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WORKING PAPER

Exploring the Relationship Between Teachers' Use of Technology During the Covid-19 Pandemic in India and Their Perspectives on Students' Motivation to Learn

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Notes

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Contents

Figures and tables

Abbreviations and acronyms

AME	Average marginal effects
MoE	Ministry of Education
NCERT	National Council of Educational Research and Training
NGO	Non-governmental organisation
NPO	Non-profit organisation
OFG	Online focus group
PAL	Personalised adaptive learning
SDT	Self-determination theory
SES	Socio-economic status
SLM	Student learning motivation

1. Introduction

1.1. Background to the study

From the onset of the Covid-19 pandemic, India's schools were intermittently closed for 82 weeks between March 2020 and October 2021, making it the country with the second longest school closures (↑UNESCO, 2020). These closures have affected more than 255 million students in primary and secondary schools across India (↑UNESCO, 2020). In response to school closures, India's education sector saw a surge in remote schooling solutions (↑UNICEF ROSA et al., 2021). In June 2020, India's Ministry of Education (MoE) and the National Council of Educational Research and Training (NCERT) released remote schooling guidelines for teachers, parents, and school principals, stressing technology's integration into teaching and learning. India's education response included some offline activities, such as the delivery of physical textbooks and home visits, but for the most part, India's education response was digital (↑Jena, 2020).

The government fixed its efforts on curating e-content (e-textbooks, worksheets, videos) and making it accessible for teachers and students (↑Bhushan et al., 2021; ↑UNICEF ROSA et al., 2021). India's MoE and NCERT leveraged India's pre-existing Digital Infrastructure for Knowledge Sharing (DIKSHA) platform to make these resources available. An open-access national platform launched in 2017, DIKSHA has enabled stakeholders within the education ecosystem to participate, contribute, and leverage a common platform to facilitate learning at scale (↑DIKSHA, no date). While the platform has been used sparsely across the nation since its launch, it became one of the most downloaded education applications during the pandemic, reaching 10 million instals (↑Banerji, 2021). Therefore, many students and teachers were using these digital tools for the first time during the pandemic.

The government also implemented TV and radio broadcasts to reach more marginalised groups of learners who did not have access to digital devices and internet connectivity. Despite extensive efforts to provide learners access to digital resources at both state and national levels in India, there is limited evidence on how effective the use of these resources was (↑ASER, 2020) and how successful remote schooling was in helping children to progress their learning.

1.2. Rationale and research questions

A wealth of research emerged to quantify student learning and the accessibility of technology for learners during the Covid-19 pandemic. Existing evidence highlights that access to advanced technology (e.g., personal digital devices with stable internet connectivity) did not equate to learning (↑Engzell et al., 2021; ↑Eroglu & Senol, 2021; ↑Haser et al., 2022), yet there is also literature to suggest that students using low-tech modalities (e.g., receipt of SMS and voice calls via feature phones) progressed in their learning (↑Angrist et al., 2020; ↑van Cappelle et al., 2021). This report investigates the underlying reasons behind the incongruity between students' access to technology and their learning progress. As a correlating factor of learning achievement (↑Reeve, 2013), the chosen focus for this report is on student learning motivation (SLM) during the pandemic and its relationship with teachers' use of technology. In the context of this report, SLM is assessed using teacher perceptions.

Although the amount of literature observing SLM during remote schooling increased during the pandemic (↑Hira & Anderson, 2021; ↑Hornstra et al., 2022; ↑Niemi & Kousa, 2020; ↑Rutherford et al., 2022; ↑Thompson et al., 2021; ↑Zaccoletti et al., 2020) much of the research has been conducted in high- and middle-income contexts and remains particularly scarce in India. Some key findings have also only been confirmed in pre-pandemic contexts. These studies have been useful for exploring pedagogical practice and teachers' use of technology to distinguish what has been successful in fostering SLM. However, not all findings are directly transferable to the Indian and pandemic context. More research on learning losses rather than SLM has been carried out in Global South contexts (↑Alvi & Gupta, 2020; ↑Ardington et al., 2021; ↑Hevia et al., 2022; ↑Khan & Ahmed, 2021; ↑Rahman et al., 2021; ↑Sabates et al., 2021). Although learning achievements can be a predictor of SLM (↑Reeve, 2018), motivation is also a multidimensional concept that needs to be explored from other angles besides test scores.

As all countries had to transition to remote schooling abruptly, it is clear that many pedagogical decisions were experimental. As a result, knowledge of what technologies and pedagogies were most effective in creating motivating learning environments remains mixed. To contribute to this knowledge gap, this study answered the main research question:

> *To what extent was students' motivation to learn influenced by teachers' use of technology during the pandemic?*

In exploring this question, the following sub-questions were also addressed:

> **RQ1.** *To what extent, if any, did the types of technology used during remote schooling impact students' motivation to learn?*
>
> **RQ2.** *To what extent, if any, did the frequency of teachers using digital tools to interact with students and parents impact students' motivation to learn?*

In conjunction with analysing student learning motivation, this study subsequently explored how student learning outcomes were impacted during the pandemic from a teacher's perspective by answering the following questions:

> **RQ3.** *Did teachers perceive that some learners experienced learning losses? If so, did this vary across different groups of learners?*
>
> **RQ4.** *How do teachers think schools and governments should address any experiences of learning loss post-Covid-19?*

Although many students in India have returned to traditional schools, this issue remains pertinent as other emergency contexts may require abrupt transitions to remote schooling. Many successful technological methods may also continue to be used by schools in India for blended learning. Therefore, the question of whether teachers' use of technology influences SLM is critical.

1.3. Theoretical frameworks

This study uses Ryan & Deci's (2000) definitions for intrinsic and extrinsic motivation. Intrinsic motivation is defined as an action taken for its inherent interest and satisfaction. When individuals are intrinsically motivated, they are inclined to take action for a personal challenge rather than external pressures or rewards (Cole et al., 2004; Harmon-Jones et al., 2013; Ryan & Deci, 2000). On the other hand, extrinsic motivation is when individuals take action due to external incentives or pressures (Ryan & Deci, 2000).

A strong understanding of how to nurture different types of extrinsic motivation is important for teachers, as many routine educational activities are not intrinsically interesting. As children progress in the education system, the design of intrinsically interesting activities becomes restrained by the demands of standardised tests, for example (Ryan & Deci, 2000). However, research has shown that while intrinsic and extrinsic types of motivation co-exist, it is the extent to which a student is intrinsically or extrinsically motivated that is central (Lepper & Green, 2016).

Self-determination theory (SDT) is one of the frameworks that aims to understand the factors that enable intrinsic and extrinsic motivation (Ryan & Deci, 2020). It proposes "that all human beings have fundamental psychological needs to be competent, autonomous and related to others" (Deci & Ryan, 2012, p. 1). As Chiu claims, when pedagogical design adequately addresses student autonomy, competence, and relatedness, "students are actively motivated to engage in learning tasks" (Chiu, 2022, p. 515). In a remote schooling context, supporting student autonomy regards the creation of opportunities by teachers for students to make choices in their learning and pursue individual learning goals. Competency is achieved better when students are aware of their progress. Teachers can offer positive and constructive feedback and distribute learning materials designed to be optimally challenging to nurture feelings of capability (Hartnett, 2016). When students have a strong sense of competency, they will have a strong mastery of a topic, feel more encouraged to participate in activities and feel positive about their learning. Relatedness can be achieved through frequent interactions with peers, teachers, or learning materials. To enrich students' feelings of relatedness, teachers can respond to questions and comments and create opportunities for peer collaboration (Chiu, 2022; Hsu et al., 2019).

SDT is a significant framework for this study as it can decipher how teachers' use of technology was able to meet a student's sense of autonomy, competence, and relatedness during the pandemic. As a result, it was used in this study to analyse the extent to which teachers' actions may have unlocked a student's intrinsic and extrinsic motivation to learn.

2. Research design

This study used a mixed-methods sequential explanatory design consisting of a quantitative phase followed by a qualitative one (Bazeley, 2018; Creswell & Plano Clark, 2010; Plano Clark & Ivankova, 2015). The quantitative phase involved logit regression analysis of a large, secondary dataset (the T4 teacher survey), followed by an online focus group (OFG) discussion with eight education professionals as part of the qualitative phase. Statistical findings from the quantitative analysis were used to frame the questions used in the OFG and detail the results already obtained (Ivankova, 2014; Morse, 1991). This approach was used to first seek an understanding of the relationship between SLM and different elements of the use of technology, and then to understand how and why teachers were making decisions about their use of technologies during remote learning (Creswell & Plano Clark, 2010; Rossman & Wilson, 1985; Tashakkori & Teddlie, 2010).

2.1. Quantitative phase: Secondary data analysis

2.1.1. Data source

The secondary data analysis leverages data from T4 Education, a global organisation committed to providing engaging tools, initiatives, and events for teachers to improve education. In Spring 2021, T4 conducted the world's largest teacher survey post-Covid-19 in collaboration with EdTech Hub. The team highlighted these findings in their joint T4 Insights report (Pota et al., 2021). The rich (anonymised) dataset (freely available upon request from T4 Education) includes a wealth of metrics on teachers' use of technology during the pandemic, the digital infrastructure of the schools they teach at, and their opportunities in teacher professional development regarding remote learning during the previous year (May 2020–April 2021), making it an ideal dataset for this study. Annex A provides the complete questionnaire with the specific items analysed for this study, shown in bold. While the survey represented many countries, distribution was skewed towards a small number. It contained a large sample from India — around 15% of the total globally.

2.1.2. Sample

The T4 survey collected over 20,000 responses from 165 different countries, where 2,957 of these responses came from India. Although the total India sample almost reached 3,000, the survey was lengthy, and only 56% of these

responses were complete. As a result, a sample of 1,668 was used for this study. Table 1 provides descriptive data of the teacher sample used in the analysis.

