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Teachers on the Move: Evidence from a Large-Scale Learning Intervention during Lockdown*

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Abstract

The move to remote learning during Covid-19 school closures left children who had no access to e-learning infrastructure without options to continue their education. In this paper we present evidence from a large-scale para-teacher intervention which brought learning resources to the homes of children cut-off by school closures. Over the 6.5 months of intervention, children enrolled in the intervention saw an average increase in test scores of 1.87 SD, with greater gains for those with lower baseline assessment scores. With these gains achieved at a cost of 5.48-7.39 USD per SD, the intervention was extremely cost effective.

JEL codes I21 I24 I28 O10

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1 Introduction

The global shut-down in response to Covid-19 in March 2020 created a host of challenges for the education sector. As schools and educational institutions pivoted to remote learning, opportunities were discovered and weaknesses identified in areas which were previously off the radar. While online learning facilitated this difficult adjustment for many, those without access to e-learning infrastructure were left with few options. First generation learners, children from low socioeconomic backgrounds, children attending under-funded schools, and those living in low-income settings were particularly disenfranchised by the move to online or remote learning.

This paper presents evidence on an intervention that brought learning to the doorstep of school children caught on the wrong side of the digital divide when schools shut down. Developed as a stopgap solution by an Indian education NGO to support students they were working with before the pandemic, the intervention was then rolled out at scale in January 2021. At that time schools had already been closed for 9 months. This 'Lockdown Learning Expansion' intervention reached out to 100,500 children of grades 3 to 8 in remote, tribal, and under-resourced areas of Odisha and Jharkhand states.

The intervention sent volunteer teachers, who were recruited from the local area, to visit participating students at home or in small groups. Each week, the teacher would bring a task and any pedagogical supports to the children. The tasks drew on core curricular skills, such as math, writing and science, but were not part of the standard school curriculum: rather, they were hands-on assignments which required some degree of entrepreneurialism. Students then worked independently, using locally available resources and support from their parents, neighbors, and peers to complete tasks. At the end of the week, the teacher returned to discuss, collect, and review the work.

In this study we estimate the learning gains that students made over the course of the Lockdown Learning Expansion. All participants completed a baseline learning assessment in January 2021. The intervention ran until the end of September 2021, with a 2.5 months stoppage from mid April to June end (the severe Delta wave of Covid-19 in India led to strict travel restrictions over this period), for a total duration of 6.5 months. A 10.5% random sample of students was re-surveyed in the first week of October 2021 for an endline assessment.

Between baseline and endline, average scores on the assessment papers increased by 1.87

SD. These learning gains cost somewhere in the range of 5.48-7.39 USD per SD (alternatively, 13.53-18.25 SD per 100 USD), making the program extremely cost-effective. Improvements were slightly larger for upper primary students (grades 6-8) than primary (grades 3-5): 2.03 SD vs 1.75 SD respectively. We do not find any difference in learning gains across boys and girls, but do find evidence that children in lower grade levels had larger gains. We also find that the students with lower baseline assessment scores showed larger absolute improvements over the course of the program than those with higher initial achievement: children scoring in the first quartile at baseline had an average improvement of 2.46 SD, compared with those in the top quartile who only gained 0.90 SD.

These changes are estimated using a before-after study design. Given the operational constraints present at the time, it was not possible for the NGO to follow a control group in a non-program area over the same period.[1] It should be emphasized that children participating in the intervention were enrolled in government schools: these were closed for the duration of the intervention. Indeed, a key criteria of eligibility was that the child had no other access to education at that time. Pre-pandemic evidence from school holidays and absenteeism indicates that learning declines substantially when schools are closed (see Kuhfeld et al. (2020)). Engzell et al. (2021) compare learning outcomes of Dutch students before and after school closure and find that students made little or no progress learning at home, with students from less-educated homes disproportionately affected. Another study in Belgium found that students of the 2020 cohort experienced significant learning losses after school closures, with disadvantageous students experiencing larger learning losses (Maldonado and Witte (2022)). This suggests that even children from technologically advanced countries were struggling to learn remotely, with children from low resource families bearing the brunt of the loss. We argue that comparing the estimated learning gains from the intervention to a counterfactual of no change is conservative, with the true counterfactual likely to be a continued decline in academic skills over the 6.5 program months.

While there is no doubt that learning has suffered during school closures, evidence on the extent and incidence of learning slow-down or learning loss - particularly in low income settings - is just starting to emerge. In the absence of real-time data, early estimates were

[1] The NGO was able to launch the intervention quickly (from April 2020) in its program area due to their existing presence in these villages. The NGO was designated an official Covid-relief partner of the government as the pandemic began. During the various pandemic lockdowns, within-village movement was often restricted to government administration and its support partners: with 98% of its staff local to the villages, this designation allowed the intervention to continue during much of this time.

generated using projections (see Angrist et al. (2021) in Sub-Saharan Africa, Khan and Ahmed (2021) in Pakistan, and Kuhfeld et al. (2020) in the United States). Bakhla et al. (2021) fielded a household survey in August 2021 in 15 Indian states (including Odisha and Jharkhand), focusing on underprivileged villages. Their findings suggest that nearly 50% of sampled children in rural areas were not studying at all at the time of the survey, while just 8% were studying regularly via online learning. Learning access rates were particularly bad for children from Scheduled Castes and Scheduled Tribes - marginalised groups in India. Learning levels were also very low among the sampled children. The authors administered a simple literacy test to children and found that only half of children in the age group of 8-12 years could read a simple sentence. Only 25% of grade 3 children could read more than a few words.

Communities, governments, and civil society responded to school closures in a myriad of ways, but until recently rigorous evaluations of these engagements have been scarce. Evidence is now emerging from randomized controlled trials of phone-based interventions targeting primary school children (or their parents) during school closures. The studies to date show mixed results. Engaging parents with SMS messages or phone calls improved learning outcomes in Botswana by 0.12 SD (Angrist et al. (2022)); active phone calls by teaches or NGO staff lead to 0.14-0.19 SD improvements in learning in Nepal (Radhakrishnan et al. (2021)); while a 13-week tele-mentoring program improved learning outcomes in rural Bangladesh by 0.75 SD (Hassan et al. (2021)). In contrast, weekly tutoring phone calls had no impact on learning outcomes in Sierra Leone (Crawfurd et al. (2022)) nor, in a different design, in Kenya (Schueler and Rodriguez-Segura (2021)).

