Learning Loss Amid Closure of Learning Spaces During the COVID-19 Pandemic

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ABSTRACT

The onset of COVID19 forced restructuring of the teaching-learning system from replacement of offline education to online education – to ensure continuation of learning. Sudden transition in the education mode is bound to affect students' learning progress and may lead to learning loss. Under a circumstance of lack of empirical evidence, the present study renders some empirical insights on the factors leading to learning loss of students from different educational levels. For this purpose, 228 students from each educational level of institution – school, colleges and university – have been selected by applying a stratified random sampling technique. We apply ordered logistic regression to investigate the factors affecting the success of the online teaching-learning system and compare the same along different parameters like location and ownership of the institution, and gender of the students. The findings indicate that inadequacy of digital infrastructure and the socio-economic and demographic characteristics of students contribute to high levels of learning loss. Further, the location of the educational institute adds to discrepancies in learning progress. The study suggests the requirement of providing necessary support to remove the digital divide and ensure equitable access to learning platforms at all educational levels.

Keywords: *COVID-19; Learning Loss; online education; learning progress*

INTRODUCTION

The global educational community witnessed a grave jolt post the spread of COVID-19. Almost every educational institution faced closures while adhering to the social distancing directives to combat the spread of the coronavirus. Staying at home, adjusting to the online mode of education, unavailability of books at hand during the initial months of the session, delay in the final assessment and declaration of results, were some of the adaptations the community was subject to in the initial phase of the pandemic. The closure enabled the students to continue their learning process remotely through online classes for more than two academic years. The availability of and accessibility to the required digital infrastructure challenged the success of online education as the pandemic laid bare the discrepancies in the availability of digital facilities. Unaccustomed to online instruction, teachers and students struggled to effectively continue the online learning process. Dissatisfaction with online learning, loss in focus, distraction, and psychological distress disturbed the learning progress (Aristovnik et al., 2020; Kapasia et al., 2020). A report by UNESCO (2020) stressed that the pandemic affected over 91 per cent of the world's student population.

Studies estimate that closure of educational institutions is most likely to bear negative effects on academic achievement (Woessmann, 2020; Kuhfeld et al., 2020; Haeck and Lefebvre, 2020) especially in young students (Tomasik et al., 2021), low-achieving students (Schult et al., 2022) and students from low socio-economic families (Engzell et al., 2021; Gore et al., 2021). Further,

students in low-income countries have faced more reduction in learning than medium-income countries (UNESCO et al., 2021). In India, given the characteristics of the population where the majority of children are deprived of education due to low income, the use of digital infrastructure for education remains a luxury for the better-income households. Sensing the needs of the students from economically disadvantaged families, alternative measures like broadcast of tele classes on national television, and delivery of educational video lessons have been taken (UNESCO, 2022). However, the deployment of digital avenues to ensure the right to education raises issues regarding undiscriminated access by all income groups.

The transition in the life of academicians from face-to-face activities to face-the-screen reality raises queries regarding the effectiveness of such platforms in the growth of the future generations. Although the digital mode of education has been widely appreciated and accepted, the negative effects of the same is also evident among students. Existence of challenges like inadequate digital infrastructure, internet connectivity issues, home environment, and insufficient support from teachers and parents have affected the learning outcomes and led to learning loss among students (Donnelly and Patrinos, 2021; Whizz Education, 2021; Kim et al., 2021). Identification of the most dominant aspect affecting online learning may demonstrate the drawbacks of the application of online education, deal with challenges linked with online learning and frame policies for a resilient education system.

With a background of high rural-urban disparity, the present study, focusing on students from elementary to post graduate level, aims to produce grassroot implications of online learning modes implemented in different schools, colleges and universities in West Bengal, India. Further, comparative analysis of online education considering different parameters – location of the institution, ownership of the institution, gender of the students and type of institution - shall disclose the disparities existing in the system which can be addressed and improved for ensuring the upliftment of the academic community.

