgamated to prepare the questionnaire to make the survey easy to understand to the Bangladeshi student community. As the survey was conducted during the lockdown, the only way was conducting through online submission. A google form was designed to collect data, but there was a critical concern that only people having internet access and computer/smartphone could attend, while the study aims to investigate the digital divide.

Nevertheless, the study focused on identifying the lack of ICT access and facing the digital divide. Therefore, online participation was done by arranging a setup for engaging them. Snowball method was applied to resolve the issue, first various student community was identified from the Facebook group through different known communities of the authors. Then, they were requested to engage their friends, who are the potential target people. Some Facebook groups helped in this regard to provide devices and access to the people to respond to the survey. Finally, 123 students from five different education levels, 15 age groups, and four different residential regions responded to the survey after providing consent. Based on the data volume, Microsoft Excel was used to analyzing the quantitative data. Students were informed about the purpose of the study before beginning and asked to provide consent to proceed with the Google Form.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 30 June 2021 doi:10.20944/preprints202106.0446.v2

Maximum 82.1% respondents were college/diploma students, while 13%, 2.4%, 1.6%, and 0.8% respondents were undergrad, postgraduate, secondary school, and secondary school completed level respectively. The highest number of respondents lived in the rural area (47.2%), whereas 25.2%, 23.6%, and 4.1% of respondents live in the city, urban, and small-town.

Table 1. Respondent student's demography, ICT access, and e-learning activities overview. (N=123)

Variable	Response/Range	Percentage
Level of Study	Postgraduate	2.4%
	Undergrad	13%
	College/Diploma	82.1%
	Secondary School Completed	0.8%
	Secondary School	1.6%
Residency Region	Divisional City	25.2%
	Small Town	4.1%
	Urban	23.6%
	Rural	47.2%
Age	16-18 Years	54.4%
	19-23 Years	38.2%
	24-30 Years	7.2%
Student's Smartphone Ownership Status	Students have a personal smartphone	86.2%
	Students use smartphones owned by family members	8.1%
	The family member has a smartphone, but the student does not have access	3.3%
	Neither student nor his family member has access to a smartphone	2.4%
Student's Personal Computer (P.C.) access status	Students have PC	44.7%
	Students do not have access to P.C.	43%
	Students have access to family member's PC	9.8%
	Students' family has P.C., but they do not have access to that	2.4%
Student's Access to the Internet	Students have adequate Internet access 24x7	26%
	Students have sufficient access on demand	37.4%
	Students have limited access to the Internet	35%
	Students do not have access to the Internet at all	1.6%
Students join online classes	Can attend all the online classes	32.5%
	Can attend most of the class but not all	20.3%
	Can attend some of the classes	30.9%
	Can attend a few classes rarely	3.3%
	Can attend none of the online classes	13%
The student identified as the critical	Expensive mobile data package as most of the student's use cellular data	34.1%

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 30 June 2021 doi:10.20944/preprints202106.0446.v2

barrier to join online classes	Weak signal of the cellular Internet network	39.8%
	Do not have adequate access to the device (P.C., Smartphone)	10.6%
	Due to not having access to the Internet	2.4%
	Other Destruction (Remiss, Personal Issue, Not Feeling Interesting)	4%
	Engaged in Job during COVID-19 and not attending the online class	1.6%

5. Results

The study has revealed four critical factors that are driving the digital divide during the COVID-19 pandemic, which are:

5.1. Dependency on Mobile Internet and Price of Internet Package is Driving the Digital Divide

Among the respondents, 32.5% say they can always join their online classes seamlessly, 20.3% of students report that they can participate in their online learning activities most of the time, 30.9% say that they sometimes manage to join the online class. A group of 13% of students replies that they cannot join their online classes totally, and 3.3% says that they can join rarely. It seems that the majority of students face impediments to taking part in online learning activities. The scenario is likely to be complicated than the typical digital divide and lack access to online classes. The data shows a critical relationship between joining the online class and not having access to a digital device. Some of the students having internet access or device informed that they could not join the online class due to the price of Internet connectivity. Among the 123 respondents, only 16 students cannot join online classes at all, where 11 say they do not have a personal computer. The information might be interpreted as this 13% of students face the digital divide, but all respondents say anyhow they have access to a smartphone; therefore, they can access the Internet. The scenario implies that the lack of physical access is not resisting them to join the online class. From the group who do not have internet access, 9 of the 16 respondents describe that data price is the primary barrier to joining their online classes. It seems that the mobile Internet is costly to keep subscribed and access online classes. The data revealed that broadband Internet is not widely available among the student community. According to the data, 73.2% of students use mobile/cellular internet connection to access the Internet, 25.2% of people use wired or wireless dedicated/shared internet connectivity, and 1.6% report that they are entirely disconnected. Most people depend on mobile Internet, and the price of cellular data package high. Therefore, dependency on mobile Internet and cost seems to be a potential driver of the digital divide instead of not having access or not owning a digital device as students have sufficient access to devices. The most recent BTRC (Bangladesh Telecommunication Regulatory Commission) data shows that among 108.19 million internet subscribers, 92.08% of internet subscribers use Mobile Internet, which seems to dominate over cheap broadband internet service [42]. Compared with yield information and BTRC data, the respondents seem representative as both datasets indicate the mobile Internet dependency.