The intervention we evaluate here was implemented in a hybrid (online + physical) mode to maintain the continuity of learning for children who had no access to online learning. It is qualitatively different from the above studies as the volunteer teachers visited students at home, supported them in accessing and understanding digital resources, and set them assignments independent of the school curriculum. Assigned tasks were geared towards transforming a child into a self-directed learner. We are not aware of any rigorous evaluations of interventions of this type supporting students during school closures, either in pilot studies or at scale. While our study is not based on a randomized control trial, it nevertheless contributes to this literature by providing quantitative evidence on an intervention approach which shows great promise in a low-income low-digital-access setting.

Our study makes three contributions. First, we report evidence on the effectiveness of a low-cost, scaleable intervention which can support learning during times of institutional disruption. With conflict, environmental, and health risks ever-present, building an evidence base around such programs is important for resiliency. Second, the intervention we evaluate deviates from much of the Covid-19 impact evaluation literature in it's reliance on face-to-face contact between teachers and students. While this is a limitation to some extent – the program was forced to pause during the most intense periods of the pandemic – we feel it has also been a strength. Particularly in low-income settings, but not exclusively, there are groups of children who need additional support to thrive as learners. Perhaps due to poor parental education or engagement, a disrupted education pathway for the child themselves, or for a number of other reasons: not all children can unlock the full potential of remote learning. The intervention we study offers an approach that is particularly suited to engaging children who are at a greater risk of falling behind.

Finally, this paper also has insights for education design outside of emergency situations. With the pandemic experience to build on, and a host of excellent resources available, many education systems are looking to incorporate digital learning solutions into the standard curriculum. In India, the recently launched National Education Policy 2020 places special emphasis on the "extensive use of technology in teaching and learning", touting it as one of the fundamental principles of the future of education system of India (see Government of India (2020), page 5). Soon after, the Ministry of Education launched PM eVidya, a comprehensive approach to enable access to digital, online, and on-air education for all children. Within it, a national e-learning platform DIKSHA was launched for government schools in all states. Twelve TV channels were broadcast for children without internet access to continue their learning through TV programs. While there is great potential in these digital solutions, the widespread push for their adoption risks deepening the digital divide which has left so many children behind during the pandemic. 'Phygital' learning, where digital technology is used in combination with face-to-face interactions to facilitate hands-on, student-driven education, could offer an on-ramp for children from varied backgrounds. As an example of phygital learning implemented at scale, this intervention sets an important precedent.

The remainder of the paper proceeds as follows. Sections 2 & 3 present the context and describe the intervention. Section 4 introduces the data, while Section 5 provides an overview of the empirical methodology. Results, including main findings and heterogeneity analysis, are in Section 6. Section 7 provides some further discussion and cost-effectiveness calculations, and Section 8 concludes.

2 Context

In 2020, in response to the Covid-19 pandemic, governments across the world closed schools and educational institutions, adversely affecting 1.6 billion children and young people (UNESCO (2021)). While India followed the global trend by closing schools early in the pandemic, it soon stood apart, implementing one of the longest continuous school closures in the world at 69 weeks on average (The Economist (2021)). The Oxford Covid-19 Government Response Tracker shows that, between March 5, 2020 and July 20, 2021, all Indian schools and educational institutions were closed for 80 percent of days (Bashir and Sadath (2021)).

In Odisha and Jharkhand, two of the most resource-rich, tribal-dominated, yet underdeveloped states in India, schools were shut down for all classes on March 13 and 17, respectively, a week before the national lockdown was imposed on March 24, 2020. The national lockdown gradually relaxed over the next few months as decisions over Covid-19 containment measures were handed to states. In the next 18 months, two subsequent waves of the virus would hit the country (Delta and Omicron), with the Delta wave being particularly deadly in many states. As a result, containment policies changed abruptly multiple times: school closures were usually among the first measures that many state governments enacted.

By February 2021, both Odisha and Jharkhand gradually reopened for grades 9 to 12, with planned re openings for more grades to follow. Instead, the Delta wave of Covid-19 swept the country in March-April of that year, leading to a shut down of schools for all grades. Another phased reopening for higher grades cautiously began in October 2021, with grades 1-5 still closed. Three months later, the Omicron variant caused an alarming increase in cases. In response, both state governments again ordered the closure of schools from January 2022. Schools finally opened from July 2022 for all grade levels. Throughout this period, from March 2020 to June 2022, government schools in Odisha and Jharkhand had been physically closed for all days for primary students.

To maintain the continuity of learning, state governments responded with various distance learning solutions: e-learning platforms, video classes, messaging apps, learning apps, television programs, and public radio programs. Odisha and Jharkhand governments deployed e-learning apps (Madhu, DIKSHA), community radio stations, and e-learning platforms (e-Pathsala and e-Mulyankan) to deliver learning content to students. In rural remote areas, teachers were ordered to distribute textbooks to grade 1 - 8 children at their doorsteps.

However not all learners and teachers were ready for this transition. In the absence of proper digital infrastructure, digital literacy, internet-enabled devices, and conducive home environments both students and instructors faced unprecedented challenges. Survey data from 2017-18 showed that only 47 percent of Indian villages received electricity for more than 12 hours a day, with 16 percent receiving it for 1-8 hours daily.[2] During the same time period, only 15 percent of Indian rural households and 42 percent urban households had access to internet services (National Statistical Organisation (2017-18)). The digital divide is even more prominent in some states: less than 6 percent of households in rural Odisha had internet facilities in 2017-18. The NSO survey also highlights that only 40% of those in the age group 15-29 had basic digital literacy, e.g. the ability to use an internet browser for website navigation, use e-mail and social networking applications, etc. to find, evaluate, and communicate information.

3 Intervention

The prolonged and continuous closure of schools, coupled with a sharp digital divide, left millions of Indian children out of formal schooling for two years. The situation was especially dire for younger children enrolled in government schools, aided schools, and poor private schools: children who generally did not get much education support from their parents. Recognising this education emergency, ASPIRE, an education NGO, with funding from Tata Steel Foundation, launched a hybrid (online + physical) learning intervention to maintain continuity of learning for the children they worked with before the pandemic.