LITERATURE REVIEW

Effect of digital platforms on students' learning

To ensure no interruptions in learning progress, online learning platforms have been extensively used during the closure of educational institutions all over the world. The wide scale use of digital platforms has prompted studies investigating its efficiency. The studies enumerate the positive and negative effects of employing digital modes as per the perspective of students, parents as well as teachers. For example, Zhu and Liu (2020) appreciate the efforts of the Chinese Government in seizing the opportunity of digital technology to assure continuity of education through distance learning using online learning platforms like Blackboard and Wechat group platforms. Zhou et al. (2020) underline China's well-established Internet infrastructure in guaranteeing large-scale online education through the implementation of "School's out, But Class's On". However, the existence of certain issues like lack of student-teacher interaction, self-learning ability, self-control and parental supervision bears dissatisfactory results. Studies have found implementation of online education platforms fruitful in schools (Basilaia and Kvavadze, 2020), in higher education in Spain (Gonzalez et al., 2020); and in medical education in Saudi Arabia (Rajab et al., 2020). In the case of a French learning program, van der Velde et al. (2021) report an increase in the right answers to open questions and the students experiencing less time pressure in home-schooling. Certain studies find positive results of using digital learning in select subjects like Mathematics (Spitzer and Musslick, 2021; Meeter, 2021; Gore et al., 2021) and reading (Gore et al., 2021; Depping et al., 2021) during school closure, whereas students from Flemish schools disclosed learning loss and rise in educational inequality (Maldonado and De Witte, 2021). Also, Schult et al. (2022) report low scores of fifth-grade German students in

reading and mathematics. Further, Laupper et al. (2020) investigated whether online and offline assessing teaching quality yield the same results.

Azorin (2020) noted that transformation in the educational mode shall exclude several students from the academic circle due to non-availability of required technological infrastructure in Spain. Limited technological resources (Sintema, 2020), inaccessible Internet facilities, increased technical and monetary issues, response time, absence of traditional classroom socialisation, and lack of face-to-face interaction may cause dissatisfaction (Abbasi et al., 2020) and negatively affect students' performance, especially students who are younger, are from low socio-economic households (Hammerstein et al., 2021), and less-educated homes (Engzell et al., 2021). Higher educated parents are more likely to provide a laptop, help with school work and even afford private tutoring, if required (Haelermans et al. 2022). Andrew et al. (2020) reported that 'children from better-off families' are more likely to gain access to individualised resources – private tutoring, better home set-up for distance learning, while pupils from poor families struggle to cope with home learning. Grewenig et al. (2021) estimate the reduction in learning time to half during school closures compared to the learning time before the school closures. This is more significant in the case of low-achievers than high-achievers as low-achievers spent more time in detrimental activities such as TV, gaming, and social media, than the high-achievers. Champeaux et al. (2022) discuss that excessive time spent on screen time and high levels of parental stress have hindered the learning progress of very young children. Limited interactions with peers affected younger children's emotional status, however, this was partially compensated in the case of older children due to virtual interactions. According to Huber & Helm (2020) a substantial proportion of students reported a worryingly low level of learning at home during the school lockdown.

Aristovnik et al., (2020) found that students in higher education were pleased with the support received from their teachers via online learning. However, some students with poor socio-economic characteristics reported dissatisfaction. On investigating Pakistani students (undergraduate and postgraduate), Adnan and Anwar (2020) anticipated online education to be ineffective during the early months of the lockdown, especially in underdeveloped countries. Quattrone et al., (2020) discuss the actions that can protect higher education institutions without hampering the research and teaching activities. Toquero et al., (2020) recommended certain practices to address educational problems, while Sahu (2020) focused on the impact of the pandemic on education and mental health of the academic community.

Considering Indian students, several studies hint at the problems of using online learning tools. Referring to the agricultural education system, Muthuprasad et al., (2021) found that most students prefer online classes due to their flexibility and convenience. However, broadband connectivity hinders the prospects of students from rural areas. Lack of basic amenities – electricity, high-end gadgets, poor server system resulting in poor Internet connection, hinder rural students from attending classes regularly (Maity et al., 2021; Mishra et al., 2020) and the smooth progress of virtual classes (Dhawan, 2020). Further, absence of personal touch, connectivity issues, and lesser attendance significantly lower the actual benefits of virtual classes (Arora and Srinivasan, 2020). Moreover, school structure, willingness of the school and teachers to conduct virtual classes, availability and accessibility of high-speed internet and economic capability of parents to bear the exorbitant internet charges affect the use of virtual learning platforms in primary schools (Maity et al., 2022).

Kapasia et al. (2020) documented problems faced by undergraduates and postgraduates such as depression anxiety, poor Internet connectivity, and unfavourable study environment. Also, students from underprivileged areas have confronted more study barriers. Similar difficulties and dissatisfaction have been expressed by undergraduate students from Jordan (Maqableh and Alia, 2021), United Arab Emirates (Hussein et al., 2020), North-eastern North America (Lemay et al., 2021), and Afghanistan (Akramy, 2022; Noori, 2021). The students expressed distraction,

reduced focus, psychological issues and management issues, technology and Internet connectivity issues, and inadequate help from instructors as some of the difficulties. Mahapatra and Sharma (2021) claim that this unprecedented crisis has caused academic stress among students, parents and educators, leading to psychological morbidity. Lack of motivation, increase in stress levels, depression and financial difficulties have decreased productivity among the academic groups (Deznabi et al., 2021) and raised educational and social inequities (Shin and Hickey, 2021).