Critical analysis of the data revealed a complex relation that identifies a significant digital divide in Bangladesh. Figure.2 illustrates some factors that would clarify the reason for the inability to join online learning activities. Considering internet access, 98.4% of students said they could arrange Internet access, which seems to be an adequate number. In terms of access to digital devices, 86.2% of students said they own smartphones, and 44.7% have personal computers. Despite having sufficient access, most students cannot join their online learning activities, as only 32.5% reported that they can always access online learning activities without interruption. Interpretation of data reveals that most students rely on mobile Internet, and 34.1% of students identify data prices as a significant

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 30 June 2021 doi:10.20944/preprints202106.0446.v2

barrier. They cannot effort mobile data package maintain sustainable Internet access. Physical access and device availability become futile due to high Internet prices. Therefore, data price drives the digital divide over a satisfactory physical access arrangement among the student community. A study on rich and technologically advanced countries also finds the first-level digital divide remaining due to ongoing expenses to maintain access and devices [22]. Therefore, it is not difficult to perceive that after connecting people in Bangladesh, they will face the digital divide caused by ongoing expenses. Some students reported that they do not have a personal device (8% from the city, 15% from the rural) which is a barrier. However, they also informed that they could get device access from their family members.

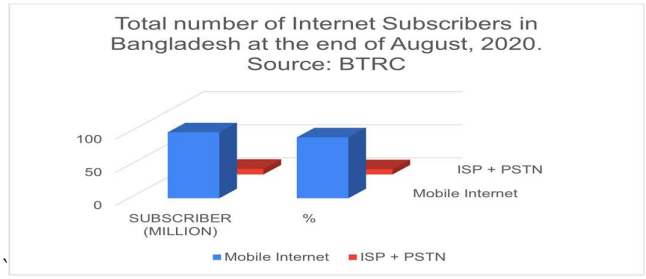


Figure.1: Internet subscribers in Bangladesh and access type.

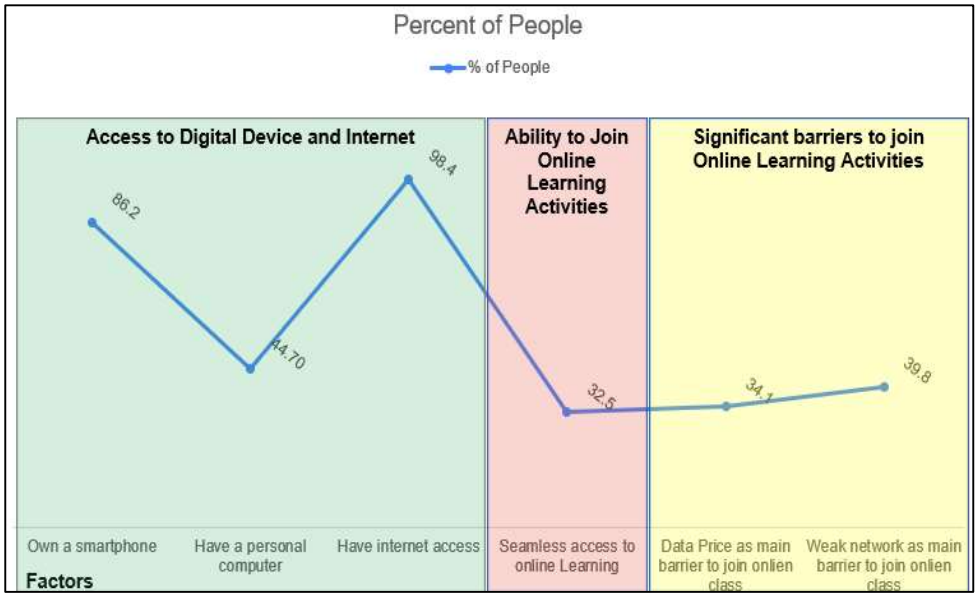


Figure.2: Access to a digital device, joining the online class, and the barrier to seamless access.