ASPIRE works in rural, remote, tribal areas of Eastern India (Odisha, Jharkhand, and West Bengal) to strengthen the mainstream government school education system through ensuring universal school access, introduction of new pedagogic practices, and empowering parents, local community, and panchayats.[3] Since 2015, ASPIRE has been running a

[2]The data is from Mission Antyodaya, a nationwide survey of villages conducted by the Ministry of Rural Development in 2017-18. https://missionantyodaya.nic.in/ma2018/preloginStateElectricityReport2018.html

[3]Panchayat is the smallest administrative unit with an elected government in India. They tend to comprise a few villages.

Learning Enrichment Project (LEP) with roughly 30,000 children in grades 3 to 8 in 19 blocks of Odisha and Jharkhand. The LEP provides supplementary instruction to bring children's skills up to their age-appropriate grade level, with an emphasis on developing self-directed learners. Children were selected for the LEP based on their performance on an assessment paper being among the lowest in their school grade. The LEP has its own innovative teaching-learning materials. The multi-faceted intervention includes remedial classes to bridge learning gaps, training government teachers in effective pedagogy, promoting use of digital technology, and setting up school libraries.

With shutdown of schools in March 2020, ASPIRE launched a village-level digital access mapping to identify areas with internet access or household smartphone availability. The mapping revealed that only 14% of the 30,000 LEP children had access to a smartphone. A decision was taken to launch a hybrid learning intervention, called Lockdown Learning (henceforth LL) to reach the remaining 86% of LEP children via physical visits. Siblings of these children who were of a similar age were also invited to join, raising the total enrolment in LL to approximately 35,000. The existing LEP teaching-learning material was redesigned to engage a child at home, on her own, with support from parents, neighbors, and peers, and using resources available locally. With limited local movement, 700 ASPIRE teachers were assigned a set of villages, where they would meet children twice a week, in an open air environment, individually or in small groups, following mask, sanitization, and distancing protocols. On the first visit, teachers introduced the learning task on their phones or tablets and on the second visit, completed tasks were collected from the children for later analysis and sharing.

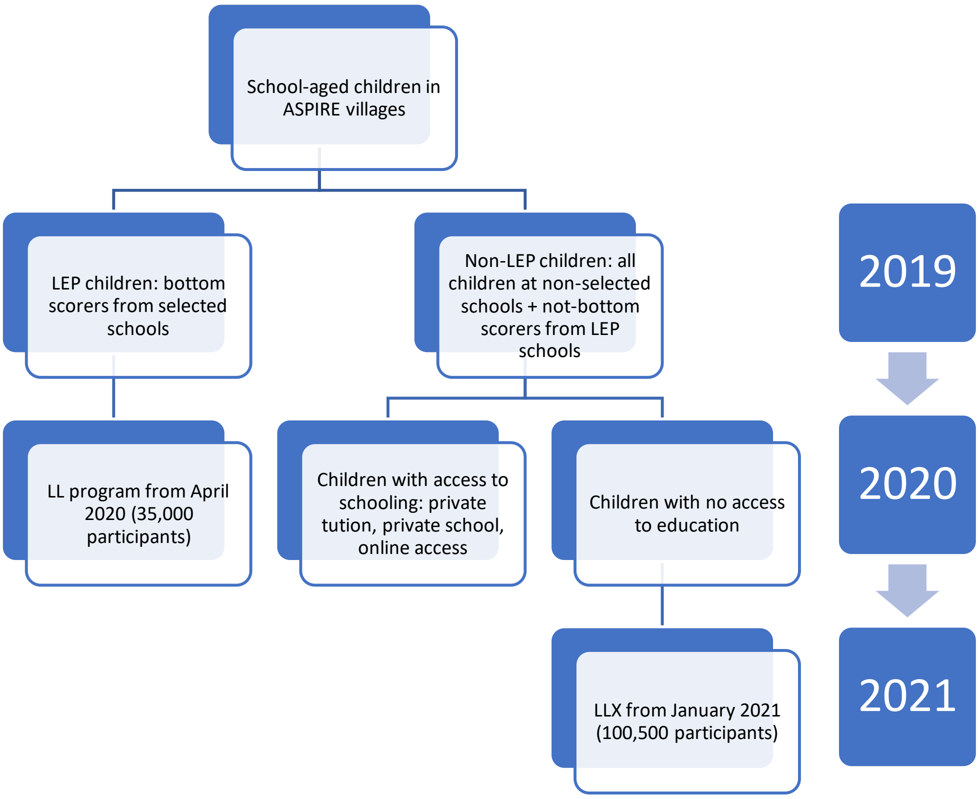
In January 2021, with schools still closed, ASPIRE expanded their hybrid learning program to non-LEP children resident in the same blocks. Around one hundred thousand additional children from primary (3 to 5) and upper primary (6 to 8) grades became eligible to take part in the expanded LL, better known as Lockdown Learning Expansion (or LLX).[4] These children were spread over 5555 villages in 19 blocks in Odisha and Jharkhand. A team of 2700 volunteer teachers were temporarily recruited and trained to support and backup the existing 700 ASPIRE teachers.[5] The eligibility criteria for children to join the interven-

[4] 100,500 children is roughly equivalent to 34 percent of total children enrolled in grades 3 to 8 in private and government schools the 19 blocks (UDISE data 2016-17).

[5] The 2700 volunteer teachers were mostly young people who were paid a daily honorarium of 125 INR or $1.5 to cover the cost of their travel and data pack. For comparison, the minimum wage for a skilled worker in Odisha and Jharkhand is roughly $5 per day.

tion was as follows: all children who had no access to learning were mapped and asked to participate. This precluded children who were taking private tuition and children who had access to online classes. Children from grades 1 and 2 were not part of the intervention as they were considered too young to do the tasks on their own. Few very remote hamlets also could not be reached due to logistic challenges.[6] Figure 1 details the selection of children into the LLX.