The previous literature reflects the consequences of COVID19 and subsequent lockdown on the lives of the academic community. Also, it documents the effect of extensively adopting digital platforms at different education levels. However, most of the existing literature theoretically examines and documents the issues related to the use of online learning platforms (Zhou et al., 2020; Mahapatra and Sharma, 2021). Most of them exclude the analytical dimension of research. Further, these studies solely focus on a particular field of education like medicine (Abbasi et al.,2020; Rajab et al., 2020), agriculture (Muthuprasad et al., 2021), higher education (Adnan and Anwar, 2020), grade 12 students (Sintema, 2020), or a specific subject (Spitzer and Musslick, 2021; Meeter, 2021) and report poor performance, especially in the case of students from low socio-economic status. The pandemic protracted the implementation of virtual learning platforms for two academic years across different education levels. The present study empirically examines the factors that have led to reduced learning outcomes by considering students from the elementary to higher education levels studying in different schools, colleges and universities which are located in rural, semi-urban and urban regions. This shall uncover whether the factors disturbing learning progress are common at all educational levels and institutions located in privileged or underprivileged areas.

Research Objectives

With the growing technological culture and digital era, it is important to address the predominant issues hindering the success of online learning across different educational levels – schools, colleges, and universities. Accordingly, the following objectives have been set:
1. To find the main factors that have led to learning loss as a consequence of online learning during closure of educational institutions, and
2. To assess whether the estimated learning loss is similar among the surveyed students irrespective of the location or type of educational institution or the gender of the student.

DATA AND RESEARCH METHODOLOGY

Data and sample size

Based on the objectives, data have been gathered from students at different schools, colleges, and universities from two administrative divisions of West Bengal, India – Midnapore and Presidency – by applying a stratified random sampling technique and disseminating a structured questionnaire online, through telephone calls and in some cases, individually, while maintaining physical distancing. The present study considers completed questionnaires received from 684 students: 228 students from each educational institution – school, colleges, and university. The selected districts were divided into different strata based on the level of education - from each stratum students were interviewed. The data was collected during January to May 2022.

The information collected includes students' basic information – age, gender, level of education, the type of educational institution, parental income, educational status, availability of digital facilities, time spent using mobile devices and watching TV. The students provided their opinion on the degree of learning loss they faced while adapting to virtual learning during school closure. Responses collected include students studying in Government (470) and Private (214)

institutions; 376 students were males; 457 of the total 684 respondents are from urban regions, and the remaining 227 are from rural areas.

Research Methodology

We utilised ordered logistic regression analysis to determine the factors which resulted in learning loss due to school closure. To compare the learning differences between the following groups: ownership (government & private), location (rural & urban), and gender (girls & boys), we applied the Welch's t-test and further, the Friedman test to compare the learning loss between the three groups of students – schools, colleges, or universities. Using a paired combination of the school, college, and university students, we used the Mann-Whitney U-test and computed the effect size to get a more specific understanding.

Overview of the variables used in the study

Previous reports and studies point out the incidence of learning loss as quite prominent due to the COVID-19 pandemic across different educational levels. Here, 'learning loss' (considered as the dependent variable 'LLS') is considered when a student responds low learning outcomes through the online teaching-learning system during school closures as compared to the offline mode or traditional method. It denotes reduction in learning levels due to partial (online classes) or no physical schooling, that is, learning outcomes is lower than the expected learning outcomes during an academic year (UNESCO et al., 2021). Based on the pilot survey, we found that students faced challenges in keeping up with the performance before the onset of the pandemic. Accordingly, we have classified the level of learning loss in four groups with ordered values 1 to 4. To understand or estimate the factors contributing to learning loss among students, here, if the respondent finds learning loss maximum, the value assigned to LLS is 4; 3 if they find it above average; 2 if it is moderate, and if it is below average the score is 1.

School closures affected the daily learning mode of the students. To continue education, Government and educational authorities resorted to online modes such as educational platforms. While several teachers telecasted lessons for students through national television programmes (especially for school students), others recorded videos and used online applications. However, given the inadequate availability of digital infrastructure in different educational institutions, and among respective teaching faculties and students, the expected positive results from the application of digital venues are questionable. Lack of access to, or inability to afford the required digital infrastructure – smartphones, Internet/data packs, laptops – is a notable observation from the survey. Further, unaccustomed to the use of digital devices, the students responded that their progress is slow when compared to the pre-pandemic period. From the survey, we found that the respondents from better-off families who reside in urban areas have greater access to digital media, which is supplemented with unmetered Internet service, whereas students from low-income families residing in rural areas struggle to complete a single online class. Slow Internet connection and access to mobile handsets with minimal specifications obstruct the flow in the learning process. Further, these problems may increase in case of those children who have to share the limited resources with their siblings. Thus, such socio-economic factors – household income, location, and type of educational institute – may affect students' learning outcomes. Also, in times of crisis, girls are more likely to face the wrath of financial instability, particularly in poor households. Considering these prominent and common observations from the survey, a total of twelve independent variables as shown in Table 1 have been considered to find the factors contributing to learning loss among students from schools, colleges, and universities. These variables represent the socio-economic structure of the respondent and their access to digital resources.