Table 1. *Descriptive statistics showing the distribution of teachers across six different metrics (n = 1668)*

Metrics	Teacher sample	
	n	%
Gender		
Female	1086	65
Male	533	32
Other	69	3
Age		
20–29 years old	249	15
30–39 years old	664	40
40–49 years old	430	26
50–59 years old	140	8
60 and over	11	1
Missing n proportion	174	10
Years of teaching experience		
Less than 2 years	237	14
3–5 years	386	23
6–10 years	552	33
11–20 years	356	21
21–30 years	110	7
More than 30 years	27	2
Location of school		
Urban	384	23
Rural	1190	71
Missing *n* proportion	94	6
School type		
Government	397	24
Private	514	31
NGO	561	34
Missing *n* proportion	196	12

As the survey was conducted online, a selection bias is likely as teachers required access to some form of technology with connectivity to respond. Those with greater digital skills may have also been more likely to complete it (↟Pota et al., 2021). The blend of purposive, convenience, and snowballing strategies used to source participants also had the potential to introduce biases as the sample stemmed from the authoring organisations' (primarily T4 Education and EdTech Hub) networks and social media reach. Although the sampling strategy was not representative or systematic, it did aim to reach

government schools in particular (↑Pota et al., 2021). The distribution of responses across states was not included in the survey, so whether the sample is nationally representative is unknown.

2.1.3. Variables

The T4 survey asked teachers whether 'learners have less self-discipline or are less motivated to learn' during the Covid-19 pandemic. This dichotomous question permitted respondents to answer 'yes', 'no', or 'do not know' and was used as the outcome variable in the logit model. Respondents who selected the 'do not know' category were removed as their responses did not provide sufficient insight into SLM. Although SLM and self-discipline represent two distinct characteristics, evidence signifies that motivation and self-regulation are both fundamentally linked, where self-regulation is highly correlated with self-discipline (↑Schunk & DiBenedetto, 2020; ↑Zimmerman & Kitsantas, 2014). ↑Reeve's work (2013) highlights that teachers can support students' self-regulation via the same mechanisms as SLM by encouraging autonomy, competency, and relatedness. The synergies between fostering motivation and self-regulation in the context of SDT built confidence that responses assessed interrelated characteristics. However, uncertainties remain about the extent to which learners are less self-disciplined and less motivated and whether teachers were more strongly referencing one or the other.

The logit model included nine predictors: the type of remote teaching modality (email, mobile, multimedia, and online), frequency of digital interaction, academic learning losses, socio-emotional losses, type of school, student socio-economic status (SES), and phase of schooling. As academic and socio-emotional learning losses were correlated, these variables were used in two separate logit models, Models 1 and 2.

Further details of the statistical model used in the secondary data analysis can be found in Annex B.

2.2. Qualitative phase: Online focus group discussion

2.2.1. Participants and sampling

Purposive sampling methods were used to recruit participants for the focus group discussion. The inclusion criteria required that participants were working as teachers, head teachers, or educational practitioners either in the EdTech, educational NGO, or education policy sectors during the Covid-19 pandemic in India. Although this study uses teachers' perspectives, education practitioners benefitted from overseeing many teachers. An equal number of

participants from schools and industries were recruited to attempt to retain a balance of perspectives.

A total of eight education professionals participated in the OFG. This included four industry professionals from different educational non-profit organisations (NPOs) and four teachers working in different types of schools during the Covid-19 pandemic in India. Table 2 gives further details of the focus group participants.

Table 2. *Details of online focus group participants*

Participant	Gender	School/ Organisation	School location	SES of school students	Gender of school students	State of participant
Teachers						
FP1	Male	Private	Urban	Medium	Mixed	Gujarat
FP2	Female	Government	Urban	Low	Female	Delhi
FP3	Female	Private	Urban	High	Mixed	Uttar Pradesh
FP4	Female	Government	Urban	Low	Mixed	Delhi

Participant	Gender	Organisation focus	State of participant
Education practitioners			
FP5	Male	Addressing children's holistic development across rural India.	Delhi
FP6	Female	Ensuring quality school education for all with strong EdTech focus.	Delhi
FP7	Female	Addressing elementary education access and improving learning outcomes.	Karnataka
FP8	Female	Working with schools and communities to improve children's learning abilities.	Gujarat

2.2.2. Sample limitations

As the focus group was conducted online and lasted 90 minutes, there is a likely sample bias as all participants were required to have a stable internet connection and access to a personal or shared device. In addition, the OFG was conducted in English as all participants were fluent in English. Again, this restricted the sample to a section of society that may be more highly educated due to their fluency in another language. Although the OFG participants may have represented a more affluent segment of Indian society, it was ensured that marginalised learners were, to some extent, still represented by selecting NPOs who were helping this group and teachers who were working in low-income government schools. It is also evident that all teachers were working in schools located in urban areas. However, this contrasted with the demographics of the wider T4 survey sample, where just 23% of teachers surveyed were from urban contexts and was somewhat counteracted by the fact that the industry professionals worked in organisations representing children living and learning in rural areas.

2.2.3. Data collection and analysis

NVivo software was used to analyse the OFG transcript and conduct thematic analysis. Using an inductive approach, codes were assigned to common themes in the data, which were then mapped to distinguish whether themes overlapped, whether too much content had been assigned to one theme, and to identify any sub-themes that emerged (↑Maguire & Delahunt, 2017). This further categorised the data and helped to surface any existing relationships. Examples of most highly referenced codes included teacher pedagogy, learning losses, and parental involvement. The questions used to guide the focus group discussion are outlined in Table 3. The survey data was analysed using a binary logit regression model to assess the association between the predictor variables and their effects on teachers' perceptions of student motivation and self-discipline. The two sub-categories of learning losses (academic and socio-emotional) are used in two separate logit models due to a strong correlation between both predictor variables. Odds ratios in both models were transformed to average marginal effects (AME) for easier interpretation.

Table 3. *Online focus group guide*

Focus area		Questions
Learning losses	FGQ1	Has remote schooling impacted student learning? If so, which aspects of learning were most affected?
Technology and student learning motivation	FGQ2	Do you think the type of technology teachers used to remote teach influenced students' motivation to learn? If yes, how?
Remote teacher pedagogy	FGQ3	How did teachers make decisions on their use of technology during remote schooling?
Student learning motivation and self-discipline	FGQ4	How were the levels of self-discipline and motivation of students during remote schooling? (If one or both decreased, why do you think that was?)

3. Findings

To mutually inform the results of this study, quantitative and qualitative findings were integrated (Bazeley, 2018). Although the quantitative results shaped the qualitative research design, both phases contributed to the results (Bazeley, 2018). The research questions drove the integration of both data sets, and the datasets were therefore used in different combinations to answer each research question. As an explanatory sequential design was used for this research, many key themes emerged from the qualitative data, which was collected primarily to explain and expand the quantitative results.

3.1. Teacher digital pedagogy is more significant than technology type

RQ1: **To what extent, if any, did the types of technology used during remote schooling impact students' motivation to learn?**

Table 4 below shows results from the logit regression where different types of remote teaching modalities acted as covariates. As displayed in Table 4, teacher reports of using online and multimedia methods to remote teach did not have a significant association ($p > 0.05$) with reports that students also had less self-discipline or motivation in either model. Email and mobile remote modalities also had a non-significant association in both models, with no large changes in average marginal effect (AME) coefficients between Models 1 and 2. This statistic suggests that the type of remote learning modality may not have influenced SLM and was explored further in the OFG to apprehend potential reasons why.

A notable finding from the OFG highlighted that the pedagogies teachers employed using different types of technologies were more dominant in influencing SLM than the technology features (e.g., audio, visual, interactive features). This somewhat substantiated the non-significant results between remote modalities in the logit models. Nevertheless, several key factors surfaced during the OFG that demonstrated what elements of technology implementation appeared to have differing impacts on SLM. These factors are discussed in the following sections.

Table 4. *Probability of teachers perceiving that students had less self-discipline and motivation to learn during the Covid-19 pandemic*

Independent variables	Dependent Variable: Learners have less self-discipline or are less motivated to learn	
	Model 1	**Model 2**
Remote learning modalities (ref: No)		
Email	0.0825	0.0622
	(0.0425)	(0.0438)
Mobile	0.0234	0.0482
	(0.0395)	(0.0404)
Online and multimedia	0.0196	0.0101
	(0.0383)	(0.0388)
Frequency of digital interaction (ref: Every day or weekly)	0.0519	0.0619
Monthly	(0.0356)	(0.0356)
	0.166***	0.149***
Annually or never	(0.0415)	(0.0434)
Learning losses (ref: No)		
Academic learning loss	0.445***	
	(0.0429)	
Socio-emotional learning loss		0.427***
		(0.0469)
Demographics		
School type (ref = Government)		
Private	-0.00240	0.0168
	(0.0429)	(0.0432)
NGO	-0.0162	-0.0182
	(0.0396)	(0.0403)
SES (ref = High)		
Medium	0.0567	0.107
	(0.0561)	(0.0585)
Low	0.0417	0.113
	(0.0588)	(0.0609)
Phase (ref = Primary)		
Secondary	0.0159	0.0314
	(0.0325)	(0.0327)
N	847	853

3.1.1. Technological curiosity

The OFG discussion made it evident that most teachers used iterative methods to experiment with different types of technology devices, resources, platforms, and pedagogies to enhance their knowledge of what was effective.

> *"Virtual teaching itself was a kind of learning process that the teachers went through in the first few weeks, and those who mastered that were being successful and able to connect with the student and all those students were getting motivated to learn." — FP5*

In some cases, this took teachers four to eight months. One teacher (FP2) stated that she began using technologies that would capture her students' attention, such as playing online educational games and watching educational films. She found that using digital resources ordinarily recognised as entertainment helped promote students' technological curiosity about how these tools could also be used for learning. The teacher's long-term efforts to nurture this curiosity and promote digital resources resulted in increased student involvement and class attendance over time.

> *"So it took me a lot of time to create that curiosity among them to, you know, embrace technology to make them understand that even though you're not coming to school, you can still learn a lot through technology because there are so many resources around you." — FP2*

Other participants also mentioned that gamified quiz apps such as Kahoot were successful in motivating students. Despite the initial engagement these tools brought, participants mentioned that there was a novelty effect around using such technologies, and as a result, this motivation did not last.

3.1.2. Active learning and participation

Keeping students motivated also appeared to be a demanding task despite the technology used. For some, this resulted in moving away from live-streamed classes due to low participation rates and connectivity issues. Instead, students were sent content in advance and were required to discuss this content in live-streamed classes.

> *"Initially, I started with only Zoom meetings, but then I saw that attendance was very less, and participation was less. Children would join, and then only very few would participate. So, then I switched my method. I would start making videos every day. I would make PowerPoint presentations, convert them into videos, load them on YouTube channel and then I would send the links to the children and then I would give them that day's work; your work is to see the lecture, understand the lecture, and next day we are going to discuss about it. We are going to talk about it and debate about it. So that is the only way I could ensure that they were participating." — FP1*

In these sessions, student participation was essential, holding students more accountable for their learning as they were required to share their knowledge and ideas with their teacher and peers. These practices mirrored flipped learning methods, and educational practitioners encouraged teachers to implement this method at a systems level. They believed that the active learning that comes with flipped learning helped address the issue of rote learning in India, particularly in rural areas, and found that this method supported students' integration back into learning rather than solely focusing on attendance and assessments.