Figure 1: **Selection of children into LLX**



Note: Flow of children into ASPIRE's different learning interventions over time. The bottom last square, children who joined the LLX in 2021, form the sample frame for this study. See Figure 2 for how the sample for this paper was drawn from the LLX 100,500. Source: Authors' illustration.

To ensure the fidelity of the LLX, a strict implementation and monitoring structure was set up. At the beginning of every week, on Sunday, volunteer teachers were oriented on

[6]The original LL cohort (35,000 LEP children and their siblings) were also continuing their learning. Since these children did not have a baseline assessment and they were previously part of ASPIRE's LEP, we have not included them in our analysis for this paper.

the task for the week. On Monday and Tuesday, they went to their assigned villages and introduced the task to the children. On average, a volunteer teacher spent 15-20 minutes per child and reached out to 30-40 children across 2-4 villages. The average class size was 5-7 children. In some areas, groups of 40-50 students also had to be created. All classes were held outdoors.

On Wednesday and Thursday, if needed, the volunteer teachers went back to the same villages to assist students with the task. Friday and Saturday were task collection days. 10% of the tasks were uploaded and shared for review and feedback. The 700 ASPIRE teachers supervised and supported the volunteer teachers, providing feedback on the ongoing cycle, and preparing tasks for next week's cycle. Above every 5 ASPIRE teachers, there was a Learning Manager, whose main job was to supervise, collect data, and provide regular inputs on pedagogy. All 19 blocks had a Learning Block in-charge who oversaw the implementation of the intervention in her respective block.

An example of an early hybrid task would be conducting an internet search on a particular topic, such as Giraffe, Mount Everest, Dinosaurs, Taj Mahal, or Penguins, and producing a drawing, write-up, or project at the end of the week. For students with no smartphone/internet access at home, the volunteer teacher would allow them use of her smartphone during the initial visit. In areas with no internet access, volunteer teachers would use pre-downloaded lessons and videos to explain the task. (A more detailed example of three tasks is given in Appendix Section A.2.1.) At their initial orientation, volunteer teachers were asked to follow certain protocols for a good classroom - address each child by name; try to know their background; maintain a good relationship with the parents; and encourage a respectful, fear-free interaction.

As weeks progressed, new tasks were designed and added. Children browsed the John Hopkins University coronavirus resource page to discuss the math and science of Covid-19, they practiced math concepts at the neighborhood shop, they observed leaves and insects in their surroundings to understand biodiversity, they listed out tasks carried out by their mothers for gender equality discussions. In a citizenship task, grade 6-8 children spread awareness about Covid-19 vaccines and helped register 16,000 people for vaccination. Total time spent by children on the tasks depended on the type of tasks. Some tasks were simple search-and-write tasks, while others involved venturing into the local environment to observe and collect information. Excluding the preparation time, a child spent roughly 20-30 minutes on the final write-up for a simple task and 50-60 mins for a higher level task.

The intervention also encouraged parents to get involved in their child's learning through tasks such as listing out recipes from the kitchen, documenting stories from grandmothers, and learning village history from elders. In 70%-80% of villages, children organised exhibitions to showcase their work to the community and parents were invited to discuss and reflect. This was important for the community as most of the children are first-generation learners, and previously their parents never took part in their education. The weekly assessment of children's responses helped ASPIRE teachers to categorize students into three groups - A (children who are working without teacher support), B (children who are doing the tasks with teacher support), and C (children who need extra help from the teachers). A close track was kept on group C children to encourage their transition to groups B and A.

The LLX ended on 30 September 2021, with a 2.5 months disruption or shut down from mid April to the end of June 2021 due to the Delta Covid-19 wave. Restrictions on movement and congregation were once again enforced by the Odisha and Jharkhand state governments during this period. Due to the deadly nature of the Delta variant, the senior management at ASPIRE and Tata Steel Foundation decided to halt the LLX from mid April until situation improved. Visits restarted in July 2021 and continued until the end of September 2021, when the intervention ended as the states had announced opening of schools for all grades from October 2021.[7].