Table 1: Description of variables

Variable	Description	Type	Notation	Measurement
Online education challenges	Device with a small screen, audio-video issues, unable to respond properly, etc.	Ordinal	OED	1 for each dimension
Teaching materials	Teacher provides with online teaching materials	Ordinal	MAT	2 = if does not provide 1 = otherwise
Assistance	Support from parents/private tutor to do online classes	Ordinal	AST	2 = if there is no support 1 = otherwise
Infrastructure	Availability of Mobile/tab/laptop/computer etc.	Ordinal	INF	4 = none; 3 = mobile; 2 = tab, 1 = laptop/computer
Internet	Internet connectivity	Ordinal	INT	5 = no connectivity; 4 =very slow connectivity; 3 = moderate connectivity; 2 = good and 1 = very good connectivity.
Social media	Time spent on social media	Ordinal	MED	5 =if more than 6 hours; 4 = 4 to 5 hours; 3 = 2 to 3 hours; 2 = 1 to 2 hours and 1 = below 1 hour.
Siblings	Number of siblings	Ordinal	SIB	4 = if 4 children and above;3 = if 3 children; 2 = if 2 children and 1 = if only child
Income	Parental income	Ordinal	INC	2 = income is not sufficient to provide infrastructure in online classes; 1 = if otherwise
Ownership	Ownership of the educational institute	Ordinal	OWN	2 = if governmental; 1 = if private
Location	Location of the educational institute	Ordinal	LOC	2 = if rural and semi-urban; 1 = if urban and metropolitan
Gender	Gender of the students	Ordinal	GEN	2 = if girl, 1 = if boy
Students' category	Students from school, colleges, or university	Ordinal	CAT	3 = school students; 2 = college students; 1 = university students

Source: Researchers' survey (2022)

ANALYSIS AND FINDINGS

Online learning platforms and factors inducing learning loss

First, the reliability of the data has been tested using Cronbach's coefficient alpha. The results from the dataset are considered as reliable since the estimated value is 0.743. We estimate the factors contributing to 'learning loss' as an outcome of using online facilities during school closures considering students from all educational levels. In Table 2, the 'Variable' column lists the various predictors/independent variables. Considering LLS as the dependent variable, ordered logistic regression analysis was applied to assess the variable(s) largely contributing to lower learning outcomes among students on following online educational facilities.

Table 2: *Result of Ordered Logistic Regression*

Method: Ordered logistic regression							LR chi^2 (12) = 251.32
Number of obs = 684							Prob > chi^2 = 0.0000
Dependent variable: Learning loss (LLS)							Log likelihood = -702.005
Mean of the dependent variable = 2.981							Pseudo R^2 = 0.1518
Variable	Coefficient	Std. Error	z	P>z	[95% Conf. Interval]		Variable mean
OED	0.4671	0.1020	4.58	0.000	0.267	0.667	3.323
MAT	0.1167	0.1838	0.63	0.525	-0.243	0.477	1.272
AST	-0.0983	0.2179	-0.45	0.652	-0.525	0.329	1.162
INF	0.4414	0.1348	3.28	0.001	0.177	0.706	2.825
INT	0.3953	0.0959	4.12	0.000	0.207	0.583	3.485
MED	0.2739	0.0776	3.53	0.000	0.122	0.426	3.307
SIB	-0.0040	0.1214	-0.03	0.974	-0.242	0.234	1.807
INC	1.2513	0.1733	7.22	0.000	0.912	1.591	1.392
OWN	-0.1808	0.1631	-1.11	0.268	-0.500	0.139	1.687
LOC	0.6082	0.1730	3.51	0.000	0.269	0.947	1.332
GEN	-0.2473	0.1515	-1.63	0.103	-0.544	0.050	1.450
CAT	0.1565	0.0937	1.67	0.095	-0.027	0.340	2.000
/cut1	4.0410	0.7381			2.594	5.488	
/cut2	5.7531	0.7457			4.292	7.215	
/cut3	8.4326	0.7891			6.886	9.979	

