Draft 1 for review – not for publication

Relationships between ICTs and primary & secondary education during the COVID-19 pandemic in India

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Abstract

Education is considered one of the basic services/infrastructures that the state ought to provide for its citizens as indicated in the conceptual framework and the literature linking it to minimum thresholds of a social contract that the state should in terms of its obligations to its citizens (Trivelli et al, 2020). The COVID-19 pandemic saw a complete halt in traditional school-based (in-person) education due to movement and gathering restrictions. This was therefore an opportunity to see how successfully (or otherwise) education delivery over digital technology filled the gap — after all, years of investment by multilateral funders, charitable foundations, and nation states in various ICT technologies in schools, along with the commercially-driven increase in ICT access, would lead one to think that countries would have made the transition to remote education and used digital assets inside schools and homes. However, the reality is somewhat different.

Using data from survey data nationally representative of all households and persons over the age of 15 in India and Sri Lanka that that educational needs indeed drove increased demand for general Internet access in India and Sri Lanka, with many (previous nonusers) coming online for the first time during the pandemic.

Data from India show only 20% of enrolled children got some form of access to education, majority using some kind of digital technology or a mix of digital and non-digital channels. In fact, having digital connectivity made a significant difference, with households with connectivity being more likely to have access to some form of education compared to households without. For example, in India, 28% of the children who lived in a household that was connected to the internet had access to some form of education while only 7% of the children in unconnected households did so. This makes the case for the correlation between digital access and education during technology. However, the households that were excluded were the already marginalized – the rural, the poor, for example. So, it calls into question the ability of ICTs to include the already excluded.

The research also shows that children and families were let down by digital technology itself (e.g., poor quality, lack of devices, digital literacy, data package pricing) as well as analogue complements (schools not being ready), and socio-cultural factors (such as parents not trusting the children to be online by themselves.

Furthermore, is also unclear if this is "education" (a two-way process involving different ways of teaching and learning) or a set of instructions the schools assigned, and the children completed. Long-term education outcomes are yet to be seen, and by third party estimates are expected to be high.

[1] This work was carried out with the aid of a grant from the International Development Research Centre, Ottawa, Canada. The views expressed herein do not necessarily represent those of IDRC or its Board of Governors. The authors also wish to thank Rajat Kathuria, Mansi Kedia, Richa Sekhani and Abhishek Raj, Sujata Gamage for feedback provided during the research design stage of the study. Ruwanka de Silva provided analytical support, while Oliver Keimweiss, Neema Jayasinghe, and Viren Beruwalage provided support in compiling the literature review for this paper. RTI International was contracted to engage in the data collection for this survey.

1. Investments in digital tech in education

1.1 Investments in education

Education is considered to be one of the basic services/infrastructures that the state ought to provide for its citizens as indicated in the conceptual framework and the literature linking it to minimum thresholds of a social contract that the state should in terms of its obligations to its citizens (Trivelli et al, 2020).) Most countries recognise this, having adopted or ratified multiple international instruments of international human rights law. Examples include the Convention on the Rights of the Child (OHCHR, n.d.), the International Covenant on Economic, Social and Cultural Rights, the UNESCO Convention against Discrimination in Education (Right to Education, 2014), and other instruments that mandate that states provide free primary education (and provide secondary and tertiary education, "progressively free of charge") (Right to Education). Around 182 countries mandate a set number of years (with the lowest being five; average, 10) of free, compulsory education guaranteed in legal frameworks (World Bank, n.d.). Other countries provide tertiary education for free as well. Of course, despite international obligations, some states still impose fees on access to primary education. Furthermore, attendance often involves certain indirect costs like books, uniform, and travel that impede access for low-income families.

In 1976, under the 42nd Amendment to the Indian Constitution, school education transitioned from being a state subject to a concurrent one, enabling the central government to recommend education policies while states retained autonomy in implementation (Jain, 2018). The Right of Children to Free and Compulsory Education Act or Right to Education Act (RTE), enacted on 4 August 2009, ensures free and compulsory education for children aged 6 to 14 (Dhar, 2021). The Midday Meal Scheme, initiated by the Government of India, provides free lunches on school days to primary and upper primary students in all the following types of schools; government, government-aided, local body (as well as alternative innovative education centers such as Madrasa and Maqtabs, supported under the Sarva Shiksha Abhiyan) and National Child Labour Project schools administered by the Ministry of Labour (Upadhyay, 2020). It caters to a staggering 120 million children across 1,265,000 schools and Education Guarantee Scheme centers, making it one of the world's largest initiatives of its kind (Upadhyay, 2020).

We know that when it comes to education indicators, the emerging economies in Africa, Asia and Latin America (many of whom are lower income countries) lag behind the more developed countries in the region and of the global north. Within the global South, in general Sub Saharan African has poorer education related indicators when compared to South Asia, and both are behind Latin America (Table 1, 2 and 3). We see that India is a mixed bag in terms of performance indicators – for example, performing poorly on enrolment rates compared to South Asian peers, but spending education amounts close to high income countries.

Table 1: Education indicators by country grouping

Group	Gross enrolment ratio in primary & secondary education (%)			Government expenditure on education as % of GDP	Pupil to qualified teacher ratio in primary education	Pupil to qualified teacher ratio in secondary education
	Total	Female	Male			

Low-income countries	73	69	77	3.5	46	25
Middle- income countries	88	88	88	4.5	27	20
High-income countries	104	103	104	5.0	-	-
India	83	84	82	4.4	30	28
South Asia	89	88	90	3.9	32	25

Source: World Bank DataBank: Education Statistics (World Bank, n.d.) ; Note the gross enrolment ratio is for the year 2018, while government expenditure and pupil to qualified teacher ratio are for the year 2019.
Note Unavailable data indicated by a "-"

Table 2: Education indicators: LDC vs. OECD comparison

Group	Gross enrolment ratio in primary & secondary education (%)			Government expenditure on education as % of GDP	Pupil to qualified teacher ratio in primary education	Pupil to qualified teacher ratio in secondary education
	Total	Female	Male			
Least- Developed Countries	77	75	79	3.3	42	28
OECD countries	104	104	104	5.3	-	-
India	83	84	82	4.4	30	28
South Asia	89	88	90	3.9	32	25

Source: World Bank DataBank: Education Statistics (World Bank, n.d.)
Note Unavailable data indicated by a "-"

Table 3: Education indicators by geography

SDG Region	Primary completion rate (%)			Upper secondary completion rate (%)		
	Total	Female	Male	Total	Female	Male
Sub-Saharan Africa	63	65	60	26	25	29
Central and Southern Asia	87	88	86	52	50	55
Western Asia and Northern Africa	89	88	89	56	58	55
Latin America and the Caribbean	92	94	91	61	65	58
Eastern and South-eastern Asia	97	97	95	70	76.1	64
India	95	96	94	32	25	38
South Asia	91	95	87	50	44	56

Source: World Bank DataBank: Education Statistics (World Bank, n.d.)