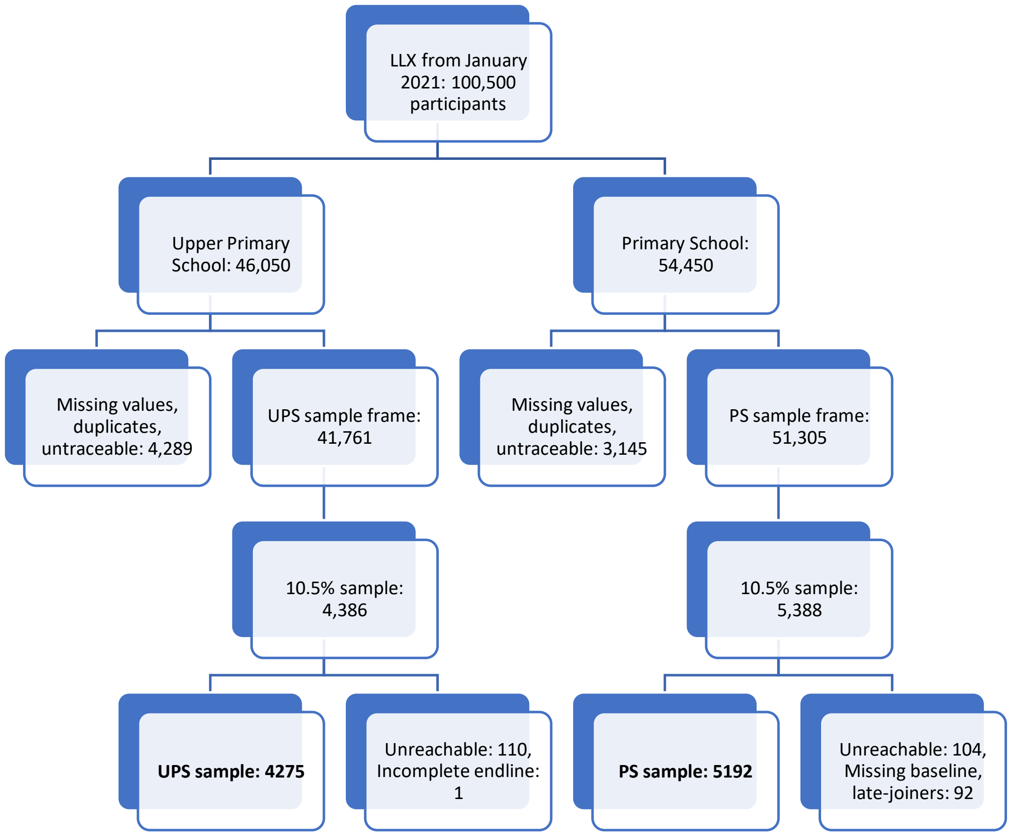
4 Data

4.1 Data collection

A baseline assessment was conducted for all 100,500 children who enrolled in the program, with primary grade children tested on their math and language (Odia, Hindi) skills and upper primary grade children tested on eight competencies - math, writing, shapes and materials, science, English language, maps, calendar, and Covid-19. Tests were administered in the local language - Odia for Odisha and Hindi in Jharkhand. These baseline assessments also collected gender, grade level at school, and social category status.

[7] As described in Section 2 schools opened for higher grades in October 2021 with plans to open for all grades soon. However, the Omicron wave hit soon after and schools were shut down again. Due to budgetary constrains, ASPIRE and Tata Steel Foundation did not run the LLX intervention beyond October 2021. The LL program with the LEP children has continued.

Figure 2: **Sample flows from enrollment to endline**



Note: Flow of children from LLX program into the sample. See Figure 1 for how the initial LLX sample was drawn from the population. Source: Authors' illustration.

An endline sampling frame was defined from this baseline data set. 6,716 children were dropped as they had migrated out of the area before the end of the intervention. We further dropped 673 duplicates and 45 children with missing identifying information. This left 51,305 primary grade children and 41,761 upper primary children. A 10.5 percent random sample was drawn separately from the primary and upper primary groups, giving us a target list of 5388 primary and 4386 upper primary children for the endline. Figure 2 provides a visual overview of this process.

The endline assessment was administered by the volunteer teachers: each teacher was responsible for giving the assessment to any of their students who were selected into the endline sample. The teachers were instructed to reach out 3 times to a child before giving up. 214 children could not be located for the endline as they were persistently absent or had migrated or moved out of the village at the time of the endline.[8] Finally, 89 children from one particular administrative block were dropped as they had joined the intervention mid way. Cleaning the data and dropping children with missing information gives us a final sample of 5192 primary grade children and 4275 upper primary grade children with matched baseline-endline assessment papers.

The endline assessment was done using the same assessment paper as used at baseline. Primary grade children were administered two papers - math assessment which was aligned with the government curriculum for grade 3, and a language assessment was bench marked to grade 5 level. The primary grade papers are similar to the assessments used by ASER to monitor learning levels across India.[9] The upper primary grade assessment was designed in response to the self-directed nature of the tasks: it evaluated a range of skills across eight topics.[10] An English translation of the assessment papers is included in Appendix A.2.2. A guideline was developed for grading the baseline and endline papers and communicated to the volunteer teachers. Assessment papers were graded by the volunteer teachers and

[8] A balance analysis comparing these non-response children to the endline sample reveals no major statistical differences: see Tables 13 and 14 in the Appendix.

[9] See http://www.asercentre.org/p/141.html

[10] The decision to use the same paper, rather than a variant with similar-but-different questions, was deliberate. It was felt that a variant on the same paper would never be exactly as difficult as the original paper: some amount of the difference in scores would therefore be due to the particular questions chosen. Without a control group to difference out this noise, it would be difficult to adjust for. Using the same paper raises concerns that students may have memorised the questions and learned to answer them. While we cannot rule this out, three features convince us this will not be a problem of any meaningful magnitude. First, a full 9 months elapsed between baseline and endline, which is a long time for a child to remember test questions. Second, the assessment papers were not corrected and returned to the children to study. Third, these were low-stakes assessments which had no bearing on program eligibility or future participation: there was little incentive for students try to manipulate their scores.

a random sample of the papers was checked by the ASPIRE teachers and re-checked by the Learning Managers. Data entry in excel was carried out by the ASPIRE teachers and Learning Managers.

4.2 Overview of the sample

An overview of the sample characteristics is presented in Table 1. Girls and boys are equally represented in both the primary and upper primary samples. Due to the location of the intervention in tribal areas, the sample is dominated by children from Scheduled Tribes (ST): 67% of the primary sample and 63% of the upper primary sample come from this population. Other Backwards Castes (OBC) make up 22% of the total and Scheduled Castes (SC) make up 10%. Children from general castes make up only 3%.

The intervention offered two curricula: one for primary grades 3-5, and the other for upper primary grades 6-8. The vast majority of students in the program complied with these cut-offs, although there were a few exceptions, e.g. grade 6 children following the primary course. Students enrolled in the primary course are quite evenly spread across grades 3-5, with only slightly more enrolled in 3rd grade than in other grades. The upper primary group is more heavily skewed towards the younger grades: 39% of the sample are in grade 6, compared with only 27% in grade 8. It could be that older children had more access to alternative learning opportunities: either by having the skills to make use of remote learning, or by having a higher likelihood of enrolment in private tuition classes. They are also more likely to be engaged in labor or home chores. Our data do not allow us to distinguish these alternatives; however, the possibility that the sample is less representative of the population at the higher grade levels should be kept in mind.

4.3 Outcome variables

Our primary outcome of interest is the overall assessment score. This score is the average of math and language papers for primary school children, and a weighted average of the eight competencies for upper primary children.[11] Table 2 provides an overview of the raw scores at baseline and endline. The overall total score at baseline for primary school students was 27%, the average of 31% for math and 24% for language. Upper primary students had

[11]Following their relative importance in the assessment paper, Writing and English were given double weight in the final score compared with the other sections.