Source: Researchers' calculation

The log-likelihood (-702.005) and the log-likelihood ratio chi-square test [LR chi2 (12) = 251.32, with p-value Prob > chi2 = 0.000] point out that the twelve-predictor model is fit. The Pseudo R^2 (0.1518) implies that the independent variables affect the dependent variable 'LLS'. Other than the parameter estimates for the twelve variables, Table 2 presents the cut points, Wald z statistics and the associated p values. From the column 'Coefficient' of Table 2, we observe that the variables – OED, INF, INT, MED, INC and LOC have strongly contributed to low learning outcomes. The logit regression coefficients (Column 2) of the variables have an associated p-value P>|z|=0.000. The analysis reveals that income (INC) insufficiency is a significant contributor to low learning outcomes. When other predictors are held constant, the level of learning loss can

be predicted to increase by 1.2513 if a student responds that the income is inadequate to afford digital facilities. Similar conclusions can be drawn for other predictor variables. Other than low income, adjustment to the sudden shift to digital modes of learning challenged the students to adapt and focus on studies using the existing devices, Internet connection, data plans and net packs. The logit regression coefficients of OED (0.4671), INF (0.4414), and INT (0.3953) with associated p values > 0.005 denote students faced challenges while adjusting to virtual learning. Availability of suitable electronic devices – mobile, tablet, laptop/computer – supplemented by high-speed Internet connection had been uncommon across these households. Furthermore, social media largely occupied the students time (as depicted by MED's coefficient 0.2739) and thus, led to distraction and less focus on studies. Other than these factors, the location of the educational institute (LOC's coefficient is 0.6082) – rural or urban – have also contributed to low learning outcomes. However, teaching materials (MAT), additional support for studies (AST), presence of siblings (SIB), ownership type of the educational institute (OWN), gender of the respondent (GEN), or whether the respondent studies in school, college, or university (CAT) show no such effect on low learning levels.

Tables 3 to 6 display the marginal effects after ologit using ordered logistic regression showing a change in probability when the predictor variables change by a one-unit increase.

Table 3: Marginal effects after ologit [Y= Pr(1) = 0.03663] using Ordered Logistic

Variable	dy/dx	Std. Error	z	P>z	[95% Conf. Interval]	
OED	-0.01648	0.00420	-3.93	0.000	-0.0247	-0.0083
MAT	-0.00412	0.00650	-0.63	0.527	-0.0169	0.0086
AST	0.00347	0.00770	0.45	0.652	-0.0116	0.0186
INF	-0.01557	0.00515	-3.02	0.002	-0.0257	-0.0055
INT	-0.01395	0.00372	-3.75	0.000	-0.0212	-0.0067
MED	-0.00966	0.00303	-3.18	0.001	-0.0156	-0.0037
SIB	0.00014	0.00428	0.03	0.974	-0.0083	0.0085
INC	-0.04415	0.00853	-5.18	0.000	-0.0609	-0.0274
OWN	0.00638	0.00581	1.10	0.273	-0.0050	0.0178
LOC	-0.02146	0.00674	-3.18	0.001	-0.0347	-0.0082
GEN	0.00873	0.00548	1.59	0.111	-0.0020	0.0195
CAT	-0.00552	0.00338	-1.63	0.102	-0.0122	0.0011

Source: Researchers' calculation

Table 4: Marginal effects after ologit [Y= Pr(2) = 0.13736]

Variable	dy/dx	Std. Error	z	P>z	[95% Conf. Interval]	
OED	-0.05065	0.01138	-4.45	0.000	-0.0730	-0.0284
MAT	-0.01265	0.01994	-0.63	0.526	-0.0517	0.0264
AST	0.01066	0.02364	0.45	0.652	-0.0357	0.0570
INF	-0.04786	0.01522	-3.15	0.002	-0.0777	-0.0180
INT	-0.04286	0.01089	-3.94	0.000	-0.0642	-0.0215
MED	-0.02970	0.00853	-3.48	0.000	-0.0464	-0.0130
SIB	0.00043	0.01316	0.03	0.974	-0.0254	0.0262
INC	-0.13568	0.02100	-6.46	0.000	-0.1768	-0.0945
OWN	0.01960	0.01771	1.11	0.268	-0.0151	0.0543
LOC	-0.06595	0.01900	-3.47	0.001	-0.1032	-0.0287
GEN	0.02682	0.01651	1.62	0.104	-0.0055	0.0592
CAT	-0.01697	0.01024	-1.66	0.098	-0.0370	0.0031