One teacher (FP3) introduced student participation into their pedagogy through personalised adaptive learning (PAL). Besides being able to personalise content to each child, PAL software was able to increase student–teacher interactions. She observed that students who were not particularly vocal in physical classrooms increased their interactions with the teacher through the software's one-to-one chat feature.

> *"What was interesting was that I could get interaction and involvement from students who may not participate as much in a physical classroom for many reasons. If they know they're writing comments or answers where only the teacher has seen it and engaging with it and responding to it personally, then they are more open to doing it versus sharing something in front of all their peers." — FP3*

Although this method encouraged teacher-student interaction, it was only feasible as the teacher worked at a private school with students of high SES who were more likely to own personal laptops.

3.1.3. Parental involvement

While students' engagement and participation were important factors to prioritise when choosing technological tools, OFG participants claimed that, ultimately, it was parental involvement in students' learning that helped maintain SLM. For example, an organisation working to implement a

game-based application in schools found that despite strong teacher buy-in, parental awareness of the solution was lacking, along with their conviction that the app would have positive learning outcomes for their children. As a result, motivation levels soon dwindled.

> *"You can create really engaging experiences through a variety of technology, it's really figuring out how you can get parents and the child to buy into it to sort of create that intrinsic motivation to engage." — FP4*

It also became apparent that teachers had lower expectations of their students to motivate themselves to learn but instead perceived themselves and parents to be more responsible. This translated into increased efforts by teachers to design and create motivational learning environments and for parents to engage with their children to encourage them to take charge of their learning.

Although participants highly valued parental involvement, in many cases, this also resulted in parents doing student activities, projects, and tests to boost their children's marks. This was observed particularly in private schools. In contrast, teachers from government schools stated that, for some, parental investment was negatively affected as "they were struggling to make [...] ends meet" (FP2) and, as a result, did not have as much time to spend with their children doing educational activities. These findings highlighted parental involvement's negative impact on education and demonstrated just one form of how SES fed into SLM.

3.1.4. Teacher motivation

Participants who worked in educational organisations and oversaw teachers across many schools stated that teachers also lost motivation to teach during school closures. For some, trying to find new ways to engage and keep students motivated became exhausting and, as a result, less effort went into teachers trying to make the content interesting. This created a vicious circle where the lack of student motivation fed into teacher motivation and vice versa.

> *"I think one thing that we often talk about is like student learning loss, but I think there's also an aspect around teachers losing motivation during the pandemic and the sort of exhaustion that comes with trying to find new ways of engaging students and then that also in itself becoming sort of like a vicious cycle, and translating to low student learning." — FP6*

This section has revolved around the use of technology; however, it is fundamental to highlight that many students and teachers did not possess personal or shared digital devices to undertake remote schooling. In many

cases, even with technology, teachers maintained a physical presence by conducting student household visits and community centre classes. Some students attending low-income government schools were provided with devices. However, it was reported that motivation to learn was still lacking for these students regardless of whether they were enthused about possessing a new device.

3.2. Teacher interaction and student motivation are associated

RQ2: **To what extent, if any, did the frequency of teachers using digital tools to interact with students and parents impact students' motivation to learn?**

As shown in Table 4 (Model 1), teachers who annually or never interacted with their students or their parents were 17% more likely to report that their students had less self-discipline and motivation to learn than teachers who contacted students or parents every day or at least weekly. This result shows a positive, statistically significant association ($p < 0.001$) and suggests the importance of continuous interaction and communication between teachers and home environments.

However, there is also a non-significant association ($p > 0.05$) between a monthly digital interaction that only increases the likelihood of teachers reporting that their students had less self-discipline and motivation to learn by 5% (Table 4, Model 1). Significance was only found at the two extremes of the frequency of teacher interactions. The findings above suggest that different results may have been found using a higher number of response categories that tracked interaction more frequently.

3.3. Marginalised groups experienced the greatest learning losses

RQ3: **Did teachers perceive that some learners experienced learning losses? If so, did this vary across different groups of learners?**

3.3.1. Perception of learning losses

A combination of logit regression results, additional T4 survey data and qualitative data were used to address this research question. Results from both logit regression models (Table 4) illustrated that students perceived to have experienced learning loss both academically and socio-emotionally were also significantly likely ($p < 0.001$) to have less perceived self-discipline and

motivation. Teacher reports of learners experiencing academic learning losses were 44% more likely to report that students also had less self-discipline and motivation to learn (Model 1). Similarly, teachers' reports of learners experiencing socio-emotional losses were 43% more likely to also report learners having less self-discipline and motivation (Model 2). Both learning loss variables have a large AME coefficient suggesting the significant impact academic and socio-emotional losses had on students' self-discipline and motivation. However, due to the high degree of missing data in these metrics and the potential of selection bias, this result needs to be interpreted with caution.

Despite this statistical limitation, findings from the OFG somewhat supported the association between academic and socio-emotional learning losses and SLM. Participants claimed that learning losses were interlinked with students' social skills, particularly for younger and the most marginalised learners.

> *"Yes, the linguistic skills are the ones which are quite, well, badly affected. That and all the other skills are built upon these linguistic skills. If we do not know how to read the language in which mathematics or science is written, everything will crumble." — FP5*

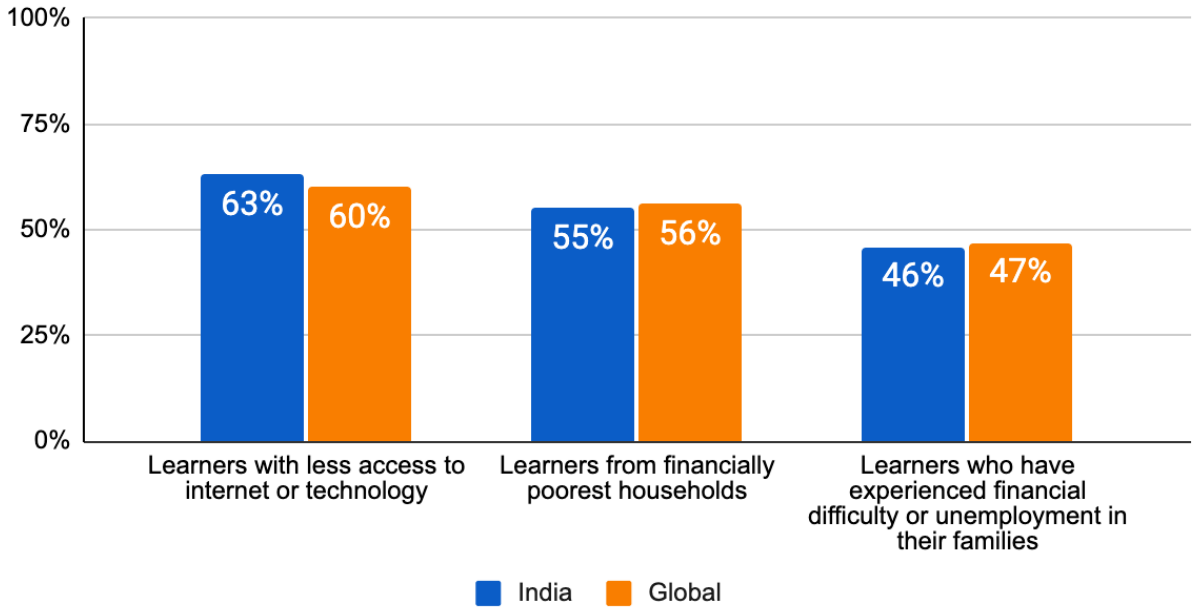
Students acquiring foundational skills before lockdown were not considered able to develop basic skills such as language and communication due to school interruptions. As these foundational skills advanced all other forms of learning, younger students suffered disproportionately as they could not improve in their academic subjects or build communication skills. For the most marginalised children, not only did they suffer from learning losses, but they were also impacted by the loss of India's midday meal by the closure of government schools. In some cases, this reportedly led to students having low concentration levels and, as a result, their "social skills were not developed that much" (FP8).

3.3.2. Learning losses across different groups of learners

Figure 1 presents T4 survey data from measuring teacher perceptions of which groups of learners experienced greater learning losses in India and globally. This data revealed that teachers considered learners with less access to the internet or technology and those from poor households who faced financial hardships during the pandemic to have experienced more learning losses than others. The most frequently observed group of children to suffer learning loss was identified as the same in India and globally. In India, of the 63% of teachers who responded 'learners with less access to the internet or technology', there was a 62% overlap with those who also responded 'learners

from the financially poorest households' and a 59% overlap with teachers who responded 'learners who experienced financial difficulties'. This suggests that these groups of learners did not represent unique categories but the same segment of marginalised students. This somewhat aligned with claims made in the OFG that for "the most vulnerable children, learning came to a halt" (FP7). While marginalised groups of learners were perceived to be most affected, teachers working in private schools reported that learning losses had occurred among their students also.

Figure 1. *Groups of learners who experienced more learning losses than other learners as perceived by teachers.*



Note. Whether a particular group of learners experienced higher learning losses than other students was a dichotomous question; therefore, the above percentages indicate teachers who responded 'yes'.

The OFG also indicated that girls and younger siblings experienced more significant learning losses than their male counterparts and older siblings. This was primarily due to the prioritisation of male and older children in their use of technology.

> *"When we talk about the pandemic, we know that it has been very gendered, and by gendered, I mean that women were more affected by the pandemic. I work in a school with girls. So, it's a girls' school, and a lot of students would not come to online classes because they have a sibling, a male kid, and they had to attend their online classes, so the parents did not give a lot of importance to their female child. They gave more importance to their male child." — FP2*

> *"At the same time, many families have more than two children, and they have only one smartphone and will share their phone. So, one child had to lose out on study time, and the second only could study. I've seen cases where the elder child was maybe 10th/12th standard was prioritised and the younger child was completely [sidelined] — there was no education at all." — FP1*

Again, these statements were investigated further using T4 survey data to establish whether this finding resonated among other teachers and could be further generalised. When teachers were asked whether girls had experienced more learning losses than boys, 29% of teachers responded 'agreed' while 32% stated that parents / caregivers had prioritised boys' education over girls during the lockdown. These findings are notably higher than global averages of 12% and 14%, respectively. Similarly, 51% of respondents perceived that children with many siblings experienced more learning losses than single children, and 53% stated that parents / caregivers prioritised older children's learning over younger children's learning.