1.2 Investments in ICTs – global trends

The use of ICTs in education has been viewed as a way for emerging economies to not just improve but to also leapfrog and catch up with developed countries on education related indicators – in access to education, quality of education and education management. Investing in ICTS within education systems was seen as a way for teachers to access teaching content that could be centrally developed and distributed. Connected devices were seen as a way for students to acquire new knowledge through newer ways of learning. Education management and information systems were seen as a way for school administration systems to have efficient and up-to-date information. There have been not only top-down government policies and national-level programmes, but also bottom-up initiatives with non-governmental/community-based organisations and demand stimulation strategies that were funded and implemented in many countries.

For example, multilateral initiatives started in the early 2000s, and many continue today in various forms. The UN ICT Task Force (UN Press, 2001) was established in 2001 and aimed to promote the use of ICTs for economic and social development, including in the education sector. The UNESCO ICTs in Education Programme (UNESCO Bangkok, 2007) was established in 2002 to support the integration of ICTs in education systems worldwide. The World Summit on the Information Society (WSIS) (UNESCO, n.d.) as far back as 2003 recognised the importance of using ICTs to improve education and promote digital literacy. The UNDP's Global e-Schools and Communities Initiative (GeSCI, n.d.) was launched in 2004 and aimed to promote the use of ICTs in education in developing countries, with a particular focus on teacher training and curriculum development. The UN's Global Alliance for ICT and Development (GAID), established in 2006, aimed to promote the use of ICTs for sustainable development, including in the education sector.

Such global initiatives have often been supported by and supportive of numerous national-level initiatives in developing and developed countries. The SchoolNet Namibia Project (EDC, n.d.), launched in Namibia in 1999, aimed to use ICTs to improve teaching and learning in Namibian schools. The National Education Technology Plan (NETP) (Arafeh, 2004) in the United States was first released in 2004 and has been updated multiple times since then to provide a framework for using technology to improve teaching and learning in US schools. The Digital Education Revolution (DER) (Australian National Audit Office, 2011) in Australia, launched in 2008, aimed to provide all Australian students in years 9-12 with access to a computer for learning. The National Strategy for Information and Communications Technology in Education (NSICTE) (UNESCO, 2017) of the Philippines, launched in 2007, aimed to improve the quality of education in the Philippines through the integration of ICTs. The South Korean Government's Smart Education Initiative (Lim & Kye, 2019), launched in 2011, aimed to promote the use of ICTs in education, with a focus on digital textbooks and online learning. The Singaporean Government's Masterplan for ICT in Education (Ministry of Education, Singapore, n.d.), launched in 1997, aimed to integrate ICTs into all aspects of education, from curriculum development to teacher training.

The impact of such initiatives has been mixed at best, with some literature pointing to failure or low impact of ICT investments in education, while others cite positive results. Many studies that are available come from the developed world, and a “comprehensive and rigorous body of evidence of the educational impacts of ICT interventions in developing countries does not yet exist and is needed to better understand if and how particular interventions will prove effective” (Tolani-Brown, McCormac, & Zimmermann, 2011, p.232) .

For example, a study on the use of mobile phones to improve educational outcomes (Valk, Rashid, & Elder, 2010) that drew from six case studies Philippines, Mongolia, Bangladesh, Thailand, and India found clear benefits, like enhanced learning, increased student interest/engagement, a rise in grades of those at the tail end, and more flexible learning (schedule-wise). On the other hand, issues identified were technological issues/technical difficulties, language barriers and a lack of familiarity with advanced smartphones, and at times higher costs (than traditional learning). Additionally, results were mixed regarding the benefits to students who have been unsuccessful in traditional learning: while one project indicated that mobile-assisted distance learning provided more opportunities for students, another project found that students with weaker academic performance prior to the study found it more difficult to leverage the mobile system, concluding that those students might benefit more from a “teacher-centric” approach. This indicates that ICTs would be useful insofar as students have basic tech literacy and a basic academic foundation.

A 2015 study of ICT intervention in Malaysia (Ghavifekr & Rosdy, 2015) yielded similar results: overall, ICTs were found to have a positive impact on education, in a number of ways: students were more engaged in lessons, were able to broaden their knowledge, were assisted in improving their language learning skills (reading, writing, listening and speaking), saw improvements in ability to be creative/imaginative and better express their thoughts and ideas teachers found it easier to teach. However, it was also found that a lack of support from school administrations and training and development for teachers in ICT use, and sufficient time to learn to use ICTs in teaching, can hinder benefits. Therefore, the results here indicate that ICTs work to the extent that teachers are sufficiently trained and competent and confident in their ability to handle systems.

A study in Kenya on the utility of low-cost ICT materials – DVD-based content – in the classroom (Tabira & Otieno, 2017) yielded similarly mixed results. The test mean scores from science classes where ICTs were used were higher than for the classes where ICTs were not used (in the two schools involved in the study). However, the test mean scores from maths class in one of the schools yielded the opposite result. This indicated certain insights on teacher/instructor use of ICTs: findings and interviews indicated that teachers with prior experience using ICTs were cognisant of its limitations, and therefore used DVD materials in an interactive approach that involved discussion, while teachers with no prior experience with ICTs used the DVD material entirely as substitutes. The latter group were found in the maths class and school in which test results in the non-ICT class were higher. The takeaway here is that positive impacts of ICTs can depend on the teacher's competency with the technology.

A 2017 Asian Development Bank (ADB) report on the adoption of ICTs in education in Bangladesh, Nepal and Sri Lanka corroborates this emerging pattern of administrative and development support for ICTs as an instrumental factor in successful implementation, with its findings of "significant gap[s] between development goals and the outcomes of implementation of ICT in education" (p. xi), identifying "fragmented efforts with redundancies and lack of sustainability and scalability of ICT in education efforts".

ICTs were expected to transform education from teacher-centred, lecture-based instruction to student-centred, interactive learning environments (Jones, n.d.). A 2015 systematic review (Gamage & Tanwar, 2017) looked at all English-language reports published between 1990 – 2014 that addressed the use of technology in the classroom. The study examined 63 studies in-depth and quantitatively synthesised a subset of them, finding that teacher training, one laptop per child, and on-site coaches contributed to positive effects. It also found that perception of teachers regarding the use of technology was twice as important as their perception of the ease of use of that technology.

Developing countries face additional barriers in adopting ICTs in education. Snoeyink and Ertmer (2001) identify a series of barriers including lack of equipment, unreliability of equipment, lack of technical support, and resource related issues, organisational (school) culture, teacher factors, beliefs about teaching and technology, and openness to change. For example, Table 4 shows that lower-income countries have fewer individuals who use the Internet and own mobile phones.

Table 4: Internet and phone usage by national income level

Group	Individuals using the Internet (% of population)	Individuals owning a mobile phone (per 100 inhabitants)
Low-income countries	20.6	49.1
Lower-middle income countries	-	65.5
Middle-income countries	57.3	-
Upper-middle income countries	-	76.3
High-income countries	89.6	95.4

Sources: Individuals using the Internet (2020 data): World Bank DataBank: SDG Statistics (n.d.); Individuals owning a mobile phone (2022 data): International Telecommunication Union (n.d.)