Source: Researchers' calculation

Table 5: *Marginal effects after ologit [Y= Pr(3) = 0.58035]*

Variable	dy/dx	Std. Error	z	P>z	[95% Conf. Interval]	
OED	-0.01944	0.00821	-2.37	0.018	-0.0355	-0.0033
MAT	-0.00485	0.00784	-0.62	0.536	-0.0202	0.0105
AST	0.00409	0.00918	0.45	0.656	-0.0139	0.0221
INF	-0.01836	0.00835	-2.20	0.028	-0.0347	-0.0020
INT	-0.01645	0.00703	-2.34	0.019	-0.0302	-0.0027
MED	-0.01139	0.00527	-2.16	0.031	-0.0217	-0.0011
SIB	0.00017	0.00505	0.03	0.974	-0.0097	0.0101
INC	-0.05206	0.01929	-2.70	0.007	-0.0899	-0.0142
OWN	0.00752	0.00731	1.03	0.304	-0.0068	0.0218
LOC	-0.02530	0.01166	-2.17	0.030	-0.0482	-0.0024
GEN	0.01029	0.00730	1.41	0.159	-0.0040	0.0246
CAT	-0.00651	0.00451	-1.45	0.148	-0.0153	0.0023

Source: Researchers' calculation

Table 6: *Marginal effects after ologit using OLR [Y= Pr(4) = 0.24567]*

Variable	dy/dx	Std. Error	z	P>z	[95% Conf. Interval]	
OED	0.08657	0.01916	4.52	0.000	0.0490	0.1241
MAT	0.02162	0.03405	0.63	0.525	-0.0451	0.0884
AST	-0.01822	0.04038	-0.45	0.652	-0.0974	0.0609
INF	0.08180	0.02500	3.27	0.001	0.0328	0.1308
INT	0.07326	0.01784	4.11	0.000	0.0383	0.1082
MED	0.05076	0.01454	3.49	0.000	0.0223	0.0793
SIB	-0.00074	0.02249	-0.03	0.974	-0.0448	0.0433
INC	0.23188	0.03196	7.26	0.000	0.1693	0.2945
OWN	-0.03350	0.03024	-1.11	0.268	-0.0928	0.0258
LOC	0.11271	0.03229	3.49	0.000	0.0494	0.1760
GEN	-0.04583	0.02813	-1.63	0.103	-0.1010	0.0093
CAT	0.02901	0.01738	1.67	0.095	-0.0051	0.0631

Source: Researchers' calculation

Learning loss across different student groups

The learning progress of students may differ with respect to the type of institution the student is enrolled in or the region he/she resides in. Differences in the capacity of educational institutes to support education remotely may likely affect the learning outcomes (Reimers and Schleicher, 2020). Further, as pointed out by several reports like UNESCO et al., (2021), the education of girls is likely to be more at-risk during crisis periods. Therefore, the learning progress of males may not be similar to females. To assess whether there is similarity in learning loss between any of the above-mentioned two groups of students, Welch's t-test is applied as the sample size of the two groups under comparison have unequal independent observations. The comparison is based on the scores of the variable 'LLS' computed for each student in the sample. First, learning loss scores of students from Government and Private educational institutions have been compared. From the results displayed in Table 7 below, we observe the Welch's t-test statistic (0.641) has the associated *p*-value (0.5217) greater than 0.05 which represents the means of the LLS of the students from Government institutes and from Private institutes not being significantly different. On comparing students enrolled in institutions located in rural regions with those in urban regions, we observe from Table 7 that the Welch's t-test statistic (6.208) has the

associated *p*-value (0.0000) less than 0.05 which points out that the means of the LLS are significantly different. From the results in Table 7, we observe that for the two groups of students – males and females – the Welch's t-test statistic (0.987) has the associated *p*-value (0.3239) greater than 0.05 which indicates that the means of the LLS of male students and female students are not significantly different.

Table 7: Result of Welch's t-test

Null Hypothesis (H$_0$)	Parameter	N	Mean	S.D.	Value of Welch t-test	Value of degree of freedom (d.f.)	p-value
There is no significant difference between govt. and private students in learning loss	Govt.	470	2.9957	0.8489	0.641	387.558	0.5217
	Private	214	2.9486	0.9101			
There is no significant difference between rural and urban students in learning loss	Rural	227	3.2687	0.8637	6.208	437.820	0.0000
	Urban	457	2.8381	0.8351			
There is no significant difference between female and male students in learning loss	Females	308	2.9448	0.8657	0.987	657.031	0.3239
	Males	376	3.0106	0.8702			

Source: Researchers' calculation

To assess whether the learning loss is similar at all levels of education – school, college, or university – Friedman's Test has been considered. The results of the Kolmogorov-Smirnov Test in Table 8 below indicate that the dataset does not have a normal distribution. As the dataset is non-normal and consists of three groups of students – from schools, colleges and universities, the Friedman test has been used to evaluate whether there exists any statistically significant difference in the means of learning loss of the three groups. Here, the null hypothesis is that the means are identical.