3.3.3. Monitoring progress

An emergent finding from the OFG was that teachers struggled to accurately monitor and evaluate their students' learning progress as the primary testing mechanism was sending digital tests and receiving responses digitally. For some, there were government-mandated guidelines to admit and receive exams via Google Forms. As a result of the digital evaluation process, many students cheated on exams and received good marks.

> *"Another problem was lack of testing mechanism — there was no way we could take tests of the children. The only thing we could do was send them papers, send them Google Forms or send them test papers online and ask them to write at home and then send the reply through WhatsApp. And they were getting good marks because they were cheating [...]. And this thing has lasted all through the 2 years like there was no testing, and it's very hard to assess the child when the test is taken at home." — FP1*

This raises questions about the basis of teachers' perceptions of learning losses established in the quantitative phase of this research as teachers were unsure of how to monitor students' learning progress accurately.

3.4. Schools should develop independent learning

RQ4: **How do teachers think schools and governments should address any experiences of learning loss post-Covid-19?**

Descriptive statistics of additional survey data were used to gain teachers' perspectives on what schools and governments can do post-Covid-19

regarding teaching, pedagogies, or structurally to help learners catch up. Figures 2 and 3 indicate the five most common teacher responses for each question. Almost three-quarters of respondents reported that schools should help learners understand how to learn better and develop independent learning to catch up with the curriculum. Government support for teacher development and training was the most reported response from teachers, pointing to the lack of training received during the pandemic. These findings will be discussed in Section 4.

Figure 2. *Teachers' perspectives on how schools should address learning losses*

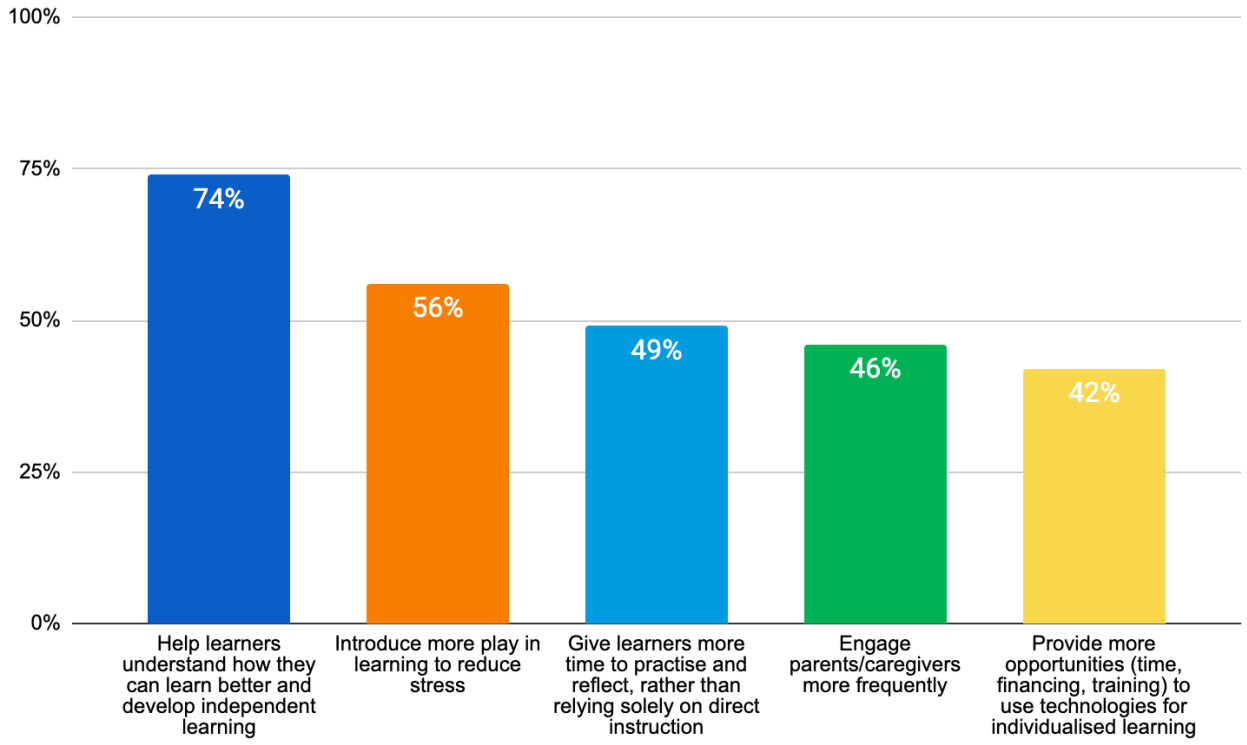
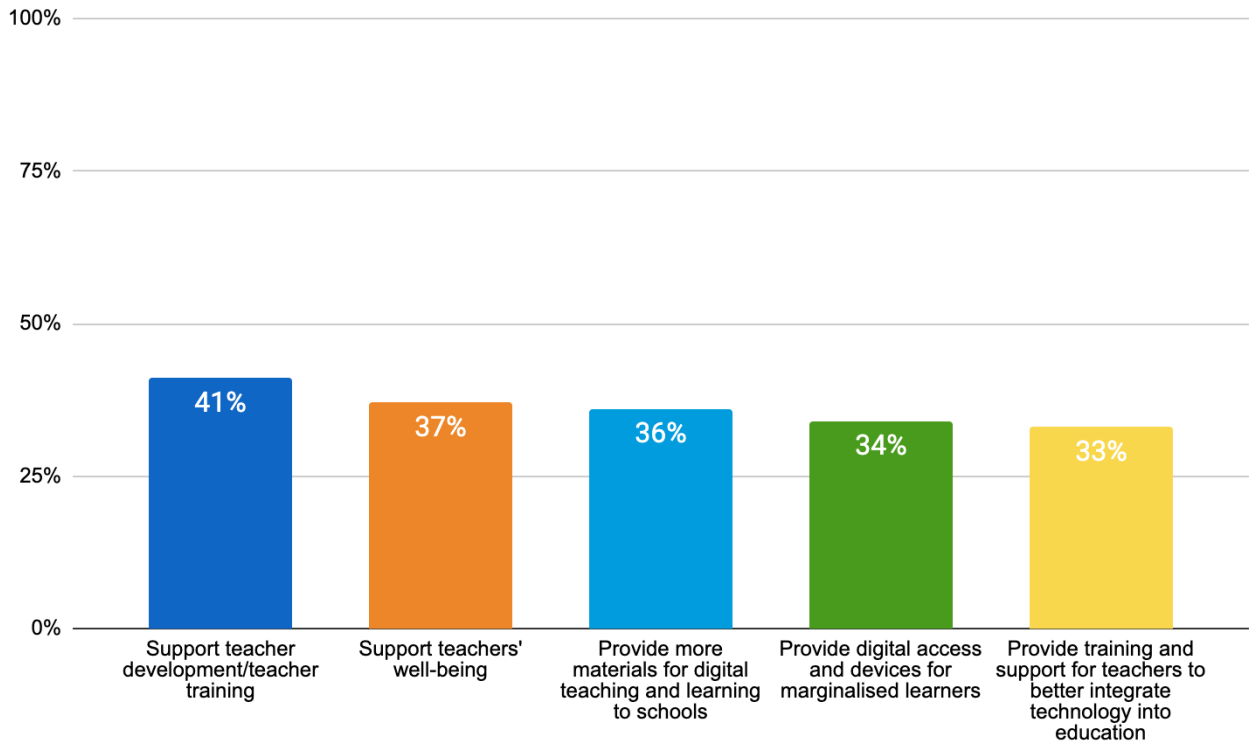


Figure 3. *Teachers' perspectives on how governments should address learning losses*



4. Discussion

This report explores the relationship between teachers' use of technology during the Covid-19 pandemic in India and their perspectives on students' motivation to learn. It elucidates the perspectives of teachers working remotely during the pandemic by leveraging the world's largest teacher survey post-Covid-19. It complements these findings with qualitative data gathered from teachers and education practitioners via an OFG. Results imply that teachers' pedagogy was more important for SLM than their use of technology and confirmed that more frequent interaction between teachers and students or parents can increase teacher perceptions of SLM. Findings also suggest that SLM may have significantly depended on the continued development of academic and socio-emotional skills. The following sections elaborate on the findings and highlight the future implications of this research for wider policy and practice.

4.1. The role of technology in education and the role of the teacher

The findings from this study claim and confirm previous research findings (↑Education Endowment Foundation, 2020; ↑Reimers & Schleicher, 2020) that access to technology, although an important determinant of learning opportunities, and a critical factor during the Covid-19 pandemic, does not in itself equate to learning. For example, students with sufficient internet connectivity and devices were still demotivated to learn. In fact, findings show that teachers' pedagogy and how technology was leveraged to achieve teachers' pedagogical goals were more significant determinants of learning and motivation to learn than the type of technology used to teach remotely.

Although this study, to a certain degree, challenges the role of technology in learning, it still supports a core narrative that technology will and should continue to be used for educational purposes. However, it is vital to note that for a significant proportion of students, using technology to learn was simply not an option due to a lack of access to digital devices. What is more, for many, their devices, internet connectivity, and data packages were insufficient for remote learning. Teachers or educational NGOs were still required to run community education hubs or conduct home visits for these groups of learners. To some degree, these realities contradict this study's core narrative in its focus on and positive view of the role of technology, as it does not fully consider the barriers faced by marginalised learners in India.

4.2. Student-centred pedagogies

Findings in response to RQ1 highlighted the inadequacies of live-streamed classes. The power dynamic between teacher and student was modified in online classes (↑Hartnett, 2016) as teachers' had a reduced capacity to take authority and students gained more control over their classroom behaviours. Although teachers' online presence factored in accountability, it appears that the physical separation between the teacher and student enabled students to create a communication void (↑Zeichner, 2018) by turning both mic and cameras off, resulting in little or no participation from students. This modified power dynamic seems to have encouraged teachers to experiment with student-centred methods such as flipped learning and PAL through a blend of synchronous and asynchronous tools, which were found to have higher student participation and interaction levels.