Unavailable data indicated by a "-"

All these translate into lower levels of ICT use in education in the lower income countries. Furthermore, within developing countries, there are significant gaps in access to the Internet, suitable devices, as already highlighted in other chapters.

1.3 Investments in ICTs – India

India too has looked to ICTs to bridge various gaps in education delivery and management. On the 28th of January 2021, the Government of India and the World Bank signed a $500 million agreement for the Strengthening Teaching-Learning and Results for States Program (STARS), aimed at improving the quality and governance of education data systems (including education management information systems-EMIS) in six Indian states: Himachal Pradesh, Kerala, Madhya Pradesh, Maharashtra, Odisha, and Rajasthan (World Bank Group, 2022). The $500 million loan from the International Bank for Reconstruction and Development (IBRD), has a final maturity of 17.5 years including a grace period of five years (World Bank Group, 2022). Moreover, with a focus on secondary education, Rashtriya Madhyamik Shiksha Abhiyan (RMSA) has integrated ICT in classrooms to enhance the quality of teaching and learning. It includes the establishment of smart classrooms equipped with digital tools (Gogoi, 2021). Moreover, the central government approved the extension of the Samagra Shiksha Abhiyan (SSA) 2.0 for school education, with a substantial financial outlay of Rs 2,94,283.04 crores for implementation from April 1, 2021, to March 31, 2026 (DNA India, 2021). This comprehensive initiative, falling under the Samagra Shiksha scheme, encompasses the establishment of 14,868 ICT labs and 58,534 smart classrooms as part of the government's digital initiatives in the 2020-21 and 2021-22 periods (Khanna, 2021). It is projected to benefit 1.16 million schools, over 156 million students, and 5.7 million teachers across government and aided schools, spanning from pre-primary to senior secondary levels, marking a significant step towards enhancing India's level of investment in ICTs (Khanna, 2021).

2.Education during the pandemic

2.1 Trends in Asia

The spread of COVID-19 resulted in many countries going into various stages of reduced mobility in Asia, similar to most parts of the world. For primary and secondary schools, this meant shutting them down to in-person learning. Attempts were made to engage in learning/teaching using various methods, including using ICTs, distribution of printed teaching material and so on. The length of closures and impacts of lack of in-person learning varied by region, country, and age group. In many (larger) countries, the length of closures varied by state or area, depending on the spread of the disease.

While different countries/regions saw different closure lengths and effects of distance education, students across the globe have incurred considerable costs due to these closures: losses in numeracy, literacy, and other skills they would have gained through in-person schooling. As expected, lower-income countries in Asia, Africa and Latin America have borne the brunt: during the peak of the pandemic, more than half of the roughly 1.6 billion students worldwide left out of school were from LICs (International Development Research Centre, 2022).

Additionally, policy responses vis-à-vis remote delivery were implemented "due to popularity in the global context rather than suitability to the specific context" (Sayed, Singh, Pesambili, Bulgrin, & Mindano, 2021, p. 35) i.e., despite the fact that students and teachers in developing countries (particularly sub-Saharan African, and South Asia, and Latin America and the Caribbean) lacked access to remote learning technologies, and training to use/competency in using them, these regions were quick to adopt distance learning along with the rest of the world. School closures exacerbated existing social problems in these poorer regions like food poverty, gender inequality, technological divides, and inequitable access to good education.

According to UNICEF (2021), 800 million children across Asia were at risk because their education was impacted by COVID-19-related shutdowns since early 2020. Schools in Asia were closed for an average of 50% of teaching days. In some countries, the number was much higher – the Philippines and Bangladesh closed schools to in-person learning the entire period from 2020 until the second half of 2021. Some countries had almost two years of school closure. Others had more than one round of closures, with open schools in between – for example, Fiji had two school closures between 2020 and 2021 (ADB, 2022). Apart from the Maldives, schools throughout South Asia were fully closed for longer than the global average. Re-opening schools was a challenge because many schools lacked water, sanitation, and health facilities.
Of course, educational activities did not stop completely for everyone. Many countries moved to remote delivery of education. Emphasis was placed on distance learning, using ICTs. While all countries in the region implemented measures to allow students to continue their studies remotely –TV, radio and the Internet were the most common methods – many children were unable to access these provisions (UNICEF, 2021). Most countries struggled with the lack of resources, lack of readiness, lack of skill, lack of access to and/or affordability of quality connectivity. Consequently, by 2021 at least 28% (around 220 million) students from pre-primary to upper secondary in the region had not been reached by remote learning measures (UNICEF). World Bank simulations predict a cost of around 0.3 to 0.9 schooling years due to the pandemic, with the possibility of around seven million students dropping out of school (UNICEF).
Overall, the loss in learning is expected to be significant for Asia's school-aged children. It was not just the loss of learning, but also the mental distress, missed school meals and routine vaccinations, heightened risk of dropping out of school, increased child labour and increased child marriage. Entry into the school system may be another fatality – for example, according to the ADB (2021), in the Philippines, participation rate in organised learning (i.e., the enrolment rate) dropped from 86% in 2019 to 65% in 2020. For much of these negative impacts, the already most vulnerable children were the hardest hit (UNICEF, 2021).
A recent Asian Development Bank estimate (2021) suggests a present value of USD 1.25 trillion in future earnings losses in Asia and the Pacific.
It is not just students who were impacted. Teachers were impacted with increased workload, heightened anxiety about losing their job, future pay cuts and job losses due to digitalisation. About 50% of teachers also did not think they were able to work efficiently due to increased time on devices. The lack of adequate resources in digital form was a worry for many, and self-reported digital tech skill levels were low among many teachers in Asia (Chandran, Sharma, & Kannamma, 2021).

2.2 The Pandemic and education in India

India too broadly followed this trend. On Monday, March 16, 2020, the government of India resorted to closing all educational institutions, encompassing schools, colleges, and universities, as a response to the COVID-19 pandemic (Gaikwad, 2023). This decision had far-reaching consequences, affecting 320 million students in the country. In April 2020, the Ministry of Human Resource Development (later renamed the Ministry of Education following the publication of the National Education Policy 2020) introduced the Alternative Academic Calendar (AAC) guidelines to facilitate continued formal education online (Gaikwad, 2023).

Under the "One Nation, One Digital Platform" initiative, the Ministry of Education launched PradhanManthri (PM) e-VIDYA on May 17, 2020, aimed at unifying digital, online, and on-air education efforts (PIB India, 2022). The initiative has expanded to include 200 channels from the initial 12, with an allocation of Rs 1 lakh in the Union Budget 2022-23 (India Today, 2022). PM e-VIDYA comprises DIKSHA, offering quality e-content for school education across states and UTs; Swayam Prabha TV channels dedicated to each class from 1 to 12; radio, community radio, and the CBSE Podcast to enhance educational accessibility; and specialized e-content for visually and hearing impaired students (PIB India, 2022). When referring to state-level curriculum-based TV programs, Tamil Nadu's Kalvi Tholaikatchi TV, launched in 2019, extended its reach to private channels during the pandemic, creating over 9,000 videos involving 8,500 teachers. To accommodate limited internet access, radio lessons and textbook distribution were introduced. The scheme is anticipated to benefit around 10 lakh students and has been allocated a budget of Rs. 240 crore (Agarwal, 2023). Kalvi TV's 30-minute episodes achieved a viewership of 1 million and were uploaded on YouTube, expanding globally to places like Sri Lanka, Singapore, and the United States (Raman, 2020).