5.2 Inadequate Mobile Network Infrastructure and Poor Signal in Rural Area is a Significant Driver

Quality internet access has become a significant digital divide in the contemporary concept [57]. At the outset, having access or not having access was a binary concept of the divide. However, profound research work revealed that the digital divide is almost an ever-evolving phenomenon that keeps inducing a new digital divide as technological progress is an ever-evolving process [23, 57, 58]. Van Dijk and Jan A.G.M researched the achievement and shortcomings in digital divide research in 2006 [23]. The study revealed that gradually research work identified the digital divide's mitigation as the access gap was bridged, but many new concepts of divide appeared. Still, the new metaphor of the digital divide is emerging like "Lack of Skill" or "Lack of Motivation" [23]. The study indicates that research on the digital divide should be a simultaneous task with the

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 30 June 2021 doi:10.20944/preprints202106.0446.v2

technology's pace as a new formation has been identified. Likewise, this study found that access quality is a significant driver of the digital divide among Bangladeshi students.

Remarkably, the network quality of mobile Internet has been identified as one of the most destructive issues driving access quality and the first digital divide. Comparatively, students from rural regions face amplified barriers regarding network signal quality. Our study revealed that 47% of students from rural areas identified weak network signals as the main barrier to online classes, 35% of their counterparts from city-urban areas, and the same issue. Moreover, poor mobile network quality seems a dominant driver of the digital divide as most students depend on cellular mobile internet service. The demography of the Internet's usage in Bangladesh supports the statement as 92.08% of internet subscribers use Mobile Internet [42].

Consequently, after having sufficient access to digital devices, many students remain out of the online classrooms. There is empirical evidence that the digital divide and network access quality foster the digital divide despite necessary access [19-20]. In recent days Internet penetration and availability of devices have been notably boosted in Bangladesh. However, the quality of the network appeared as the latent digital divide driver exposed during the emphasized online learning during COVID-19.

5.3 Students from Rural Region Likely to Face Discrimination to Access Online Class

While the wealthy can continue their schooling online during the coronavirus pandemic, low-income rural children cannot do so because of a lack of infrastructure and amenities. Out of the 21.6 million students enrolled in Bangladesh's elementary and primary schools, another 13 million students are enrolled in secondary schools, and the remaining 4 million are enrolled in universities and colleges. According to the Bangladesh Ministry of Education, 76% of the country's secondary schools are located in rural communities. In addition, according to the article, approximately 60% of primary school students attend government-run schools, mostly in rural areas.

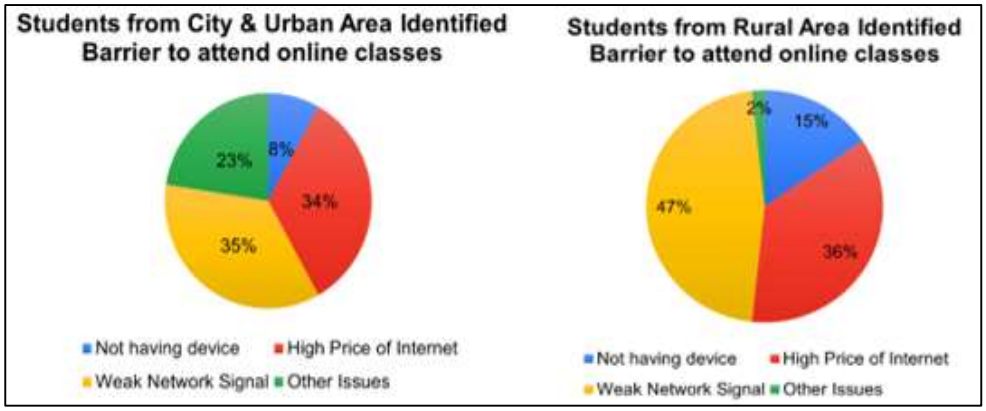


Figure3: Barrier to join online classes in different geographic regions.

"Rural schools lack infrastructure including digital equipment, qualified teachers and hygiene facilities," stated an independent study by a South Asian NGO (SANEM). Uddin claimed that online schooling had stopped education efforts in the country, and rural schools are cooperatively underprivileged to deal with the situatuin[3]. Meanwhile, Bangladeshi private schools have quickly adopted online learning methods after the attack, using social media platforms like Facebook and YouTube to deliver lectures. Generally found in urban cities, these private schools serve the upper classes. The schools are better equipped and prepared, and the students have access to technology because their parents are also computer literate. In a recent study conducted by BRAC, the organization found that over half of Bangladesh's rural households lacked access to the Internet. We also found that rural students are falling behind in accessing online classes.

There is an explicit difference in online class participation patterns between the students from the rural and city-urban areas. Among all respondents, 13% reported that they

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 30 June 2021 doi:10.20944/preprints202106.0446.v2

could not join any online learning activities during the COVID-19 pandemic. Analyzing quantitative data, we revealed that 62.5% of the students who cannot attend online classes are from rural areas (Figure.4). It illustrates that students from rural regions face an amplified digital divide from the city and urban areas. Figure.5 shows the pattern of online class participation of students from different locations. The number of students from rural areas who cannot attend online classes seems twice that of students from cities or urban areas.