As teachers employed student-centred design approaches in their pedagogies, students were supported to practise agency and have greater control over their learning experience and outcomes. In addition, providing students with resources to revise before live sessions enabled students to self-pace and regulate their learning. These attributes strongly generate a sense of autonomy for students, increasing their learning motivation. Similarly, students introduced to PAL programmes could work at their level and be challenged through individualised teacher feedback, providing students with a sense of competency. Reviewing student-centred pedagogies through an SDT lens justifies the rationale of teachers who switched their pedagogy from teacher-centred to student-centred designs.

4.3. Learning losses

One of the key contributions this study makes to the literature is its understanding, from a motivation angle, of why learning losses occurred despite some students attending online classes daily, for example. Findings demonstrate how academic learning loss may have been entwined with the losses of many other socio-emotional skills. For example, a loss in academic knowledge could have also impaired a child's communication skills and lowered confidence, and vice versa. This holds implications for further research that aims to assess learning losses solely through test scores. These findings suggest that the educational losses children have encountered during the pandemic have been holistic and pertain to both academic and socio-emotional skills.

4.4. Limitations

From this study, it remains unclear whether extrinsic or intrinsic learning motivation had a greater impact on students and teachers during the pandemic. Although some teachers may have adjusted their pedagogies to incorporate greater elements of student autonomy, competency, and relatedness, which, theoretically, feed into students' intrinsic motivations, their assessments of SLM may still have been based on extrinsic factors: how quickly or correctly students were completing work, for example. This creates a disjoint between how teachers were designing their pedagogies and how they were assessing student motivation, leading to some uncertainty within the results presented in this study.

Teachers considered parental buy-in to the technologies and resources students were using to learn remotely to be a significant determinant of SLM. As this study primarily focuses on teachers' provision of remote learning environments, it does not consider students' home environments and parents' roles in influencing student motivation. This is a slight limitation of the study as both school and home contexts could not be analysed simultaneously. Education is widely prioritised by many parents in India (↑Varkey Foundation, 2018). Therefore, whether parental buy-in was a cultural factor that influenced SLM remains unknown, yet it presents an opportunity for a comparative study across different countries.

The fact that key survey metrics such as academic and socio-emotional losses and self-discipline and motivation were measured dichotomously in the T4 survey is critical. It cannot be deduced to what extent these skills and characteristics influenced one another and whether one was more dominant, as all responses were subjective. This acts as a limitation to this study's secondary data analysis elements.

4.5. Implications for policy and practice

Teachers were on the frontline of education throughout the Covid-19 pandemic. Therefore, findings in response to RQ4 hold credibility in contributing to the recovery methods implemented at the state and national levels in India, as these provide first-hand insights from teachers working during the pandemic. Responses to what schools should do to address learning losses spotlighted student-centred pedagogies, activity-based learning, and greater involvement of parents in students' education. Some of these recommendations could be incorporated efficiently into pedagogy, such as helping learners to develop independent learning, introducing more play

into learning, and reducing the amount of direct instruction in teaching. However, school leaders must create an enabling environment and offer teachers the autonomy to make these pedagogical changes.

Other recommendations, such as engaging parents more frequently and providing more technologies for PAL, have further social, cultural, and financial constraints. First, teachers may face resistance from engaging more frequently with parents depending on how much education is valued by parents or caregivers. This can be relevant for parents who work long hours or prefer their children to contribute to household income through employment — situations prevalent among marginalised communities. Second, providing technology for PAL can be costly in contexts where schools are technologically under-resourced. However, there is a growing body of research and work in India that is making PAL more accessible on smartphones (↑Banerjee et al., 2016; ↑Muralidharan et al., 2019) and adopting multi-user systems to address the resource and financial constraints of deploying technology in schools (↑Alcoholado et al., 2012; ↑Brunskill et al., 2010; ↑Karnati, 2008).

Findings from this study advocate for improvements to teacher pedagogies through using technology rather than an increase in hardware installations or updates in schools. In response to the growing body of evidence (↑Education Endowment Foundation, 2020; ↑Reimers & Schleicher, 2020) claiming that well-designed teacher pedagogy is more influential than technological delivery, EdTech companies need to ensure that their platforms embed pedagogical design principles for impactful learning and consider how digital content that PAL software delivers can be reworked to low- or no-tech modalities to reach the most marginalised learners. EdTech Tulna, an EdTech evaluation index launched in 2021 in India, defines a set of expectations for the design of EdTech products to ensure quality and impactful products in India's EdTech ecosystem (↑EdTech Tulna, no date). EdTech Tulna has made a good start in ensuring that EdTech solutions are pedagogically informed by theory and national educational policies. This initiative is gradually changing the narrative towards quality and effective software rather than procurement focused on hardware.

Responses regarding what governments should do to address learning losses underlined supporting teacher training and well-being, providing more materials for digital teaching and learning in schools and increasing digital access for marginalised learners. As discussed in Section 3.1.2, teachers faced exhaustion from finding methods to motivate students and the associated increased workload. In turn, this appeared to impact SLM negatively. Therefore,

it is critical to find efficient ways to train teachers and provide more support for their well-being.

In addition, Section 3.1.1 shows that it took some teachers 4–8 months to realise which teaching methods successfully enhanced SLM, substantially increasing student learning losses over this period. In cases where teachers may need to revert to remote teaching, relevant teacher training and development is essential to help teachers pair their pedagogical and technological knowledge to create motivational learning environments swiftly. Although teacher pedagogy can be more important than technology, it is still essential for marginalised learners to have access to digital devices to sustain some form of communication with their teachers and continue their learning. Groups of marginalised learners suffered the most in their learning progress. Greater efforts need to be targeted toward these groups to avoid further exacerbating learning inequalities.

5. Conclusion

During the Covid-19 pandemic, a plethora of research emerged to quantify the learning losses that occurred among students globally and how accessible remote teaching technological solutions were for learners. This research acknowledged an incongruity between students' access to technology and their learning progress. Although learning losses have been measured objectively, assessing why learning did not occur is still under-researched. This report investigates students' motivation to learn in India as an established factor in learning achievement and how this may have been influenced by teachers' use of remote technologies during the pandemic.

A key feature of this study is that it is one of the few that assesses the influences of technology and pedagogy on SLM from teachers' perspectives. The study aims to distinguish whether the types of technology used during remote schooling and the frequency of remote teacher interactions impacted SLM. It also explores whether any learning losses perceived by teachers differed by groups of learners and addresses how teachers thought schools and governments in India should mitigate these learning losses post Covid-19.

This study finds that as a factor affecting SLM, the quality of teacher pedagogy was more significant than the technology used to teach during the pandemic. It also sheds light on what teacher pedagogies successfully enhanced SLM and how technology was used to realise these pedagogical goals. The pedagogies primarily focused on student-centred methods achieved through a blend of asynchronous and synchronous technologies, including PowerPoint presentations, videos, and live-streamed classes. Frequent interactions between teachers and students or parents are also found to foster motivational learning environments. Besides frequent communication with parents, parental involvement and buy-in to educational activities are key in sustaining SLM.

Results suggest that SLM may strongly depend on maintaining other socio-emotional and academic skills, indicating the holistic nature of the losses incurred. Findings from this study also indicate that learners with less access to the internet or technology, those facing financial difficulties within their households, younger learners, and female students made less learning progress than their peers. Therefore, schools and education authorities must prioritise the learning of these groups of students and ensure the delivery of tailored programmes that address academic and socio-emotional concerns.

A central limitation of this research is the ambiguity surrounding how teachers might assess students' motivation to learn and whether their perceptions

consider extrinsic and intrinsic motivational factors equally. Further work needs to deviate from using categorical data or Likert scales to measure SLM and conduct more qualitative research to distinguish between student and teacher evaluations of student motivation.

A key takeaway of this study is that teachers must understand how their pedagogies can influence their students' motivation to learn remotely. While we may have managed the worst of the pandemic, natural disasters will continue to occur and may warrant further remote schooling. Hence, it is essential that teachers can quickly transition their practice from physical to remote learning environments while achieving the same quality to continue motivating students and helping them to progress. Considering that the role of technology is likely to become increasingly relevant in K-12 education in India, the findings of this study offer initial evidence in understanding how technology and pedagogy can address students' motivational needs. Lastly, rote learning remains a prevalent issue across India's education system. This study highlights the criticality and effectiveness of student-centred pedagogy, which can help address the issues surrounding rote learning and help regenerate a form of learning that is less centred around assessments and more encouraging for students.

Bibliography

This bibliography is available digitally in our evidence library at https://docs.edtechhub.org/lib/D7VXZW6I

ASER. (2020). *Annual Status of Education Report (Rural) 2020. Wave 1*. ASER Centre. http://img.asercentre.org/docs/ASER%202020/ASER%202020%20REPORT/aser2020fullreport.pdf. (details)

Alcoholado, C., Nussbaum, M., Tagle, A., Gomez, F., Denardin, F., Susaeta, H., Villalta, M., & Toyama, K. (2012). One Mouse per Child: interpersonal computer for individual arithmetic practice. *Journal of Computer Assisted Learning*, *28*(4), 295–309. https://doi.org/10.1111/j.1365-2729.2011.00438.x. (details)

Alvi, M., & Gupta, M. (2020). Learning in times of lockdown: how Covid-19 is affecting education and food security in India. *Food Security*, *12*(4), 793–796. https://doi.org/10.1007/s12571-020-01065-4. (details)

Angrist, N., Bergman, P., Brewster, C., & Matsheng, M. (2020). Stemming learning loss during the pandemic: a rapid randomized trial of a low-tech intervention in Botswana. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3663098. Available from https://papers.ssrn.com/abstract=3663098. (details)

Ardington, C., Wills, G., & Kotze, J. (2021). COVID-19 learning losses: Early grade reading in South Africa. *International Journal of Educational Development*, *86*, 102480. https://doi.org/10.1016/j.ijedudev.2021.102480. (details)

Banerjee, A. V., Banerji, R., Berry, J., Duflo, E., Kannan, H., Mukerji, S., Shotland, M., & Walton, M. (2016). *Mainstreaming an effective intervention: evidence from randomized evaluations of "teaching at the right level" in India* (SSRN Scholarly Paper No. 22746). National Bureau of Economic Research. https://doi.org/10.2139/ssrn.2846971. Available from https://www.nber.org/papers/w22746.pdf. (details)

Banerji, O. (2021, February 8). India's public edtech broadcast system DIKSHA has a private bottleneck. *The Ken*. https://the-ken.com/story/public-edtech-private-bottleneck/?searchTerm=DIKSHA

Bazeley, P. (2018). *Integrating analyses in mixed methods research*. SAGE Publications Ltd. https://methods.sagepub.com/book/integrating-analyses-in-mixed-methods-research. (details)