Table 1: **Summary statistics: sample**

	Total		Primary		Upper Primary	
	Mean	SD	Mean	SD	Mean	SD
Girls	**0.50**	0.50	**0.50**	0.50	**0.50**	0.50
General	**0.03**	0.16	**0.02**	0.15	**0.03**	0.17
OBC	**0.22**	0.41	**0.20**	0.40	**0.24**	0.43
SC	**0.10**	0.30	**0.10**	0.30	**0.10**	0.31
ST	**0.65**	0.48	**0.67**	0.47	**0.63**	0.48
Grade 3	**0.20**	0.40	**0.36**	0.48	**0.00**	0.00
Grade 4	**0.17**	0.38	**0.31**	0.46	**0.00**	0.02
Grade 5	**0.18**	0.38	**0.32**	0.47	**0.00**	0.03
Grade 6	**0.18**	0.38	**0.01**	0.07	**0.39**	0.49
Grade 7	**0.15**	0.36	**0.00**	0.00	**0.34**	0.47
Grade 8	**0.12**	0.33	**0.00**	0.00	**0.27**	0.44
Grade 9	**0.00**	0.03	**0.00**	0.00	**0.00**	0.04
N	**9,467**		**5,192**		**4,275**	

Abbreviations: General = general caste; OBC = Other Backwards Caste; SC = Scheduled Caste; ST = Scheduled Tribe. This table is discussed in Section 4.2.

slightly lower scores at baseline, with an overall average of 20%. Upper primary students scored an average of 21% in math and 15% in writing, with particularly high scores on the shapes and materials topic (41%), and lowest average scores on Covid-19 knowledge (11%). It should be emphasised that the primary and upper primary scores are not comparable, as they come from different assessment papers.

Endline scores are considerably higher for all groups, in all subjects. Primary school students increase their mean score by 44 points to achieve an average of 71%; upper primary increase by 40 points for an endline average of 60%. Increases are similar across math and language for primary students. There is more variation in subject-level increases in upper primary, from a 26 point increase in Covid-19 knowledge to a 59 point increase in maps. For core subjects, upper primary students saw an increase of 32 points in writing, and 48 points in math.

For analysis, we normalise the assessment score data with respect to the baseline in each group. Specifically, we normalise the primary school total, as well as subject scores, with respect to the baseline mean and standard deviation for each score. This is repeated for the upper primary scores. These normalised scores are now in equivalent units across the two groups. For our headline results, we use normalised total score as our outcome variable, and aggregate primary school and upper primary students together. In further analysis, we split

Table 2: **Summary statistics: assessment scores**

	Primary School				Upper Primary School			
	Baseline		Endline		Baseline		Endline	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Total	**26.99**	25.34	**71.26**	20.96	**19.98**	19.72	**60.00**	20.82
Math	**30.65**	30.93	**78.43**	23.66	**20.54**	31.06	**68.17**	35.36
Language	**24.09**	24.37	**64.09**	22.61				
Writing					**14.89**	21.57	**46.81**	26.91
English					**18.64**	22.78	**54.18**	27.55
Science					**14.87**	24.22	**55.22**	32.14
Shapes Materials					**41.27**	32.82	**82.40**	20.42
Calendar					**23.54**	35.88	**74.42**	36.55
Maps					**21.20**	28.50	**81.00**	26.20
Covid					**11.28**	20.66	**36.95**	28.42

Note: This table is discussed in Section 4.3.

the two groups, and also investigate the different subjects individually.

5 Empirical approach

Our analysis is based on a pre-post design. Given the pandemic conditions under which the intervention was developed and implemented, it was not possible to collect data on an untreated control group while the intervention was running. Without a control group, we do not have a precise counterfactual of how assessment scores would have evolved over this time period, in the absence of the intervention.

What we do know is that, for the duration of the intervention, government schools were closed for grades 3 - 8. Furthermore, children selected for the intervention were those who had no other learning opportunities available to them. To complement our estimated average improvements in test scores over the course of the intervention, we extend our analysis with a discussion of possible counterfactuals, drawn from the recent literature on learning loss during the pandemic.

Our primary estimating equation is as follows:

$$y_{it} = \beta_0 + \beta_1 Post_{it} + \Gamma X_i + \epsilon_{it}, \tag{1}$$

where y_{it} is the assessment score of student i at time $t = 1, 2$; $Post_{it}$ is a dummy variable equal to 1 in the post period; and X_i are a set of time-invariant individual characteristics: sex, school grade at baseline, and social category (General, Other Backward Caste (OBC), Scheduled Caste (SC) or Scheduled Tribe (ST)). ϵ_{it} is the unobserved error term. Our coefficient of interest is $\hat{\beta}_1$, the empirical estimate of the difference in baseline and endline assessment scores.

While our primary outcome of interest is the total or overall assessment score of each student, we also explore the component scores (the subjects covered by the primary and upper primary assessment papers are presented in Section 4). We also test for heterogeneous effects by splitting the sample according to student characteristics and re-estimating Equation 1. We re-estimate our main results using child fixed effects, for robustness, and using assessment score in percentages, for a natural-unit interpretation (these results are in Section A.1 of the Appendix).

6 Results

6.1 Main results

Our primary outcome of interest is the normalised total assessment score of each student. Table 3 presents estimates of Equation 1 with the total score as the outcome variable, measured in standard deviations of the baseline test score (primary and upper primary papers are normalised with respect to their own baselines, see Section 4). Column (1) combines primary and upper primary students, while Columns (2) & (3) consider each of them individually.

Overall, assessment scores increased by 1.87 SD between baseline and endline. Primary school students had slightly smaller relative gains, at 1.75 SD, compared to upper primary student with a 2.03 SD improvement. Averaging across baseline and endline assessments, girls perform better than boys (by 0.06-0.07 SD). Compared with the general population (which is a minority in many parts of the study region), OBC, SC, and ST students perform worse on average, with SC and ST most substantially behind by 0.4-0.5 SD.