3. Methodology

This paper draws on data from LIRNEasia's 7,500[2] sample nationally representative survey conducted between March 2021 and October 2021, which allows for national level estimates to be made within a 95% confidence interval with ±2.8% margin of error. The target populations for the survey included all households and population aged 15 and above in Sri Lanka. National representation at the desired levels of precision was achieved by using a comprehensive national sample frame at the most granular level possible (most granular administrative division level data) and ensuring random selection at every level of sample selection.

Table 5: Coverage and sample frame related information of the survey

Coverage	Sample frame used	Level of representation
350 wards and villages covering 22 states and 150 districts. The state of Kerala is excluded from the sample.	Ward (urban) and village (rural) level data from the 2011 National Primary Census Abstract Data	National, urban-rural level and five states (National Capital Territory of Delhi, Maharashtra, Tamil Nadu, Assam and Kerala)

The sampling methodology in steps is as follows.

- Separation of national sample frame into urban and rural primary sample locations (PSUs)
- Sampling the required number of PSUs from each stratum (urban and rural) using probability proportionate to size (PPS)
- Segmentation of the PSUs where the number of households exceeds a certain threshold (about 200 to 250 households)
- Mapping, listing, and marking all households in the selected PSU or a randomly selected segment of the PSU.
- The lists serve as the sample frame for simple random selection of households. This was done with the assistance of key informants (e.g.: Gram panchayat, Village/ward officers etc.)
- Systematic random selection of the required number of households (20-25) from each selected PSU or the PSU segment

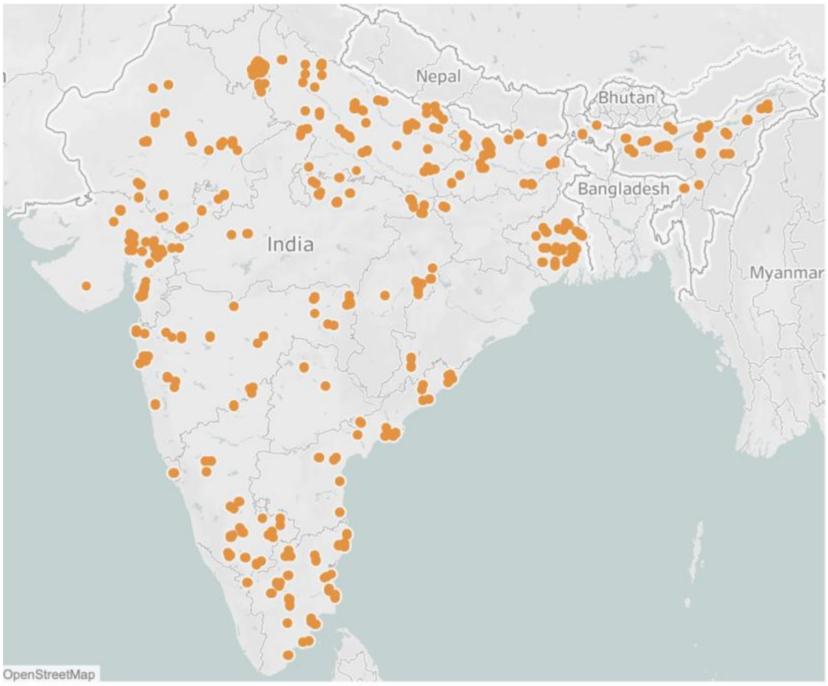
[2] The state of Kerala was excluded from the sample in the 2021 India survey since fieldwork could not be carried out in Kerala throughout the duration of the survey period due to particularly strict travel restrictions imposed by the state to control the prevailing COVID-19 pandemic situation. Hence, the final achieved sample size was limited to 7,000 households and individuals instead of the planned 7,500. As such all the estimates from the 2021 India survey are excluding the state of Kerala

- Listing all household members or visitors aged 15-65 staying the night at the selected household.
- Simple random selection (using the CAPI programme) of one household member for individual survey from household list compiled in the previous step.

The lowest administrative level sampling frames available to the public in India were villages (in rural areas) and wards (in urban areas). Therefore, villages and wards were considered as Primary Sampling Units for sampling for the Sri Lanka survey.

Villages and wards were divided into smaller areas for listing and enumeration. These administrative units typically have a larger number of households. For instance, some wards (specifically in Mumbai, India) can have as many as 100,000 households, making the listing of all households impossible if selected into the sample. Therefore, such large administrative units were segmented while in the field, according to pre-defined methodology, and one or more smaller segments then randomly selected for listing and enumeration. It is important to note that the core principle of random selection was incorporated at every stage of sample selection to ensure national representation. There was no purposive, convenience or quota selection of any kind.

Figure 1: 2021 COVID impact survey sample locations based on GPS coordinates recorded during fieldwork.



Sample size determination

The desired level of accuracy was set to a confidence level of 95% and an absolute precision (relative margin of error) of 2.8%. The population proportion (p) was set conservatively to 0.5, which yields the largest sample size. The minimum sample size (n) was determined by the following equation:

$$n = \left(\frac{Z_a \sqrt{p(1-p)}}{C_p} \right)^2$$

Where,
n = Minimum sample size
Za= Z-value for 0.05 level of significance
Cp = Margin of error
p = Population proportion

Inserting the parameters for the survey yields the minimum sample size for simple random sampling; therefore, for our sample design (stratified with multiple levels in some cases) the minimum sample size was multiplied by the design effect variable.

In the absence of empirical data from previous surveys that would have suggested a different value, a value of 2 was used as the design effect for each country. The actual sample size increased beyond the minimum requirement to compensate for clustering effects, and allow for urban/rural disaggregation of data, as well as gender-based disaggregation and more importantly to have representative data at more granular levels in the sample.

Statistical methods

Logistic regression:
Logistic regression modelling was employed to understand the relationships between enrolled student receiving any form of remote education and receiving education via online means during the COVID-19 lockdowns in March to July in 2021.

Table 6: Variable coding for logistic regression models

Variable	Value	Interpretation
Receiving any form of remote education	1	Received education
	0	Did not received education
Receiving remote education via online means	1	Received education
	0	Did not received education

Logistic regression models were utilized as a binary regression technique suited for scenarios in which the variable of interest is binary.

The logistic models established connections between determining and mediating factors and the outcome variable in Table 6. These models contributed to the estimation of the probability of the outcome variable being above or below a particular threshold, thus leading to the observed outcome.