5.4 Pandemic Increased Digital Distraction Which is Resulting Third Level Digital Divide

Many recent studies probe the second and third-level digital divides. The digital divide moves from the first-level access divide to the second-level digital divide as Internet and device penetration grows—the utilization disparity of ICT is defined as the third digital divide [7]. After having sufficient access to ICT, not everybody can gain equal outcomes of ICT. The gain from ICT depends on the usage pattern of an individual. For instance, some research has found that economically backward individuals spend more time on the Internet [9,16]. The outcomes of using ICT are not guaranteed by spending more time with ICT; it depends on how and why a person uses ICT [16]. In this study, the students who spend more time with ICT found media vulnerable as they were overusing ICT for social networking and entertainment purposes. We identified in some cases ICT usages destructing their study while the COVID-19 pandemic exacerbated the usage of ICT. According to the respondents, 50.04% of students used social media most of the time, 21.95% used ICT frequently for entertainment purposes, and 26.83% used ICT mainly for study purposes, illustrated in Figure.6. During the lockdown, 52.8 percent of participants strongly think that the COVID-19 pandemic scenario has spurred them to increase their use of cellphones, computers, and the Internet. However, 51% of the participants are worried that excessive ICT usage is devastating for their study, and 50.4% anticipated adverse effects on health. A similar scenario has been found in other countries.

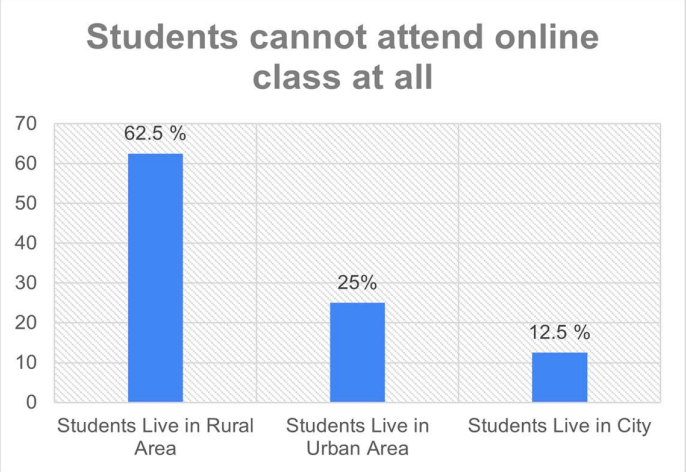


Figure 4: Distribution of students who cannot join any online learning activities based on location

Some students who do not have a reliable internet connection or access to technology find it difficult to participate in digital learning; this gap occurs across countries, is seen among income brackets, and is seen across different income brackets. For example, the percentage of students in Norway, Switzerland, and Austria with a computer to use in the classroom is higher than the percentage of students in Indonesia, which is lower in that country (compared to the OECD average).

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 30 June 2021 doi:10.20944/preprints202106.0446.v2

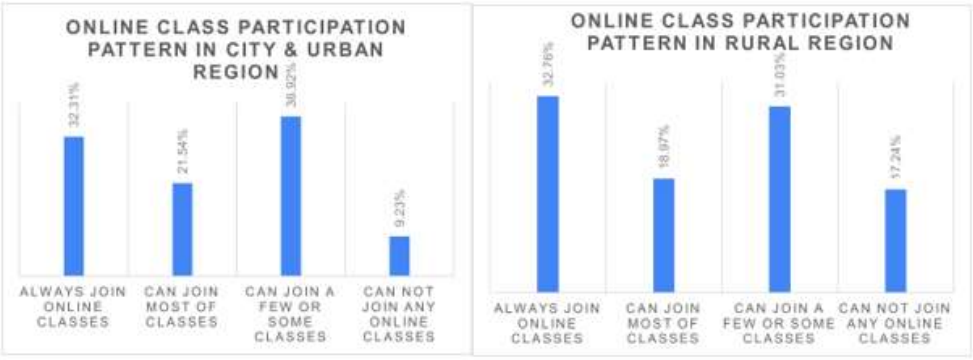


Figure 5: Participation pattern in online classes based in a different location.

Evidently, we conclude that the COVID-19 pandemic increased ICT usages. As a result, gradually, students adopted ICT to get into the online trend. However, the difference in ICT usage will cause different outcomes, which results in the third level of the digital divide considering the usage pattern of ICT by the Bangladeshi students' community.