The differences in performance by school grade level are comparatively modest. Primary school students have an average difference of 0.15 SD per grade level, with 4th graders scoring 0.18 SD higher than 3rd graders, and 5th grades scoring an additional 0.12 SD above that (Column (2)). The scores of upper primary school students are more compressed: 7th graders score 0.14 SD higher than 6th graders, but 8th graders score only 0.03 SD higher than 7th graders (Column (3)).[12]

Table 3: **Main results: total score in standard deviations**

	(1) Full Sample		(2) Primary		(3) Upper Primary	
Post	1.874***	(0.0800)	1.747***	(0.0835)	2.029***	(0.0998)
Girls	0.0636***	(0.0196)	0.0663**	(0.0236)	0.0590**	(0.0273)
OBC	-0.186*	(0.0985)	-0.113	(0.107)	-0.260**	(0.117)
SC	-0.426***	(0.114)	-0.432***	(0.114)	-0.410***	(0.137)
ST	-0.499***	(0.112)	-0.481***	(0.113)	-0.514***	(0.129)
Grade 4	0.181***	(0.0184)	0.179***	(0.0180)	1.516***	(0.102)
Grade 5	0.293***	(0.0290)	0.294***	(0.0285)	-0.202	(0.195)
Grade 6	0.182***	(0.0542)	-0.0699	(0.0616)		
Grade 7	0.322***	(0.0432)			0.137***	(0.0267)
Grade 8	0.349***	(0.0514)			0.163***	(0.0398)
Grade 9	-0.109	(0.113)			-0.291***	(0.0979)
Constant	0.173	(0.109)	0.209*	(0.101)	1.824***	(0.151)
Observations	18925		10375		8550	

Note: Each column reports estimates from a separate OLS regression with total score (in standard deviations of the baseline score) as the outcome variable. Column (1) includes the full sample, (2) primary only, (3) upper primary only. Omitted categories: Pre-period, Boys, General caste, youngest expected grade (grade 3 for Columns (1) and (2); grade 6 for Column (3)). Standard errors in parentheses clustered at the block level; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. This table is discussed in Section 6.1.

To explore in which areas learning has increased to the greatest extent, we re-estimate Equation 1 with subject scores as the outcome variable. The total assessment scores are aggregates of several component subjects. All students took a math assessment, but primary school students' assessment had only two parts: math and language, while the upper primary school assessment had 8 parts.

Selected estimated coefficients are shown in Table 4. With the exception of Maps, the subject-specific relative increases are smaller than the overall score increases shown in Table 3. These lower standardised increases can be explained through a combination of greater variation in the subject scores than the total score, and smaller increases in assessment scores in some subjects than others. For example, the standard deviation in math scores on the primary school assessment was 30.9 points, compared to a standard deviation of 25.3 for the total score (see Table 2): a similar percentage point increase in math scores will be normalised into a smaller standardised increase. As shown in Table 2, the percentage point

[12]The LLX intervention for primary school students was targeted at students in grades 3-5 at baseline, while the upper primary intervention was for students in grades 6-8. There are occasional students whose grades do not fall in those target ranges: they have been retained in the analysis, but we do not interpret the results for their grade level - e.g. students reporting 9th grade at baseline, or students in 6th grade who wrote the primary school assessment.

increases also vary considerably.

Although the effect sizes are smaller than for the overall score, the gains in individual subjects remain substantial: in all cases these are greater than 1 SD, with most around 1.5 SD, including the core subjects of math,[13] language, and writing. The smallest relative gains are seen in the Shapes and Materials subject (Column (6)) and Covid knowledge (Column (9)).

Table 4: **Subject results: score in standard deviations**

	(1) Math	(2) Language	(3) Writing	(4) English	(5) Science	(6) Materials	(7) Calendar	(8) Maps	(9) Covid
Post	1.540***	1.641***	1.480***	1.560***	1.666***	1.253***	1.418***	2.098***	1.243***
	(0.0716)	(0.0885)	(0.0920)	(0.0865)	(0.102)	(0.0606)	(0.0821)	(0.0823)	(0.131)
Girls	0.0193	0.104**	0.126***	0.0210	0.0277	0.0279	0.0412	0.00271	0.0892**
	(0.0149)	(0.0302)	(0.0306)	(0.0268)	(0.0336)	(0.0163)	(0.0281)	(0.0227)	(0.0278)
OBC	-0.159	-0.179	-0.253*	-0.155	-0.208	-0.115	-0.227*	-0.216	-0.163
	(0.0938)	(0.137)	(0.103)	(0.0996)	(0.128)	(0.0898)	(0.0821)	(0.113)	(0.119)
SC	-0.374**	-0.481***	-0.345**	-0.336**	-0.322*	-0.177	-0.347**	-0.269	-0.253*
	(0.109)	(0.120)	(0.111)	(0.109)	(0.139)	(0.109)	(0.121)	(0.129)	(0.105)
ST	-0.431***	-0.558**	-0.486***	-0.482***	-0.311	-0.313**	-0.265**	-0.385**	-0.319*
	(0.103)	(0.153)	(0.118)	(0.105)	(0.151)	(0.104)	(0.0833)	(0.126)	(0.125)
Observations	18926	10376	8550	8550	8550	8549	8550	8550	8537

Note: Each column reports estimates from a separate OLS regression with subject score (in standard deviations of the baseline score) as the outcome variable. Omitted categories: Pre-period, Boys, General caste; other controls (not shown): indicator for grade at baseline. Column (1) includes the full sample, as all students were tested in Math. Column (2) is primary only; Columns (3)-(9) are upper primary only. Standard errors in parentheses clustered at the block level; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. This table is discussed in Section 6.1.

Two alternate specifications for the analyses above are explored for robustness and ease of interpretation. First, Equation 1 is re-estimated with child fixed effects: the resulting estimates are almost identical to the primary specification (see Tables 9 and 10 in the Appendix). Second, we replicate the analysis with assessment score in percentages. While change in standard deviations is a more widely comparable measure, it is also helpful to see the magnitude of the changes in real terms. The average change in score across the sample is 42 percentage points (see Tables 11 and 12 in the Appendix).

6.2 Heterogeneity analysis

To determine whether students from different groups saw larger or smaller learning gains over the course of the intervention, we re-estimate Equation 1 on sub-samples of our data. Formally, we estimate a series of equations on splits of the data in a seemingly unrelated

[13] Here the math results are aggregated: separate estimates of the change in math scores for primary and upper primary are found in Appendix Table 8. They are very similar to each other.

equation framework, and test the equality of the resulting $\hat{\beta}_1$ estimates (Chow test).

Table 5 shows the the estimated learning gains for the sample split by gender (Columns (1) & (2)) and by social category (Columns (3)-(6)). The estimates are very similar for both boys (1.89 SD) and girls (1.86 SD), as confirmed by the Chow test (Chi2=1.77; p-val=0.184). In contrast, the Chow test rejects equality of coefficients across social category status (Chi2=29.86, p-value=0.000). Estimates for these groups range from 1.67 SD for general category students, to 1.94 SD for Scheduled Tribes.