The probability of the outcome variable (Yi) was calculated using the logistic function:

$$Probability\ (Yi) = \frac{1}{1 + \exp\left(-\alpha - \sum_{t=1}^{n} \beta_i X_i\right)}$$

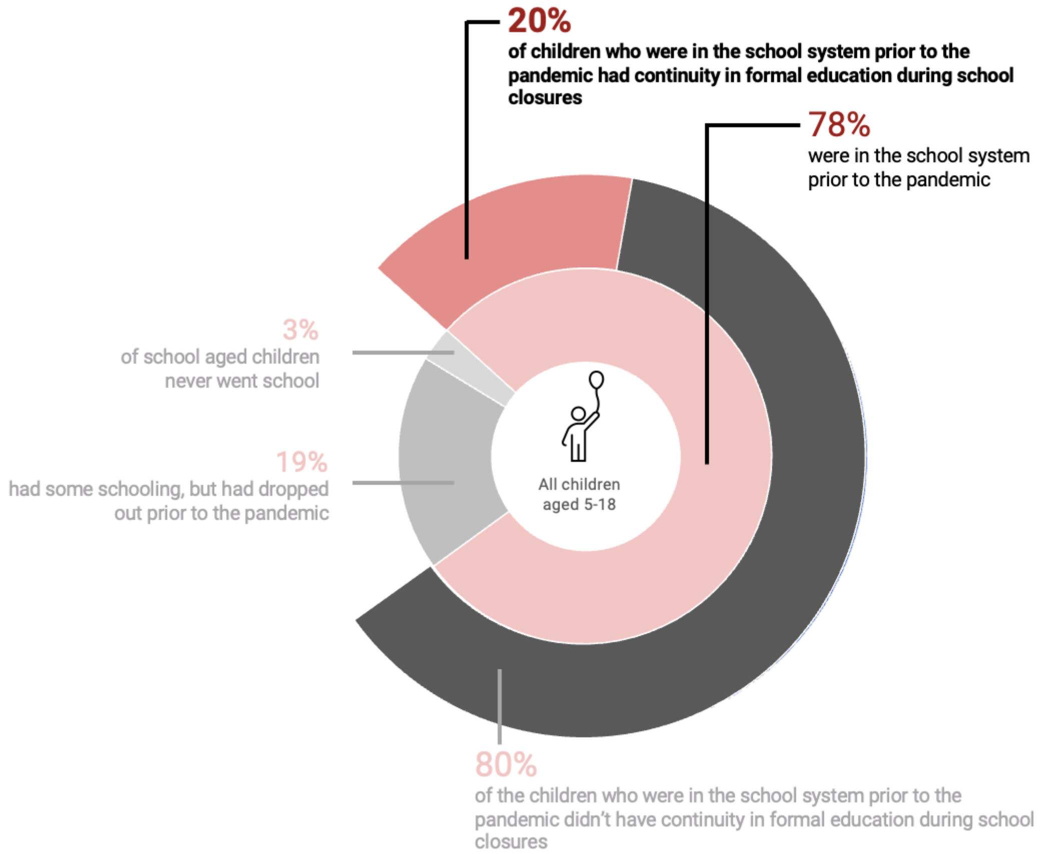
In this equation, Yi represented the dichotomous outcome of interest, as defined in Table 4, while Xi referred to the influential factors (also known as determining and mediating factors) that influenced this outcome. The values of βi indicated the sensitivities of each influential factor Xi. These influential factors corresponded to the series of factors which are related to receiving remote education during the COVID-19 lockdowns. The use of the exponential function in modelling the dependent variable ensured that its predicted value fell within the range of 0 and 1.

4. Findings

4.1 Access to education

First, we examine the extent to which education continued during the lockdowns. We note here that we mean access to some kind of education, irrespective of the quality, quantity or intensity of the content. All respondents who had at least one child in school (in kindergarten up until grade 12/year 12) before the lockdown were asked the question "When schools were closed due to COVID-19, did any child in the household receive any educational services from the school they attended or from the tuition providers?". Among households that had children already enrolled in school prior to the pandemic, 20% received educational services (Figure 2).

Figure 2: Access to education during COVID-19 lockdowns in India



Source: LIRNEasia survey, 2021

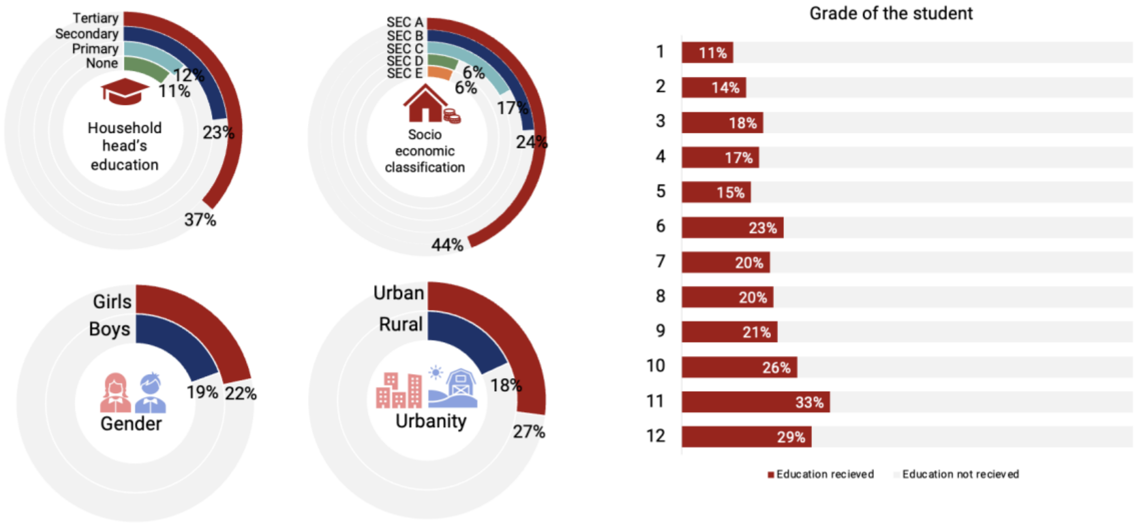
4.2 Characteristics of students receiving education

We can further analyse the 20% of school going children who received some kind of education during school closures to understand their individual and household characteristics.

We see from Figure 3 that the children who received education services were more likely to be in households with educated parents (e.g. with tertiary and secondary education), from middle class or upper middle class households. Interestingly, we see there is not a significant gender gap between boys and girls, both being equally likely to be educated during this period. We see that the small gender difference between male vs female students enrolled in primary education (Table 1) seen at national level continues with a small gender difference in accessing education during the lockdowns too.

The data also shows that that as the age (and school year) of the child increases, the more likely they are to have been educated. This makes sense intuitively in the Indian context, since the most important exams are in year 12 (university entrance), year 10 (after which a small percentage of students drop out) and year five or six (a scholarship scheme that determines entry into better secondary schools). It is of course ironic the age group that received the least amount of education were the primary school children, or those in their first year of school. Primary schools were also closed for the longest period of time even though all research points to the vital role primary education plays (World Bank, 2023). But it is possible that primary school children were taught at home by parents, despite not receiving education from schools.