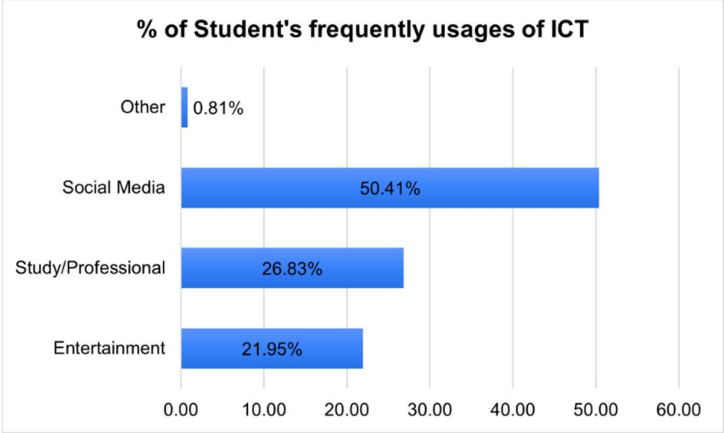
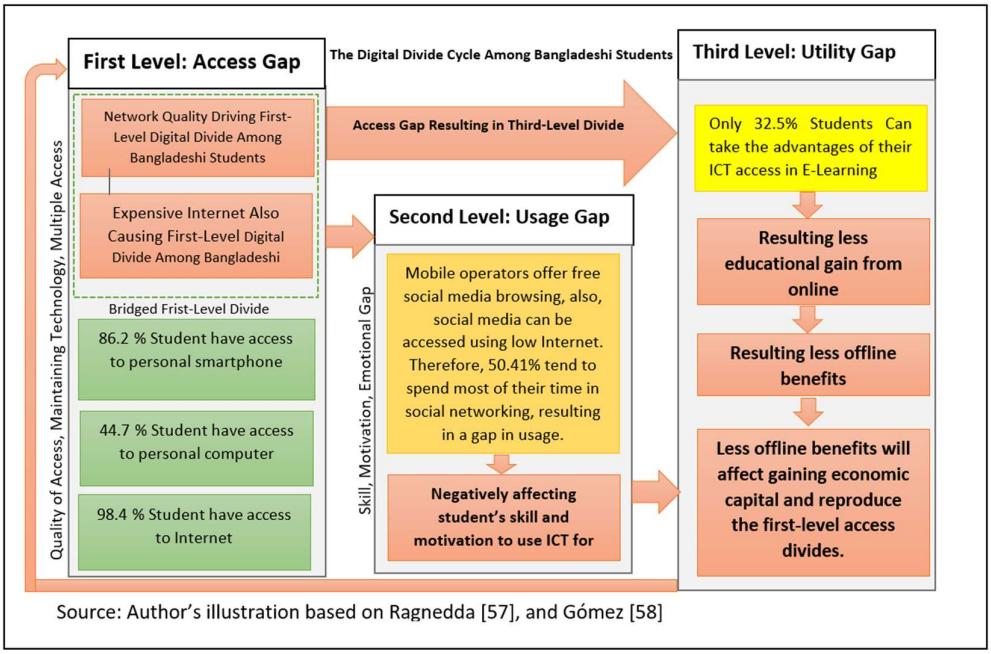


Figure 6: Most frequently, usage of ICT by students during COVID-19 pandemic.



Source: Author's illustration based on Ragnedda [57], and Gómez [58]

 doi:10.20944/preprints202106.0446.v2

Figure 7: Illustration of digital divide among Bangladeshi students based on multilevel digital divide and bidirectional capital conversion theories.

6. Conclusions

This study explored what type of digital divide Bangladeshi students face in online learning during the COVID-19 pandemic and the leading causes of such divides formulated in RQ1 and RQ2. We examined the yield data thoroughly and produced some critical statistical reasons in this article. We also synthesized the results using a variety of theoretical frameworks. The students are likely to be submerged in a vicious cycle of digital divides, illustrated in Figure-7. Although the majority of students possess physical access to ICT still, a complex first-level digital divide exists. Consequently, excluded students fail to gain knowledge using their physical access for e-learning, resulting in a third-level digital divide [57]. According to the bidirectional capital conversion theory, less gain from online capital (access to ICT, skill, utility) results in less gain offline capital (economic, social, cultural) [58]. Likewise, less offline capital will narrow down the opportunity to access ICT, which has constructed a vicious cycle of the digital divide. The effect of this phenomenon may take a long time to be manifested; however, profound research warned this consequence.

The critical finding reflects that pandemic increased digital destruction during online learning. Internet accessibility disparity has emerged as a significant digital divide amid the covid-19 pandemic. The issues addressed in RQ1 have been that a significant number of students are deprived of online learning activities, students from rural areas are more likely to face inequalities to access online classes. Despite having access to digital devices, the high cost of internet packages and dependency on mobile Internet is driving the digital divide. According to our study, 98% of students reported they have access to devices and can arrange internet connection, but they can not afford it. Therefore, availability is enough, but affordability is the critical barrier. Inadequate mobile network infrastructure and poor signal quality in rural areas are significant drivers of the digital divide during the covid-19 pandemic. Almost twice of students in a rural area can not join the online classes compared with students from cities. Digital disruption has become an alarming issue. Instead of using ICT for learning purposes, students spend more time on social media and entertainment while getting access to ICT and being media vulnerable.