Bhushan, M., Joshi, P., & Sharma, S. (2021). *Remote learning in the times of COVID-19*. Central Square Foundation. https://bhartifoundation.org/wp-content/uploads/2021/08/Remote-Learning-Case-Study_CSF-x-Bharti_vF_compressed.pdf. (details)

Brunskill, E., Garg, S., Tseng, C., Pal, J., & Findlater, L. (2010). Evaluating an adaptive multi-user educational tool for low-resource environments. *Proceedings of the IEEE/ACM International Conference on Information and Communication Technologies and Development*. https://www.cs.cmu.edu/~ebrun/ictd_brunskill2010.pdf. (details)

Chiu, T. K. F. (2022). Applying the self-determination theory (SDT) to explain student engagement in online learning during the COVID-19 pandemic. *Journal of Research on Technology in Education*, *54*(1), S14–S30. https://doi.org/10.1080/15391523.2021.1891998. (details)

Cole, M. S., Feild, H. S., & Harris, S. G. (2004). Student learning motivation and psychological hardiness: interactive effects on students' reactions to a management class. *Academy of Management Learning & Education*, *3*(1), 64–85. https://doi.org/10.5465/amle.2004.12436819. Available from https://journals.aom.org/doi/10.5465/amle.2004.12436819. (details)

Creswell, J. W., & Plano Clark, V. L. (2010). *Designing and conducting mixed methods research* (2nd ed.). SAGE Publications. https://books.google.co.uk/books/about/Designing_and_Conducting_Mixed_Methods_R.html?id=6tYNo0UpEqkC&redir_esc=y. (details)

DIKSHA. (n.d.). *About DIKSHA*. Retrieved March 12, 2022, from https://diksha.gov.in/about/. (details)

Deci, E. L., & Ryan, R. M. (2012). Motivation, personality, and development within embedded social contexts: an overview of self-determination theory. In *The Oxford Handbook of Human Motivation*. https://doi.org/10.1093/oxfordhb/9780195399820.013.0006. Available from https://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780195399820.001.0001/oxfordhb-9780195399820-e-6. (details)

EdTech Tulna. (n.d.). *EdTech Tulna Evaluation Centre*. Retrieved June 27, 2022, from https://edtechtulna.org/evaluation-centre-catalogue/. (details)

Education Endowment Foundation. (2020). *Remote learning: Rapid evidence assessment*. https://educationendowmentfoundation.org.uk/public/files/Remote_Learning_Rapid_Evidence_Assessment.pdf. (details)

Engzell, P., Frey, A., & Verhagen, M. D. (2021). Learning loss due to school closures during the COVID-19 pandemic. *Proceedings of the National Academy of Sciences*, *118*(17). https://doi.org/10.1073/pnas.2022376118. (details)

Eroglu, M., & Senol, C. (2021). Emergency remote education experiences of teachers during the COVID-19 pandemic: a phenomenological research. *Shanlax International Journal of Education*, *9*(3), 161–172. https://doi.org/10.34293/education.v9i3.3918. (details)

Harmon-Jones, E., Harmon-Jones, C., & Price, T. F. (2013). What is approach motivation? *Emotion Review*, *5*(3), 291–295. https://doi.org/10.1177/1754073913477509. (details)

Hartnett, M. (2016). *Motivation in online education*. Springer. https://link.springer.com/book/10.1007/978-981-10-0700-2. (details)

Haser, Ç., Doğan, O., & Kurt Erhan, G. (2022). Tracing students' mathematics learning loss during school closures in teachers' self-reported practices. *International Journal of Educational Development*, *88*, 102536. https://doi.org/10.1016/j.ijedudev.2021.102536. (details)

Hevia, F. J., Vergara-Lope, S., Velásquez-Durán, A., & Calderón, D. (2022). Estimation of the fundamental learning loss and learning poverty related to COVID-19 pandemic in Mexico. *International Journal of Educational Development*, *88*, 102515. https://doi.org/10.1016/j.ijedudev.2021.102515. (details)

Hira, A., & Anderson, E. (2021). Motivating online learning through project-based learning during the 2020 COVID-19 pandemic. *IAFOR Journal of Education*, *9*(2), 93–110. https://doi.org/10.22492/ije.9.2.06. Available from https://iafor.org/journal/iafor-journal-of-education/volume-9-issue-2/article-6/. (details)

Hornstra, L., van den Bergh, L., Denissen, J. J. A., Diepstraten, I., & Bakx, A. (2022). Parents' perceptions of secondary school students' motivation and well-being before and during the COVID-19 lockdown: the moderating role of student characteristics. *Journal of Research in Special Educational Needs*, *22*(3), 209–220. https://doi.org/10.1111/1471-3802.12551. Available from https://onlinelibrary.wiley.com/doi/10.1111/1471-3802.12551. (details)

Hsu, H.-C. K., Wang, C. V., & Levesque-Bristol, C. (2019). Reexamining the impact of self-determination theory on learning outcomes in the online learning environment. *Education and Information Technologies*, *24*(3), 2159–2174. https://doi.org/10.1007/s10639-019-09863-w. (details)

Ivankova, N. V. (2014). *Mixed methods applications in action research*. Sage. https://us.sagepub.com/en-us/nam/mixed-methods-applications-in-action-research/book237798. (details)

Jena, P. K. (2020). Impact of pandemic COVID-19 on education in India. *International Journal of Current Research (IJCR)*, *12*(7), 2582–12586. https://doi.org/10.24941/ijcr.39209.07.2020. (details)

Karnati, R. (2008). *Computer aided instruction for out-of-school children in India: An impact study in Andhra Pradesh* [Ph.D., University of Pennsylvania]. https://www.proquest.com/docview/304493546/abstract/96CFD7A446444C9CPQ/1. (details)

Khan, M. J., & Ahmed, J. (2021). Child education in the time of pandemic: Learning loss and dropout. *Children and Youth Services Review*, *127*. https://doi.org/10.1016/j.childyouth.2021.106065. (details)

Lepper, M. L., & Green, D. (Eds.). (2016). *The hidden costs of reward: new perspectives on the psychology of human motivation*. Psychology Press. https://www.taylorfrancis.com/books/edit/10.4324/9781315666983/hidden-costs-reward-mark-lepper-david-greene. (details)

Maguire, M., & Delahunt, B. (2017). Doing a thematic analysis: A practical, step-by-step guide for learning and teaching scholars. *All Ireland Journal of Higher Education*, *9*(3). http://ojs.aishe.org/index.php/aishe-j/article/view/335. (details)

Morse, J. M. (1991). Approaches to qualitative-quantitative methodological triangulation. *Nursing Research*, *40*(2), 120–123. https://doi.org/10.1097/00006199-199103000-00014. Available from https://journals.lww.com/nursingresearchonline/Citation/1991/03000/Approaches_to_Qualitative_Quantitative.14.aspx. (details)

Muralidharan, K., Singh, A., & Ganimian, A. J. (2019). Disrupting education? Experimental evidence on technology-aided instruction in India. *American Economic Review*, *109*(4), 1426–1460. https://doi.org/10.1257/aer.20171112. (details)

Niemi, H. M., & Kousa, P. (2020). A case study of students' and teachers' perceptions in a Finnish high school during the COVID pandemic. *International Journal of Technology in Education and Science*, *4*(4), 352–369. https://doi.org/10.46328/ijtes.v4i4.167. Available from https://ijtes.net/index.php/ijtes/article/view/167. (details)

Plano Clark, V. L., & Ivankova, N. V. (2015). *Mixed methods research: A guide to the field* (Vol. 3). Sage Publications. https://us.sagepub.com/en-us/nam/mixed-methods-research/book241462. (details)

Pota, V., Hennessy, S., Koomar, S., Kreimeia, A., Zubairi, A., Aerts, C., & Gault, C. (2021). *Turning to technology: a global survey of teachers' responses to the Covid-19 pandemic*. T4 Education. https://t4.education/t4-insights/reports/turning-to-technology. (details)

Rahman, T., Sharma, U., & World Bank. (2021). *A simulation of COVID-19 school closure impact on student learning in Bangladesh*. World Bank. http://hdl.handle.net/10986/35043. (details)

Reeve, J. (2013). How students create motivationally supportive learning environments for themselves: The concept of agentic engagement. *Journal of Educational Psychology*, *105*(3), 579. https://doi.org/10.1037/a0032690. (details)

Reeve, J. (2018). *Understanding motivation and emotion* (Seventh edition). John Wiley & Sons, Inc. https://www.wiley.com/en-us/Understanding+Motivation+and+Emotion%2C+7th+Edition-p-9781119367604. (details)

Reimers, F. M., & Schleicher, A. (2020). *A framework to guide an education response to the COVID-19 pandemic of 2020*. OECD. https://teachertaskforce.org/sites/default/files/2020-04/A%20framework%20to%20guide%20an%20education%20response%20to%20the%20COVID-19%20Pandemic%20of%202020.pdf. (details)

Rossman, G. B., & Wilson, B. L. (1985). Numbers and words: Combining quantitative and qualitative methods in a single large-scale evaluation study. *Evaluation Review*, *9*(5), 627–643. https://doi.org/10.1177%2F0193841X8500900505. (details)

Rutherford, T., Duck, K., Rosenberg, J. M., & Patt, R. (2022). Leveraging mathematics software data to understand student learning and motivation during the COVID-19 pandemic. *Journal of Research on Technology in Education*, *54*(sup1), S94–S131. https://doi.org/10.1080/15391523.2021.1920520. Available from https://www.tandfonline.com/doi/full/10.1080/15391523.2021.1920520. (details)

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: classic definitions and new directions. *Contemporary Educational Psychology*, *25*(1), 54–67. https://doi.org/10.1006/ceps.1999.1020. Available from https://www.sciencedirect.com/science/article/pii/S0361476X99910202. (details)

Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology*, *61*, 101860. https://doi.org/10.1016/j.cedpsych.2020.101860. (details)

Sabates, R., Carter, E., & Stern, J. M. B. (2021). Using educational transitions to estimate learning loss due to COVID-19 school closures: The case of Complementary Basic Education in Ghana. *International Journal of Educational Development*, *82*, 102377. https://doi.org/10.1016/j.ijedudev.2021.102377. (details)

Schunk, D. H., & DiBenedetto, M. K. (2020). Motivation and social cognitive theory. *Contemporary Educational Psychology*, *60*, 101832. https://doi.org/10.1016/j.cedpsych.2019.101832. Available from https://www.sciencedirect.com/science/article/pii/S0361476X19304370. (details)