Table 8: Results of Kolmogorov-Smirnov Test and Friedman test

Students of	Mean	Standard Deviation	Kolmogorov-Smirnov Test		Friedman test	
			Kolmogorov-Smirnov Z	Asymp. Sig.	Chi-Square	Asymp. Sig.
Schools	3.1228	0.8035	4.182	0.000		
Colleges	2.9737	0.8999	3.819	0.000	13.578	0.001
Universities	2.8465	0.8796	3.828	0.000		

Source: Researchers' calculation

Friedman's Q [Chi-Square (test statistic of the Friedman Test)] in Table 8 indicates how far the mean ranks lie apart. Here, Friedman's Q (13.578) has an associated p value less than 0.05 (Asymp. Sig.) indicating that the differences are statistically significant which suggests that the mean learning loss is not identical for all institutions. The learning loss experienced by the students is different with respect to the educational level – schools, colleges, or universities. Further, we applied the Mann-Whitney U-Test and Effect Size to understand the level of difference between school and college; college and university; university and school.

Table 9: *Results of Mann-Whitney U-Test and Effect Size*

Pair	Mean Difference	Mann-Whitney U-test (2-tailed)	Pooled Std. Deviation	Measure of effect size (Cohens d)	Measure of effect size (with Mean absolute deviation)
School-college	0.1491	1.573 (0.116)	0.8531	0.1748	0.2378
School-university	0.2763	3.301 (0.001)	0.8424	0.3280	0.4301
College-university	0.1272	1.603 (0.110)	0.8898	0.1429	0.1125

Source: Researchers' calculation

Using a paired combination of the school, college, and university students, we used the Mann-Whitney U-test to compute whether there is any difference in the learning loss across these groups of students. To further check the robustness of the above test, Effect size under Cohen's d and mean absolute deviation (shown in Table 9) has been computed. Effect size, that is, how large an effect is, for large sample sizes (>50) can be measured using Cohen's d that can suggest whether the difference between two groups' means is less, medium, or large even if it is statistically significant (Cumming, 2012; Hedges and Olkin, 2014). If, d = 0.2 it indicates small effect size; if it is 0.5, then effect size is medium; 0.8 indicates large effect size. Here, the difference in learning loss in the case of students from schools, colleges and universities is quite less, indicating that students from all educational levels have suffered from the shift in the teaching-learning mode.

DISCUSSION

Students have passed almost two academic years without the benefits of the face-to-face teaching-learning system. The experience of sudden implementation of any system is bound to be either satisfactory or bring dissatisfaction. Adherence to virtual learning platforms instead of the conventional method is bound to challenge the effectiveness of imparting education on a large scale. Considering the socio-economic condition of the majority of students, the present study documents the scenario of 684 students from different educational levels. The Ordered Logistic regression analysis clearly indicates that students faced huge challenges while adjusting to the online medium of learning. The six independent variables – online education challenges, digital infrastructure, Internet connectivity, time spent on social media, income of the parent and location of the educational institute – have contributed to learning loss. Due to low-income potential, affording a suitable device with high-speed Internet connection was a luxury for few. Many others had to suffice with cell phones having small screens and slow Internet connection. This led to audio and visual issues which was a common hindrance in the otherwise smooth delivery of lessons at the time of face-to-face interactions. These barriers easily affected their concentration and deviated their focus to less productive activities. Constant fear of getting affected by the virus, reduced inter-personal interactions and replacement of group activities with solo activities – playing games, watching online shows and series, spending time on Facebook, WhatsApp, Instagram, and other social media handles – weakened students' attention on studies. The scenario was even more grim for students enrolled in educational institutions located in the rural and semi-urban regions. Lack of digital infrastructure and Internet connection had been a common hindrance in learning progress. Further, where in some cases Internet connection was available, weak connectivity disrupted conversations, and led to loss of motivation among students. This finding is consistent with Kapasia et al., (2020), Maity et al., (2022), Mishra et al., (2020) and Aristovnik et. al., (2020). Some of the students agreed that the assessments were not taken sincerely. Also, in some cases, where pupils could not gain support or afford additional support, the development of skills totally depended on students' resilience. Unfamiliar with how

online learning platforms could be used, students and teachers faced hindrances in proceeding with the learning process especially in the initial months. Due to unavailability of books in hand, students had to rely on materials received from teachers, e-books, or pdf which they were not much accustomed to in the earlier days.