Figure 3: **Percentage of children who received education services, by location, household head's education, and socio-economic classification.**



Source: LIRNEasia survey, 2021

4.3 Channels for reaching students

Children in India received education through a multitude of means or channels. While many of the channels included the internet/data connectivity via a device (e.g. assignments sent to a smartphone/computer, life online-line lessons, information/instructions sent via text message etc), information and assignments physically delivered to the home played a significant part (Table 7). There is no way to judge from the questionnaire (or the responses if these methods of sending instructions were successful in achieving learning objectives. It is likely that a two-way interaction between teachers and students was better than students simply receiving instructions from the teacher (one way) without any feedback or discussion. Some channels may have been better suited for delivering content in new and interesting way due to the use of multimedia (e.g. video) which is not possible on other channels (e.g. voice calls).

Table 7: Modes of delivery of education during the pandemic in India (as % of students who received education)

Channel	% of students who received education
Live online lessons	55%
Info/work delivered over a phone call	69%
Info/work delivered via text messages	61%
Info/work delivered (physically) home	58%
Instructions to listen to radio programmes	46%
Instructions to watch TV programmes	52%
Recorded audio or video lessons	68%

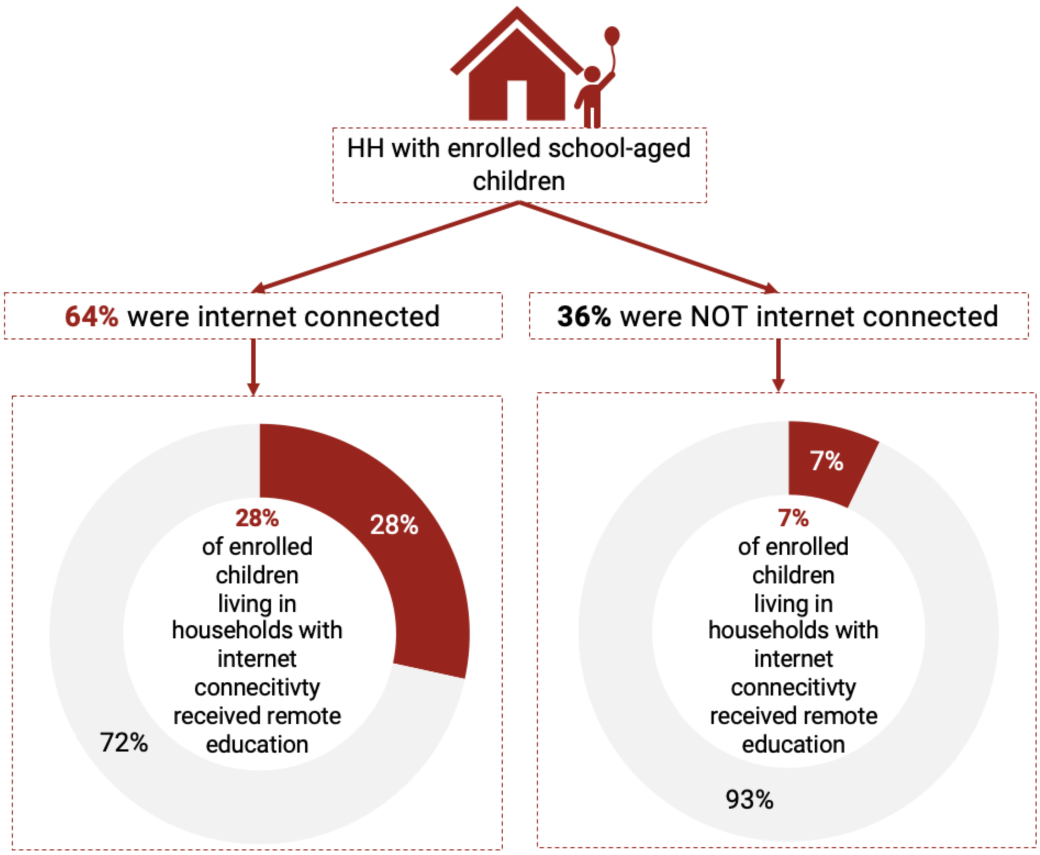
Source: LIRNEasia survey, 2021

4.4 Corelation between internet connectivity and getting educational services

We know that education was a key driver of Internet adoption. In 2020-2021, around 132 million Indians came online for the first time. Of the 81 million who came online in the 2020, 43% said "needs that arose during COVID-19" were the reason they came online"– needs such as working and education.

We also see that having Internet access strongly correlates to accessing education. In India of households that had children of school going age going into the pandemic, 64% had a working connection and 31% of the children in these households had access to educational services. On the other hand, in the 24% of households that had no Internet connectivity only 8% had access to educational services. (Figure 4). While overall the total percentage of children having access to education is low, the households with internet access had higher access to education.

Figure 4: Access to education services by connected vs. unconnected households during the lockdowns



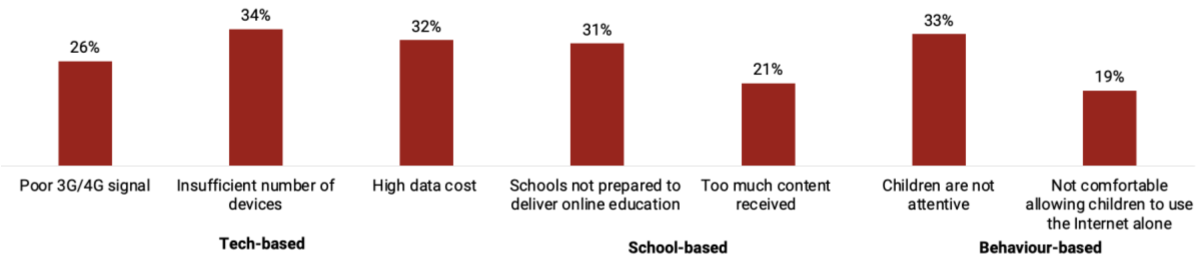
Source: LIRNEasia survey, 2021

4.5 Challenges faced

The survey also asked the respondents to identify the problems faced when accessing education. This question was asked from all households that had children – therefore those with children who did receive education as well as those that didn't.