Tashakkori, A., & Teddlie, C. (Eds.). (2010). *Sage handbook of mixed methods in social & behavioral research* (2nd ed). SAGE Publications. https://methods.sagepub.com/book/sage-handbook-of-mixed-methods-social-behavioral-research-2e. (details)

Thompson, J., Fraser, S., Archambault, I., Beauregard, N., Dupéré, V., & Frohlich, K. (2021). Schooling, interrupted: a critical account of motivation and education during the first wave of the COVID-19 pandemic in Quebec. *Journal of Teaching and Learning*, *15*(2), 60–80. https://doi.org/10.22329/jtl.v15i2.6722. Available from https://jtl.uwindsor.ca/index.php/jtl/article/view/6722. (details)

Thompson, J., Fraser, S., Archambault, I., Beauregard, N., Dupéré, V., & Frohlich, K. (2021). Schooling, interrupted: a critical account of motivation and education during the first wave of the COVID-19 pandemic in Quebec. *Journal of Teaching and Learning*, *15*(2), 60–80. https://doi.org/10.22329/jtl.v15i2.6722. Available from https://jtl.uwindsor.ca/index.php/jtl/article/view/6722. (details)

UNESCO. (2020, March). *Education: From disruption to recovery*. https://en.unesco.org/covid19/educationresponse. (details)

UNICEF ROSA, UNICEF EAPRO, UNESCO Bangkok, & Cambridge Education. (2021). *Situation analysis on the effects of and responses to COVID-19 on the education sector in Asia*. UNICEF. https://www.unicef.org/rosa/reports/situation-analysis-effects-and-responses-covid-19-education-sector-asia. (details)

Varkey Foundation. (2018). *Global Parents' Survey 2018: India findings*. https://www.varkeyfoundation.org/media/3735/17-091869-01-varkey-foundation-gps_india-pack_230218_iuo-v2.pdf. (details)

Zaccoletti, S., Camacho, A., Correia, N., Aguiar, C., Mason, L., Alves, R. A., & Daniel, J. R. (2020). Parents' perceptions of student academic motivation during the covid-19 lockdown: a cross-country comparison. *Frontiers in Psychology*, *11*, 592670. https://doi.org/10.3389/fpsyg.2020.592670. Available from https://www.frontiersin.org/articles/10.3389/fpsyg.2020.592670/full. (details)

Zeichner, O. (2018). The impact of cognitive and non-cognitive feedback on students' achievement in a distance learning environment. *Journal of Educational Technology*, *14*(4), 13–27. https://doi.org/10.26634/jet.14.4.13976. Available from https://eric.ed.gov/?id=EJ1179519. (details)

Zimmerman, B. J., & Kitsantas, A. (2014). Comparing students' self-discipline and self-regulation measures and their prediction of academic achievement. *Contemporary Educational Psychology*, *39*(2), 145–155. https://doi.org/10.1016/j.cedpsych.2014.03.004. Available from https://www.sciencedirect.com/science/article/pii/S0361476X14000162. (details)

van Cappelle, F., Chopra, V., Ackers, J., & Gochyyev, P. (2021). An analysis of the reach and effectiveness of distance learning in India during school closures due to COVID-19. *International Journal of Educational Development*, *85*, 102439. https://doi.org/10.1016/j.ijedudev.2021.102439. Available from https://linkinghub.elsevier.com/retrieve/pii/S0738059321000924. (details)

Annexes

Annex A: T4 Education: Turning to technology survey questions

Questions used in this study are highlighted in bold.

About you

1. During the last 12 months, did you work as a school teacher?

2. What best describes your gender? Select one answer.

3. Select where you teach.

4. Do you have any long-standing illness, disability or infirmity?
(Long-standing means anything that has troubled you over a period of time or that is likely to affect you over a period of time).

Yes | No | Prefer not to say

5. How many years of school teaching experience do you have?

Less than 2 years | 3 to 5 years | 6 to 10 years | 11 to 20 years | 21 to 30 years | More than 20 years

6. What is the highest qualification for teaching you have received?

About your school.

7. What type of area is your school located in? Select one answer.

8. What type of school do you teach at?

Public / State / Government-funded / Charter / Academy school | Private school | Low-cost private school | Religious school | Charity or NGO-funded school

9. Select your school's main curriculum

10. Describe the infrastructure usually available in your school

- My school has access to the internet Yes | No
- All or most teachers have access to the internet at home Yes | No

11. Which of the following best describe(s) the digital devices usually available in your school? Select all answers that apply to you

- My school does not have any digital devices
- My school has one computer / laptop / tablet for the school
- My school has one computer / laptop / tablet for each class
- My school has one computer / laptop / tablet or mobile device per teacher
- My school has one computer / laptop / tablet per child
- My school has digital devices available but none of them are working
- Teachers have to bring their own device
- Learners have to bring their own device

About your learners

12. What age are the learners you are teaching this year? Select all answers that apply to you.

0–4 years old | 5–7 years old | 8–11 years old | 12–16 years old | 17 years or older

13. If you are teaching at a secondary school or tertiary college/university, what subject(s) do you teach? Select all answers that apply to you.

- Language studies / foreign languages (These are different from the main language you teach in and include language and literacy in a language that is not your mother tongue)
- Reading, writing, literacy, literature in your mother tongue or first language
- Mathematics
- Economics
- ICT and Computing (e.g., coding, information technology, electronics, graphic design, design technology, construction)
- Science (e.g., life science, biology, chemistry, physics, environmental science, engineering, surveying)
- Personal, Social and Health Education (e.g., health studies, grooming, hygiene, personal health & safety, social relationships, character)

- Business Studies (e.g., accounting, bookkeeping, human resources, marketing, project management, international business, operations)
- Physical Education (e.g., sport, physical education, gymnastics, dance)
- Domestic Sciences (e.g., cooking, knitting, sewing, home economics)
- Social and Human Sciences (e.g., psychology, law, community or contemporary studies, civic education, citizenship, environmental studies, legal studies, political science, anthropology, sustainability studies)
- Practical, Trade and Vocational Skills (These are skills that help prepare you for a specific job. e.g., mechanics, plumbing, electrical, childcare, hairdressing, tourism, driving, chef, welding, technician, fitting, fashion, hospitality, scaffolding)
- Religion/Ethics (e.g., religion, history of religions, religion culture, ethics)
- Arts (e.g., arts, music, visual arts, drama, photography, drawing, film, media studies)
- Humanities (e.g., geography, history, philosophy, theory of knowledge)
- I only teach in primary school

14. Overall, how would you describe the socio-economic status of the learners at your school? Select all answers that apply to your school.

High socio-economic status | Medium socio-economic status | Low socio-economic status

Teaching during the COVID-19 pandemic.

15. What happened to your school during the COVID-19 pandemic?

16. My school remained open throughout the pandemic | My school was open some of the time, but closed during lockdown(s) | My school remained closed throughout the pandemic

17. You said that your school was closed during lockdowns. Were teachers able to undertake remote learning in those times? Select one answer.

Yes | No | Some of the time

18. Did you do any of the following in the COVID-19 pandemic?

- Make printed copies of digital resources to share with learners

- Contact learners through messaging services (e.g., SMS, Whatsapp, other)
- Contact parents/caregivers through messaging services (e.g., SMS, Whatsapp, other)
- Contact parents/caregivers via phone
- Share lessons and tasks with learners by e-mail
- Contact parents/caregivers via email
- Make audio recordings to share with learners
- Record instructional videos to share with learners
- Share lessons and tasks with learners using a school learning platform
- Teach classes online
- Teach learners online and face-to-face at the same time
- None of the above or no technology was used

19. During the last 12 months, how often did you do the following activities?

Every day or almost every day | About once or twice a week | About once or twice a month | About once or twice a year | Never or almost never

- Use digital resources to create lesson plans
- Use digital resources to design tasks
- Use digital resources to find instructional materials
- Use digital resources to explore new teaching methods
- Use digital resources to assign learning tasks
- Use digital resources to enable student collaboration
- Use digital resources to provide feedback to students
- Use digital resources to provide access to instructional material for students who cannot physically attend class
- Use digital resources to communicate with parents or guardians
- Use online tools or computer-based testing to assess students' learning

- Use digital resources to share ideas or resources with colleagues
- Take part in professional communities of practice online

20. Did your school encourage you to use any digital resources for lesson planning and teaching?

Yes | No

21. Which digital resources did your school encourage you to use?

- Virtual Learning Environment / LMS (E.g. Seesaw, Blackboard, Canvas Edmodo)
- School or community interactive platform (E.g. ClassDojo)
- Video conferencing tools (E.g. Zoom, Google Meet, Microsoft Teams, Skype)
- Digital textbooks
- Quiz tools
- Video resources (E.g. online/digital TV, YouTube)
- Audio resources (E.g. podcasts, audio recording, online/digital radio)
- Web-based resources (For example: Wikis, lesson plans, Other)
- Messaging and social media (For example: WhatsApp, SMS, Facebook, Messenger, other)
- Broadcast radio
- Broadcast television
- None of the above

22. Overall, how useful was the Virtual Learning Environment/LMS to your teaching?

Rating scale: 1 | 2 | 3

- Overall, how useful was the School or community interactive platform to your teaching?
- Overall, how useful was the video conferencing tool to your teaching?
- Overall, how useful were the digital textbooks to your teaching?

- Overall, how useful were the quiz tools to your teaching?
- Overall, how useful were the video resources to your teaching?
- Overall, how useful were the audio resources to your teaching?
- Overall, how useful were the web resources to your teaching?
- Overall, how useful was messaging and social media to your teaching?
- Overall, how useful was broadcast radio to your teaching?
- Overall, how useful was broadcast TV to your teaching?
- Overall, how useful were the other digital resources used to your teaching?

Current teaching challenges

23. To what extent is this school's capacity to provide quality instruction currently hindered by any of the following issues? Select one answer per row.

Not at all | To some extent | Quite a bit | a lot

- Shortage of qualified teachers
- Shortage or inadequacy of instructional materials (For example: textbooks)
- Shortage or inadequacy of digital technology for instruction (For example: software, computers, tablets, smart boards)
- Insufficient internet access
- Shortage of support personnel
- Shortage or inadequacy of instructional space (For example: classrooms)
- Shortage or inadequacy of physical infrastructure (For example: classroom furniture, school buildings, heating/cooling, and lighting)

Learning loss and teaching post-COVID-19.