The above factors which interrupted the daily study pattern and triggered loss of knowledge and skills may be more pronounced with respect to the educational institute the student is enrolled in, that is, private, or governmental. However, on comparing the learning loss values of students enrolled in private institutes with Governmental institutes, no significant difference has been found. Due to school closure, it has been noted that girls were at higher risk of dropping out of school (UNESCO et al., 2021). This may affect the learning outcomes and increased the gender divide. In the present study on applying the Welch's t-test, no such significant difference in learning loss is evident between girls and boys (Table 7). However, significant difference has been found on comparing learning loss scores of students from rural and urban regions. The presence of dissimilar access to and availability of digital infrastructure in rural regions may lead to such differences. Students could not completely rely on educational programmes that were broadcasted on national television or video lessons delivered through WhatsApp. The above analysis points out that other than learning loss, closure of educational institutions has led to learning inequalities as well. Expected growth in learning inequality in particular subjects have been reported in Ethiopia (Kim et al., 2021), Australia (Gore et al., 2021), Germany (Schult et al., 2022). Learning loss is more pronounced among students from poor socio-economic demographics which indicates learning inequality among students of the same age or educational level. Differences among students' motivation, skills and determination to study online shall increase the learning gaps among students at the same educational level. Reports (UNESCO et al., 2021; UNICEF, 2020) and studies (Gore et al., 2021; Donnelly and Patrinos, 2021) remark on the likelihood of growing inequality in education due to the existence of the demographic structure. This reflects the requirement to design a better pedagogical system for the upcoming generations, especially in the rural belt to ensure equal education.

CONCLUSION

Class disruption due to the pandemic affected students, especially in low and lower-middle income countries (United Nations, 2020). Closure of learning spaces threatened the progress of children, youth, and adults, particularly those from more disadvantaged families. The onset of COVID-19 accompanied by physical distancing measures and lockdown initiated a transition from the offline to online mode of education. However, the suitability and sustainability of using digital learning platforms instead of conventional methods are uncertain, as evident from the current study and previous reports (Andrew et al., 2020). The findings disclose the lacunae and problems of mainstreaming online platforms to impart education. Although the presence of virtual learning resources has ensured continuity of education amidst the crisis, several factors have hindered this process and widened the learning gaps. The study confirms low learning outcomes among students due to insufficient digital learning resources, Internet connectivity issues, low parental income (Maity et al., 2020), rural location of the educational institute and increased social media usage. While some students have thrived through these difficulties, others have suffered losses.

The analysis of the adoption of the online education mode has showed how students from different levels of education (schools, colleges, and universities) who are from rural and urban regions of West Bengal have dealt with the 'new normal'. The study throws light on the impact of the COVID19 induced closure of educational institutions on the academic community. Comparative analyses regarding the successful implementation of digital learning regarding parameters like location, type, and ownership of the institution draw attention to the ingrained disparities pre-existing in West Bengal. The assessment of learning loss among students from

rural and urban regions points out the inadequacies faced by underprivileged regions. The situation is grim especially for very young students from less privileged families who rely on the school curricula to complete their education. They have received less support in their studies from parents and their families as they did not possess the required skills and resources. Further, fear and uncertainty during the pandemic shifted the priority of the household from the significance of education to taking survival measures. These implies the requirement of revision and update of students' curriculum, educational policies, and steps to remove the digital divide and digital illiteracy to ensure the best interest of society.

Though technological resources are convenient to use and connect people far away, restricted availability of the same among individuals in the lower socio-economic demographics deepens the already existing inequalities. The COVID-19 pandemic has highlighted the necessity of digital avenues to sustain the current era. To harness the potential of the budding students in each belt – rural or urban, students must have access to improved and effective delivery of knowledge. This can be ensured by building and equipping educational institutions with digital infrastructure and upskilling the educational fraternity. Further, the vulnerable population warrants special attention and adequate support to mitigate the impact of the pandemic. Learning support programmes addressing the deficiencies created due to interruption in the learning process may turn beneficial in the long run. For example, the 'Wings of School' initiative, taken in the remote villages in the *Sunderbans* (a mangrove area in West Bengal, India) intends to revive the learning habit among rural students (Mitra, 2022). Equality in access to quality education, irrespective of where the student is enrolled - a private or governmental institution – or studies in the urban or rural area, may reduce the regional divide. Formulation of policies to provide efficient and timely support to the academic community may help develop a resilient education system. The user experiences highlight the need to implement new fora and solutions for the upcoming generations to prepare the academic community for any similar, uncertain, and difficult times. Overall, this ground-level evidence attempts to bring the attention of concerned authorities to take steps to design an education system to ascertain the achievement of the goals of 'education for all'. Further research exploring the impact of remote or digital learning on students learning progress, especially in less privileged areas, may produce more evidence and contribute to preparation of educational policies in the national interest.

Data availability statement:

The data that support the findings of this study are available from the corresponding author upon request.

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