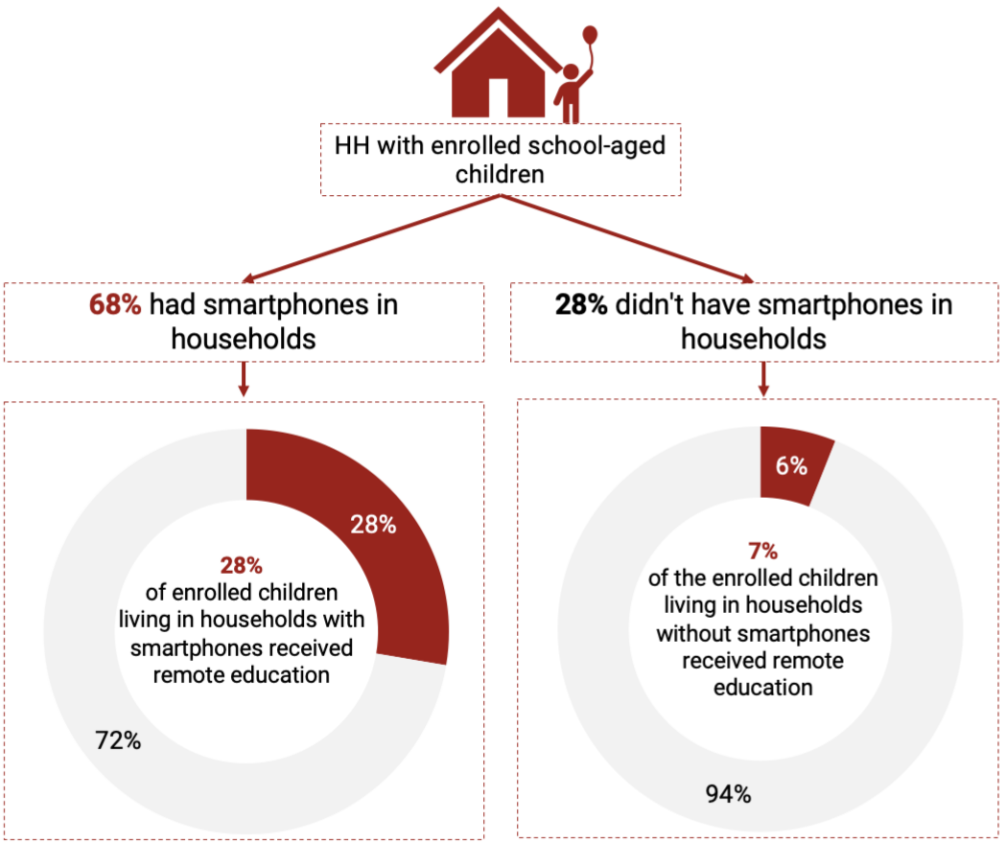
Technology challenges related to signal, availability of devices and affordability of data were faced by all. But those that didn't access education reported a higher incidence of finding data quality poor, possibly indicating a reason why they didn't continue with the education of their children.   6). But technology was just one part of the problem. Schools themselves were not prepared. It appears that households discovered this as their children were accessing education.
Similarly, personal factors such as childrens lack of ability to concentrate in front of a device or engage with content remotely became a probem once they started accessing education.

Figure 5: Difficulties faced with respect education during COVID-19 pandemic (% of households with enrolled school-aged children)



The technology challenges specifically that of insufficient devices, can be explained by looking at Figure 7, which shows the % of households with school-aged children who received education and also had a smart phone in the household. We need to keep in mind that often the phones were used by more than one child for accessing education, and often by a parent for accessing their work.

Figure 6: Access to education services by households with and without smart phones



We know anecdotally that across many countries the situation improved with subsequent periods of lock down because both schools and households/students were better prepared for remote education. More devices were bought too. This is seen in the survey where 24% of households responded “yes” when asked “that were receiving education said they had “Did you observe any improvement in online education delivery over time (from the lockdown in March to today?)”. (Figure 8).   But for some, the improvements may have come too late – 38% of households that had enrolled children in school going into the pandemic reported that a child had dropped out of school by the time of the survey. (Figure 9)

Figure 8: Improvements in education delivery since March 2020 (as % of households whose children received education during lockdown)

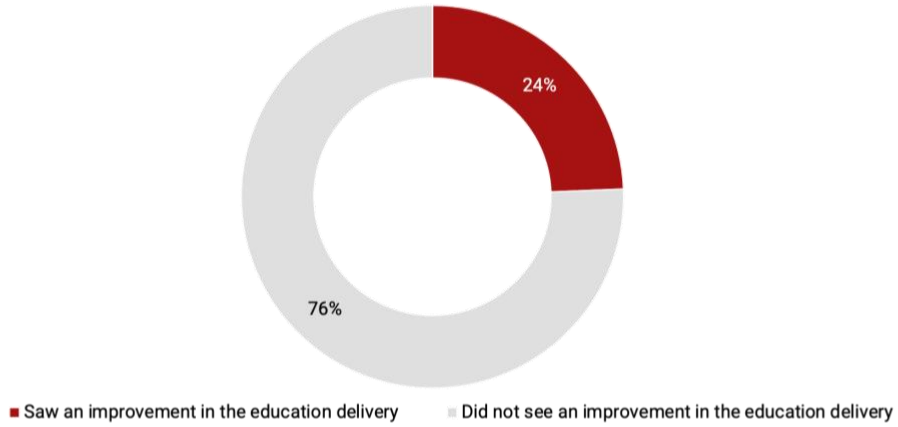
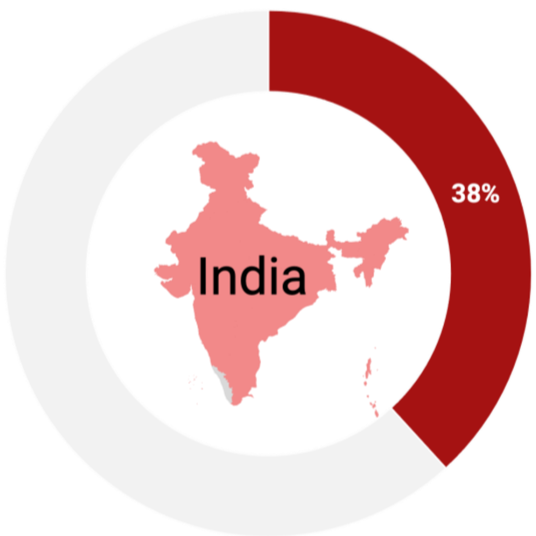


Figure 9: Households with children who dropped out of school (as % of households with enrolled school-aged children)



4.6 Explaining likelihood of getting educational services during COVID – a logistic regression model

We noted above that having intern access is correlated to the likelihood accessing education during the pandemic. However, it's not the only factor, and internet access itself is impacted by a series of factors. As mentioned earlier the data shows a substantial only 20% of the enrolled students received remote education during the initial phase of the COVID-19 lockdowns in India. Among these students, 16% accessed education through online platforms, thereby leaving 4% of the enrolled students exclusively reliant on offline remote education methods. Two logistic regression models designated as model 1 and model 2 to examine the profiles of these student groups. The results of these models are presented in Table 8, highlighting the determinants associated with the 20% of students who participated in remote education in any form and the subgroup of individuals who specifically adopted online educational methods.

Table 8: Logistic regression models on receiving remote education by both online and offline means and online means in India.