24. What are your experiences with learners in your class(es)?

Agree | Disagree | Don't know

- All students continued to progress their learning
- Some students have not progressed their learning

- No students have progressed their learning

a) You told us that some or none of your students have progressed their learning (or you didn't know). Have any of these things been affected?

Yes | No | Don't know

- Learners have less self-discipline or are less motivated to learn
- Learners' literacy skills have suffered
- Learners' numeracy skills have suffered
- Learners' communication and interpersonal skills have suffered
- Learners' confidence has suffered
- Learners' well-being has suffered
- Learners are finding it more difficult to pay attention during (in-person or online) lessons
- Learners are choosing not to participate or they make less contribution in the lesson

b) Have you noticed anything else has been affected as a result of your students not being able to progress their learning during this time?

25. If your school reopened following closures for the COVID-19 pandemic, which of the following has taken place? Select all answers that apply to you.

- Assessment of students' learning levels
- The curriculum was adapted to meet students' learning levels
- Lessons focused on remediation/making up for lost learning
- None of the above

26. Have any of these groups of learners experienced more learning loss than other students?

- Learners from the financially poorest households (including food poverty)
- Learners with physical disabilities, learning difficulties or other special needs
- Learners who have been displaced from their home

- Learners whose mother tongue / first language is not the language of instruction
- Learners with less access to the internet or technology
- Learners who have experienced illness or bereavement in their families due to COVID- 19
- Learners who have experienced financial difficulty or unemployment in their families due to COVID-19
- Learners who had low levels of attainment prior to the pandemic
- Learners who have an unstable home background
- Learners whose parents/caregivers have been unable to support them in their lessons outside school (e.g., because they are working)
- Learners that you consider to be vulnerable or have other needs / special requirements

27. In your experience over the past 12 months, are any of these true?

a) Girls have experienced more learning loss than boys

- Yes
- No
- Don't know

b) Parents/caregivers have prioritised boys learning over girls during lockdown

- Yes
- No
- Don't know

c) Parents/caregivers prioritised older children's learning over learning of younger children

- Yes
- No
- Don't know

d) Boys have experienced more learning loss than girls

- Yes
- No
- Don't know

e) Single children have experienced more learning loss than children with many siblings

- Yes
- No
- Don't know

f) Children with many siblings have experienced more learning loss than single children

- Yes
- No
- Don't know

28. Have you noticed any other groups of learners who have had a poorer quality or reduced learning experience compared to others?

29. What should your school do post COVID-19 in teaching, pedagogies or structurally to help learners to catch up? Select all answers that apply.

- Help learners understand how they can learn better and develop independent learning strategies
- Introduce more play in learning to reduce stress
- Give learners more time to practise and reflect, rather than relying solely on direct instruction
- Allow for more peer-to-peer learning and interaction in the classroom/remotely
- Engage parents/caregivers more frequently
- Add more hours or days to teaching time
- Provide more opportunities (time, financing, training) to use technologies for individualised learning
- Reduce class sizes

- Reduce administration to focus on teaching and learning
- Provide more direct instruction
- Focus on specific group(s) of marginalised/vulnerable learners who experienced learning loss
- Give teachers more autonomy to deliver lessons targeted to the learners' needs and learning levels
- Allow teachers more freedom in lesson planning
- Support socio-emotional learning
- Introduce remedial tutoring

30. What should governments do post-COVID-19 to address any loss of learning experienced?

- Promote the teaching profession in order to increase the number of teachers
- Focus on teacher recruitment and retention
- Support teachers' well-being
- Support teacher development / teacher training
- Revise curriculum
- Provide digital access and devices for marginalised learners (e.g., learners from low-income households, SEND learners, girls, minority language learners)
- Provide more technology for individual learning by those who need more support
- Provide more materials for digital teaching and learning to schools
- Provide training and support for teachers to better integrate technology into education
- Cancel exams and replace them with regular assessment and monitoring
- Collect learning outcomes data to monitor progress over the long term
- Provide support for socio-emotional learning

Your professional learning

31. During the past 12 months did you take part in any form of teacher professional development or training (organised or self-initiated)?

Yes | No

a) You told us that you took part in teacher development or training in the past 12 months. Who paid for the cost of it?

b) You told us that you took part in teacher development or training in the past 12 months. What did it focus on?

- Using technology tools and resources for online or remote teaching and learning (including audio, video, broadcast radio and TV, WhatsApp, etc.)
- Pedagogies for online or remote teaching and learning
- Progress monitoring during remote learning
- Learner safeguarding online and during remote learning
- Safe online behaviour for teachers
- Understanding online learner behaviour
- Engaging parents/caregivers during remote learning
- Engaging in teacher communities of practice
- Teachers' physical, mental and/or emotional well-being

c) You told us that the focus of your professional development or training was the use of technology tools and resources for online teaching. What kind of tools or resources did you learn about?

- Virtual Learning Environment / LMS (E.g. Seesaw, Blackboard, Canvas Edmodo)
- Video conferencing tools (E.g. Zoom, Google Meet, Microsoft Teams, Skype)
- Digital textbooks
- Quiz tools
- Video resources (E.g. online/digital TV, YouTube)
- Audio resources (E.g. podcasts, audio recording, online/digital radio)

- Web-based resources (E.g. Wikis, lesson plans, etc.)
- Messaging and social media (E.g. WhatsApp, SMS, Facebook)
- Broadcast media (E.g. radio, TV)
- School or community platforms (E.g. ClassDojo)

32. Think back across the (organised or self-initiated) professional development or training you experienced over the last 12 months (on any topic). Overall, to what extent did your practice change as a result?

Rating scale: 1 | 2 | 3

33. How much time in total was spent on your professional development or training over the last 12 months? Add up the actual time you spent and answer in whole days.

34. An extensive global platform might be developed over the coming year where teachers can share classroom practices with others outside their regions. Would you consider using this to share teaching resources and lesson plans that you have created yourself?

Yes | No

35. Which is NOT the type of school you teach at?

Public / State / Government funded / Charter / Academy school | Private school | Low-cost private school | Religious school | Charity or NGO-funded school

Your needs as a teacher

36. Which of the following areas could support your teaching in the next 12 months? Select up to five (5) answers maximum.

- Teaching online/remotely
- Caring for my mental health and well-being
- Developing skills and confidence in using digital technologies in teaching
- Subject/content knowledge for my own professional development
- Pedagogy / teaching methods for my own professional development
- Curriculum-related for my own professional development
- Integrating digital technologies into classroom practice

- Protected time during the working week for professional development and peer collaboration
- More interactive or engaging learning resources
- Assessment and monitoring of learners
- Safeguarding
- More administrative support
- More social or peer encouragement from people in your school
- Engaging in (remote) communities of practice with other educators
- Tackling gender issues related to learners' technology use
- Teaching/adapting to marginalised learners' needs (e.g., students with disabilities; minority language speakers; displaced, orphaned or otherwise vulnerable students)
- Coaching / mentoring
- No support needed

37. What further support could help you in the next 12 months?

38. Do you need more access to software or other (non-hardware) digital resources for the following tasks? Select one answer per row.

- My professional learning. Yes | No
- Planning lessons. Yes | No
- Assessment and evaluation. Yes | No
- Learners to use themselves (e.g., worksheets, quizzes, digital textbooks). Yes | No

39. Which of these statements best describes the quality of your teaching during the COVID-19 pandemic? Select one answer.

The experience has had no impact on your teaching quality | The experience has made you a better teacher | The experience has made you a worse teacher

40. How do you feel about teaching since the pandemic started? About the same | Less enthusiastic | More enthusiastic

a) You told us you were more enthusiastic about teaching now. Why?

b) You told us you were less enthusiastic about teaching now. Why?

41. How would you describe the level of respect/esteem that parents/ caregivers have for teachers since the pandemic started? Select one answer.

About the same | More respect/esteem | Less respect/esteem

42. How would you describe what has happened to your physical, mental and emotional well-being since the pandemic started? Select one answer.

My well-being has improved | My well-being has suffered | My well-being is about the same

43. Which of these statements best describes your current plans in the teaching profession?

I am undecided about my teaching plans | I plan to leave the teaching profession | I plan to remain a teacher

44. How likely are you to recommend teaching to friends, family or others?

Rating scale: 1 | 2 | 3

Annex B: Logit regression model

The binary logit regression model in Equation 1 assesses the association between the predictor variables and their effects on teachers' perceptions of student motivation and self-discipline. The table below describes the terms used in Equation 1. The two sub-categories of learning losses are used in two separate logit models (Model 1 & 2) as they are correlated; however, the remaining variables in the model are equivalent, therefore, Equation 1 applies to both models.

Equation 1

$$logit(Pr(M_{ij} = 1) = \gamma_0 + \gamma_1 M_{aj} + \gamma_2 M_{oj} + \gamma_3 M_{uj} + \gamma_4 I_j + \gamma_5 S_j + \gamma_6 E_j + \gamma_7 P_j + \gamma_8 L_j + \varepsilon_{ij}$$

Terms in equation	Descriptions
M_{ij}	M_{ij} is a binary outcome variable indicating whether students' motivation and self-discipline have reduced (1) or not (0) as perceived by teachers
γ_0	Intercept
M_{aj}	Whether teachers used email during remote schooling
M_{oj}	Whether teachers used mobile during remote schooling
M_{uj}	Whether teachers used multimedia and online tools during remote schooling
I_j	Frequency of digital interaction
S_j	Type of school
E_j	Socio-economic status
P_j	Phase of schooling
L_j	Learning losses (both academic and socio-emotional)
ε_{ij}	Error term which accounts for the variation in student motivation that is not captured by the predictor variables

Annex C: Descriptive statistics for independent variables

Independent variables	Teacher sample	
	n	%
Remote learning modalities		
Email		
Yes	287	17
No	1381	83
Mobile		
Yes	1338	80
No	330	20
Online and multimedia		
Yes	1326	79
No	342	21
Frequency of digital interaction		
Everyday or weekly	1010	61
Monthly	425	25
Annually or never	233	14
Learning losses		
Academic learning loss		
Yes	925	56
No	185	11
Missing *n* proportion	558	33
Socio-emotional learning loss		
Yes	972	58
No	149	9
Missing *n* proportion	547	33
Demographics		
School type		
Government	397	24
Private	514	31
NGO	561	34
Missing *n* proportion	196	12
Socio-economic status of students		
High	175	11
Medium	625	38
Low	707	42
Missing n proportion	161	10
Phase		
Primary	1088	65
Secondary	580	35