The study was carried out during the strict lockdown period at the research site. Therefore, reaching a large sample was tough. We anticipate the number of samples as the limitation of our study. Nevertheless, many contemporary newspapers reported that a large number of students are deprived of e-learning amid the COVID-19 pandemic in Bangladesh; the U.N. report also found exacerbated digital divide in developing countries concerning e-learning [34]. We found the results valid from multiple theoretical explanations, although reaching more respondents was a constraint.

Concerning the findings, we strongly suggest that the respective stakeholders should immediately take account of the internet cost issues and reduce the price for the student with swift action and policy development. Besides, the broadband internet connection should be considered and improve the existing mobile network in rural areas. Along with that, parents and teachers need to take care of students for their digital wellbeing. Moreover, to understand a comprehensive scenario and resolve the nationwide problems, further research is essential by the government and the internet service provider's side. We strongly suggest extensive nationwide research, including a large sample, to rigorously examine the divides and prevent emerging digital divide-driven educational inequalities among Bangladeshi students.

Funding: The study has been conducted from the self-initiative of the authors without any external funding.

Data Availability Statement: The data regarding this study has been securely stored following research integrity and data management rules; the corresponding author can provide them with needs.

Acknowledgments: We are thankful to Dr. Jung-Sook Lee, the faculty member of the school of social science at UNSW, Sydney, Australia. She provided her valuable opinion while designing the survey questionnaires. We apricate and accolade her effort to help the authors design the survey questionary as an expert on this research area. This research was undertaken while corresponding author Md Badiuzzaman was waiting to be enrolled in UNSW, and according to Bangladesh's human ethics expectations and standards. Author Md Badiuzzaman is now affiliated with UNSW, Sydney, Australia.

Conflicts of Interest: The authors declare that there is no conflict of interest

References

1. Chipeva, P., Cruz-Jesus, F., Oliveira, T., & Irani, Z. (2018). Digital divide at individual level: Evidence for Eastern and Western European countries. Government Information Quarterly, 35(3), 460–479. https://doi.org/10.1016/j.giq.2018.06.003
2. Cohen, M. Z., Phillips, J. M., & Palos, G. (2001). Qualitative research with diverse populations. Seminars in Oncology Nursing, 17(3), 190–196. https://doi.org/10.1053/sonu.2001.25948
3. COVID-19 deepens divide between Bangladesh's rural and urban students | Asia| An in-depth look at news from across the continent | Grishchenko. | 22.10.2020. (n.d.).
4. CPS to buy new computers for students to use at home, ramp up e-learning during coronavirus shutdown - Chicago Sun-Times. (n.d.).
5. Dewan, S., & Riggins, F. J. (n.d.). The Digital Divide : Current and Future Research Directions. 6(12), 298–337.
6. Entaban, A., Ismail, A., Jambari, M., Ting, P., Amin, K. M., Ping, C. C., Zou, S., & van Spronsen, G. (2013, March). By-Pass Pigging - A 'Simple' Technology with Significant Business Impact. International Petroleum Technology Conference. https://doi.org/10.2523/IPTC-16905-MS