Model number		1			2		
Dependent variable		Received remote education in any means			Received remote education in online means		
Nagelkerke R square		0.240			0.296		
Predictors		Sign	exp(b)	Significance	Sign	exp(b)	Significance
Location: Urban (vs Rural)		(+)	1.242	0.013	(+)	1.174	0.099
Gender: Female (vs Male)		(+)	1.211	0.013	(+)	1.119	0.192
Grade category of the child (grade 1-5 is the reference category)				0.000			0.000
Grade 6-9		(+)	1.427	0.000	(+)	1.718	0.000
Grade 10-12		(+)	1.700	0.000	(+)	2.284	0.000
Availability of computers, tabs or smartphones at households		(+)	2.070	0.000	(+)	5.793	0.000
Availability an internet connection		(+)	2.157	0.000	(+)	2.477	0.000
Socio economic classification (SEC E is the reference category)				0.000			0.000
SEC A		(+)	4.874	0.000	(+)	3.101	0.000
SEC B		(+)	2.335	0.002	(+)	1.438	0.209
SEC C		(+)	1.767	0.034	(-)	0.948	0.854
SEC D		(-)	0.858	0.596	(-)	0.485	0.027
Household income reduced during the lockdown		(-)	0.972	0.832	(-)	0.906	0.500
Parent's perception	Poor 3G/4G signal	(+)	1.587	0.000	(+)	1.572	0.000
	High data cost	(+)	1.075	0.453	(+)	1.066	0.550

on education delivery during the lockdowns	Insufficient number of devices	(+)	1.215	0.030	(+)	1.277	0.013
	Uncomfortable with children using the Internet alone	(+)	1.015	0.898	(+)	1.115	0.388
	Too much content received	(+)	1.079	0.461	(+)	1.072	0.546
	Schools were not prepared to deliver remote education	(-)	0.545	0.000	(-)	0.426	0.000
	Children were not attentive	(-)	0.685	0.000	(-)	0.720	0.001
State (rest of India is the reference category)				0.000			0.001
Delhi		(+)	1.002	0.996	(+)	1.139	0.691
Tamil Nadu		(+)	2.152	0.000	(+)	1.478	0.045
Maharashtra		(+)	1.878	0.000	(+)	1.882	0.000
Assam		(+)	1.284	0.367	(+)	1.659	0.092
Constant		(-)	0.025	0.000	(-)	0.010	0.000

In Model 1, the highest positive relationship with receiving remote education was observed for individuals belonging to households classified as SEC A. Being part of an SEC A household increased the odds of receiving remote education by a factor of 4.9, holding all other variables constant. Similarly, households in the SEC B category exhibited a likelihood 2.3 times higher to receive remote education. Moreover, a positive trend emerged concerning the student's grade level, with those in higher grades displaying a greater likelihood of remote education participation compared to their counterparts in lower grades. The presence of an internet connection in households increased the likelihood of receiving remote education by approximately 2.2 times. Similarly, having access to devices such as computers, tabs, or smartphones was associated with a 2.1-fold increase in the probability of remote education receipt. In terms of regional variation, students residing in Tamil Nadu and Maharashtra were more inclined to receive remote education, as compared to the reference group of students from the rest of India.

The parental perspective on education delivery during the lockdowns provided additional insights. Students whose parents perceived schools as unprepared were approximately 46% less likely to engage in remote education. Furthermore, students whose parents reported inattentiveness displayed a reduced likelihood of remote education receipt, at 0.685 times the odds.

Turning to the receipt of education via online means in Model 2, the variable most strongly associated with this outcome was the availability of computers, tabs, or smartphones within households. Students with access to these devices were approximately 5.8 times more likely to receive remote education through online channels. The possession of an internet connection also played a significant role, increasing the odds of remote education receipt by about 2.5 times. Moreover, higher-grade students and those from SEC A households exhibited a likelihood 3.1 times higher of participating in remote education via online means.

The schools' preparedness factor was noteworthy, as perceiving schools as unprepared led to a substantial reduction in the likelihood of online education receipt, with odds lowered to 0.426 times. Additionally, parental observations of student inattentiveness were associated with a diminished probability of online education receipt, at 0.720 times the odds.

Upon comparing the two models, the possession of digital devices (computers, tabs, smartphones) emerged as a consistent determinant, significantly enhancing the probability of both remote education receipt and, notably, remote education via online means. The impact was markedly stronger for online education (Exp(b) = 5.793) than for any remote education (Exp(b) = 2.070). Similarly, the presence of an internet connection yielded a heightened likelihood for both forms of education, with a more pronounced effect on online education (Exp(b) = 2.477) in comparison to any remote education (Exp(b) = 2.157). While higher socioeconomic classification categories generally corresponded to a greater likelihood of education receipt in both models, it is noteworthy that the negative impact of SEC C was more pronounced in the context of online education. Furthermore, higher-grade students consistently displayed an elevated likelihood of receiving both forms of education. Urban residences exhibited a heightened likelihood of receiving education, with a slightly stronger effect observed for online education. The perception of schools as unprepared for online education had a more substantial adverse effect on online education receipt when compared to any remote education. Finally, reporting student inattentiveness demonstrated a more pronounced negative impact on online education receipt as opposed to any remote education.

5. Conclusions

The findings of the study show that having Internet connectivity made a significant difference in the likelihood of accessing education services during the lockdown. Households with connectivity were far more likeley to have children accessing education compared to households without. However, the connected households are still likely to be richer, more educated and more urban – all factors that drive the demand for more and better-quality education in the first place.

India, like other countries, relied on a range of modes or channels to deliver education – from TV to mobile phones to physically printed paper being delivered. Some modes were interactive while others were one-way forms of communication. Parents and children faced significant technical challenges due to poor connectivity, not having sufficient devices and unaffordable connectivity prices as they attempted to access education. The challenges were not only technical – schools were not ready and children found it difficult to concentrate on remote lessons.

But India overall performed poorly in delivering education services to its students during the lockdown. Significant numbers of children dropped out of school. Schools were unprepared. Even though digital connectivity (Which was very poor going into the pandemic) improved drastically during the pandemic (with people over 132 million first time internet users reported), that didn't translate into improved access to education. In part, this has to do with supply side factors – schools were unprepared to deal with the remote delivery. But possibly the new users had significant trouble connecting to the internet and engaging in meaningful (education) too – since they had not necessarily gone through a natural evolution of digital device use.

The hope of digital connectivity substituting as a channel during a lockdown and including the excluded remains unrealized in India. With those who did receive education coming from richer, urban and richer households – in other words, those left behind by the digital revolution (the rural, the poorer, etc.) were still left behind. Furthermore, the mere delivery of "lessons" or "assignments" does not guarantee learning. We already know this to be true in the use of ICTs in education – the systematic evidence (from systematic reviews and other studies cited previously) shows that learning outcomes change only when the educators/teachers incorporate ICTs into the teaching process and believe it to be valuable as a tool. So the lesson for education policy makers is that the benefits of ICTs can be experienced to the extent that curricula and teaching methods change to incorporate ICTs. The use of ICTs to deal with the shutdown of school was probably a simple holding pattern. The loss in education that accrued has to be solved with particular attention and care, and will only be felt in the coming years.

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