7. Grishchenko, N. (2020). The gap not only closes: Resistance and reverse shifts in the digital divide in Russia. Telecommunications Policy, 44(8), 102004. https://doi.org/10.1016/j.telpol.2020.102004
8. Hacker, K. L., & Mason, S. M. (2003). Ethical gaps in studies of the digital divide. Ethics and Information Technology, 5(2), 99–115. https://doi.org/10.1023/A:1024968602974
9. Han, E. S., & goleman, daniel; boyatzis, Richard; Mckee, A. (2019). History, Education, and the Schools. In Journal of Chemical Information and Modeling (Vol. 53, Issue 9).
10. Hoffman, D. L., Novak, T. P., & Schlosser, A. E. (2001). The evolution of the digital divide: Examining the relationship of race to Internet access and usage over time. The Digital Divide: Facing a Crisis or Creating a Myth, January 2001, 47–98. http://books.google.es/books?hl=en&lr=&id=MbareJicwKAC&oi=fnd&pg=PA47&dq=The+evolution+of+the+digital+divide:+Examining+the+relationship+of+race+to+internet+access+and+usage+over+time.&ots=B_Dmr4kgIi&sig=ZFd9q3jSFNeijzz2O7a-5LC6vf0
11. Huang, C., Wang, Y., Li, X., Ren, L., Zhao, J., Hu, Y., Zhang, L., Fan, G., Xu, J., Gu, X., Cheng, Z., Yu, T., Xia, J., Wei, Y., Wu, W., Xie, X., Yin, W., Li, H., Liu, M., … Cao, B. (2020). Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. The Lancet, 395(10223), 497–506. https://doi.org/10.1016/S0140-6736(20)30183-5
12. Islam Rabby, M., Hossain, F., Al Islam, M., Sadrul Islam, A. M., Akhi, I., & Huda, S. (2020). Clinical management and suggested treatment for COVID-19 in the Indian sub-continent: A comparative study. Current Medicine Research and Practice, 10(5), 230. https://doi.org/10.4103/cmrp.cmrp_21_20
13. Malaysian Communications and Multimedia Commission. 2020. "3Q 2019 Communications and Multimedia Facts & Figures." Malaysian Communications and Multimedia Commission. - Google Search. (n.d.).
14. Pang, J., Wang, M. X., Ang, I. Y. H., Tan, S. H. X., Lewis, R. F., Chen, J. I.-P., Gutierrez, R. A., Gwee, S. X. W., Chua, P. E. Y., Yang, Q., Ng, X. Y., Yap, R. K. S., Tan, H. Y., Teo, Y. Y., Tan, C. C., Cook, A. R., Yap, J. C.-H., & Hsu, L. Y. (2020). Potential Rapid Diagnostics, Vaccine and Therapeutics for 2019 Novel Coronavirus (2019-nCoV): A Systematic Review. Journal of Clinical Medicine, 9(3), 623. https://doi.org/10.3390/jcm9030623
15. Pick, J., & Sarkar, A. (2016). Theories of the digital divide: Critical comparison. Proceedings of the Annual Hawaii International Conference on System Sciences, 2016-March, 3888–3897. https://doi.org/10.1109/HICSS.2016.484
16. Pick, J., Sarkar, A., & Parrish, E. (2020). The Latin American and Caribbean digital divide: a geospatial and multivariate analysis. Information Technology for Development, 0(0), 1–28. https://doi.org/10.1080/02681102.2020.1805398
17. Rabby, M. I. I., & Hossain, F. (2020). Study of ongoing registered clinical trials on covid-19: A narrative review. In Sao Paulo Medical Journal (Vol. 138, Issue 5, pp. 441–456). Associacao Paulista de Medicina. https://doi.org/10.1590/1516-
18. Ragnedda, M., & Laura Ruiu, M. (2020). defining digital capital. 9–38.
19. Robinson, L., Schulz, J., Blank, G., Ragnedda, M., Ono, H., Hogan, B., Mesch, G. S., Cotten, S. R., Kretchmer, S. B., Hale, T. M., Drabowicz, T., Yan, P., Wellman, B., Harper, M.-G., Quan-Haase, A., Dunn, H. S., Casilli, A. A., Tubaro, P., Carvath, R., … Khilnani, A. (2020). Digital inequalities 2.0: Legacy inequalities in the information age. First Monday, July. https://doi.org/10.5210/fm.v25i7.10842

20. Robinson, L., Schulz, J., Dunn, H. S., Casilli, A. A., Tubaro, P., Carvath, R., Chen, W., Wiest, J. B., Dodel, M., Stern, M. J., Ball, C., Huang, K.-T., Blank, G., Ragnedda, M., Ono, H., Hogan, B., Mesch, G. S., Cotten, S. R., Kretchmer, S. B., … Khilnani, A. (2020). Digital inequalities 3.0: Emergent inequalities in the information age. First Monday, July. https://doi.org/10.5210/fm.v25i7.10844
21. Tarman, B. (2003). The Digital Divide in Education. Online Submission, January 2003.
22. van Deursen, A. J. A. M., & van Dijk, J. A. G. M. (2019). The first-level digital divide shifts from inequalities in physical access to inequalities in material access. New Media and Society, 21(2), 354–375. https://doi.org/10.1177/1461444818797082
23. van Dijk, J. A. G. M. (2006). Digital divide research, achievements and shortcomings. Poetics, 34(4–5), 221–235. https://doi.org/10.1016/j.poetic.2006.05.004
24. Vicente, M. R., & López, A. J. (2010). A multidimensional analysis of the disability digital divide: Some evidence for internet use. Information Society, 26(1), 48–64. https://doi.org/10.1080/01615440903423245
25. Zhang, J., Yang, J., Chang, M., & Chang, T. (2016). Towards a critical understanding to the best practices of ICT in K-12 education in global context. In Lecture Notes in Educational Technology (Issue 9789811003721). https://doi.org/10.1007/978-981-10-0373-8_1
26. NTIA, "Digital Nation: Expanding Internet Usage," National Telecommunications and
27. Information Admin., U.S. Dept. of Commerce, Washington, DC, 2011.
28. Grazzi, M., & Vergara, S. (2014). Internet in Latin America: Who uses it?…and
29. forwhat?Economics ofInnovation and New Technology, 23(4), 327–352. https://doi.org/10.1080/10438599.2013.854513
30. Mendonca, S., Crespo, N., & Simoes, N. (2015). Inequality in the network society: An integrated
31. approach to ICT access, basic skills, and complex capabilities. Telecommunications Policy, 39(3–4), 192–207. http://dx.doi.org/10.1016/j.telpol. 2014.12.010
32. Karakara, A. A. W., & Osabuohien, E. S. (2019). Households' ICT access and educational
33. vulnerability of children in Ghana. Cogent Social Sciences, 5(1), 1–21. https://doi.org/10.1080/23311886.2019.1701877
34. U.N. (2020). Education during COVID-19 and beyond A U G U S T 2 0 2 0. August, 2–26.
35. https://unsdg.un.org/resources/policy-brief-education-during-covid-19-and-beyond
36. Milek, A., Stork, C., & Gillwald, A. (2011). Engendering communication: A perspective on ICT
37. access and usage in Africa. Info – The Journal of Policy, Regulation and Strategy for Telecommunications, 13, 125–141. doi:10.1108/14636691111131493
38. World Bank. (2019). GDP per capita (current US$) | data.
39. Https://Data.Worldbank.Org/Indicator/NY.GDP.PCAP.CD.
40. ITU. (2020). Statistics. Www.Itu.Int. https://www.itu.int/en/ITU
41. D/Statistics/Pages/stat/default.aspx
42. BTRC. (2020, April). Internet | BTRC. Www.Btrc.Gov.Bd. http://www.btrc.gov.bd/telco/internet
43. The Daily Star. (2020, October 28). Mobile data speed: Bangladesh only ahead of Afghanistan in
44. South Asia. Https://Www.Thedailystar.Net/. https://www.thedailystar.net/business/news/mobile-data-speed-bangladesh-only-ahead-afghanistan-south-asia-1985365
45. Chinn, B. M. D., & Fairlie, R. W. (2007). The determinants of the global digital divide : a cross-country analysis of computer and internet penetration. 59, 16–44. https://doi.org/10.1093/oep/gpl024
46. Karar, H. (2019). Algorithmic Capitalism and the Digital Divide in Sub-Saharan Africa. Journal of Developing Societies, 35(4), 514–537. https://doi.org/10.1177/0169796X19890758
47. Lopez-Sintas, J., Lamberti, G., & Sukphan, J. (2020). The social structuring of the digital gap in a developing country. The impact of computer and internet access opportunities on internet use in Thailand. Technology in Society, 63(June), 101433. https://doi.org/10.1016/j.techsoc.2020.101433
48. Ming-te Lu. (2014). Digital Divide in Developing Countries. Journal of Global Information Technology Management, 6846(2001). https://doi.org/10.1080/1097198X.2001.10856304
49. Pick, J., Sarkar, A., & Parrish, E. (2020). The Latin American and Caribbean digital divide: a geospatial and multivariate analysis. Information Technology for Development, 0(0), 1–28. https://doi.org/10.1080/02681102.2020.1805398
50. Tewathia, N., Kamath, A., & Ilavarasan, P. V. (2020). Technology in Society Social inequalities , fundamental inequities , and recurring of the digital divide : Insights from India. Technology in Society, 61(April), 101251. https://doi.org/10.1016/j.techsoc.2020.101251
51. Zhou, Y., Singh, N., Kaushik, P. D., & Asia, S. (2011). The digital divide in rural South Asia : Survey evidence from Bangladesh , Nepal and Sri Lanka *. IIMB Management Review, 23(1), 15–29. https://doi.org/10.1016/j.iimb.2010.12.002
52. World internet stats https://www.internetworldstats.com/stats.htm
53. Gómez, D. C. (2018). The Three Levels of the Digital Divide: Barriers in Access, Use and Utility of Internet among Young People in Spain. Interações: Sociedade e as Novas Modernidades, 34, 64–91. https://doi.org/10.31211/interacoes.n34.2018.a4
54. The Daily Star. (2021). Online classes: Increasing the education divide. Https://Www.Thedailystar.Net/. https://www.thedailystar.net/opinion/news/online-classes-increasing-the-education-divide-1931409
55. The Daily Star. (2020). Mobile internet slowest in Bangladesh among 42 countries. https://www.thedailystar.net/business/news/mobile-internet-slowest-bangladeshamong-42-countries-1892761
56. Ookla. (2021). Ranking mobile and fixed broadband speeds from around the world on a monthly basis. https://www.speedtest.net/global-index

57. Ragnedda, M. (2017). The Third Digital Divide: A Weberian Approach to Digital In- equalities. New York: Routledge.
58. Gómez, D. C. (2020). The third digital divide and Bourdieu : Bidirectional conversion of economic , cultural , and social capital to (and from) digital capital among young people in Madrid. https://doi.org/10.1177/1461444820933252
59. https://www.worldometers.info/coronavirus/country/bangladesh/