Table 5: **Heterogeneity in improvement by sex and caste: total score**

	(1) Boys	(2) Girls	(3) General	(4) OBC	(5) SC	(6) ST
Post	1.890***	1.859***	1.673***	1.718***	1.856***	1.937***
	(0.0776)	(0.0840)	(0.0876)	(0.0718)	(0.0955)	(0.0861)
Observations	9490	9435	486	4113	1962	12364

Note: Each column reports estimates from a separate OLS regression with total score (in standard deviations of the baseline score) as the outcome variable. Controls (not shown): social category and grade (Columns (1) & (2)); gender and grade (Columns (3)-(6)). Standard errors in parentheses clustered at the block level; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. This table is discussed in Section 6.2.

Table 6 repeats this analysis for students at different grade levels at baseline. Columns (1)-(3) consider only those students who took the primary assessment paper, while Column (4)-(6) compare those who took the upper primary assessment.[14] Equality of coefficients is strongly rejected for both sets (primary: Chi2=46.66, p-value=0.000; upper primary: Chi2=10.15, p-value=0.006). Within each set, the coefficients are decreasing with grade level. This is much more pronounced in the primary group, where Grade 3 students show a 1.87 SD improvement, compared to a 1.61 SD improvement for Grade 5 students. The upper primary estimates are more compressed, ranging from 2.08 for Grade 6 students to 1.95 for Grade 8 students.

Finally, Table 7 replicates the analysis on sub-samples sliced by baseline assessment score quartiles. These are defined at the assessment and grade level: e.g. separately for students in grades 3, 4 and 5 taking the primary assessment, and for students in grades 6, 7 and 8 taking the upper primary assessment. The interpretation is therefore *within grade-level* relative performance at baseline. The differences in learning gains across these groups are stark: students at the lowest quartile at baseline had a learning gain of 2.46 SD,

[14]The small number of students with a-typical grade levels, e.g. outside of the 3-8 range or mis-matched to their assessment, are excluded here.

Table 6: **Heterogeneity in improvement by grade: total score**

	(1) Grade 3	(2) Grade 4	(3) Grade 5	(4) Grade 6	(5) Grade 7	(6) Grade 8
Post	1.865***	1.762***	1.609***	2.082***	2.039***	1.947***
	(0.0911)	(0.0888)	(0.0705)	(0.105)	(0.102)	(0.102)
Observations	3783	3214	3326	3340	2872	2316

Note: Each column reports estimates from a separate OLS regression with total score (in standard deviations of the baseline score) as the outcome variable. Controls (not shown): gender and social category. Columns (1)-(3) include students who took the primary school assessment only; Columns (4)-(6) those who took the upper primary assessment only. Standard errors in parentheses clustered at the block level; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. This table is discussed in Section 6.2.

compared with those in the top quartile who gained only 0.90 SD on average (equality of the 4 coefficients strongly rejected: Chi2 = 306.70, p-value = 0.000). The worst performers (who on average scored just over 1 point out of 100 on the baseline assessment) are seeing learning gains almost 3 times larger than the top quartile (who scored an average of 56% at baseline). These results point to a substantial degree of catch-up over the course of the intervention.

Table 7: **Heterogeneity by baseline grade: total score**

	(1) 1st Quart	(2) 2nd Quart	(3) 3rd Quart	(4) 4th Quart
Post	2.455***	2.315***	1.875***	0.898***
	(0.106)	(0.0938)	(0.0894)	(0.0862)
Observations	4530	4742	4790	4788

Note: Each column reports estimates from a separate OLS regression with total score (in standard deviations of the baseline score) as the outcome variable. Controls (not shown): gender, social category, and grade. Standard errors in parentheses clustered at the block level; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. This table is discussed in Section 6.2.

6.3 Plausible counterfactuals

Early in the pandemic, when schools in the United States had closed early for the summer and were expected to re-open fully in September 2020, a team of researchers sought to estimate the degree of learning loss anticipated in the new academic year. In their review of previous studies of learning loss during normal summer closure or absenteeism, Kuhfeld et al. (2020) finds daily losses from summer or absenteeism for grades 3-5 in the range of 0.005-0.007 SD for math and 0.003-0.005 SD for English; for grades 6-8, 0.002-0.008 SD for math and 0.001-0.006 SD for English (Kuhfeld et al. (2020): Table 1). School closures on the scale experienced by Indian pupils have no precedent in the modern era: extrapolating learning loss from a closure of several months to a closure measured in years is problematic. Nevertheless, the estimates assembled by Kuhfeld et al. (2020) give us a starting point to compare our measures of learning gain.

Starting in January and running until the end of September, with a break during the Delta-wave strict lockdown from mid April-June, the LLX ran for 6.5 months, or approximately 200 days.[15] If the program had not run, children would have been fully out of school during that time. If we apply the estimates of summer or absentee learning loss from Kuhfeld et al. (2020), we would expect a loss for primary students of 1-1.4 SD in math and 0.6-1 SD in language, while for upper primary the equivalents would be 0.4-1.6 SD for math and 0.2-1.2 SD for language. In other words, absent any schooling, these are the losses in learning we would project over a period of time equivalent in duration to the intervention.

It is likely that these extrapolated learning losses based on holidays and absenteeism overstate the learning loss our students would have experienced over the period of the intervention. At the start of the intervention, these students had already been out of school for nine months, and may already have lost nearly all of the math and literacy skills they had learned at school. Multiplying the estimated daily losses by 270 (roughly 9 months) gives expected losses of 1.35-1.89 SD for math and 0.81-1.35 SD for English for grades 3-5; and 0.54-2.16 SD for math 0.27-1.62 SD for English for grades 6-8. If we assume these losses had already been incurred, many students would have effectively forgotten everything they had learned at school to date. This may well have been the case: in our data 10.3% of primary students and 14.2% of upper primary students score a 0 on the baseline assessment. These students had no remaining learning to lose by continued school closures.

We expect therefore that the true counterfactual evolution of learning for the students in our sample, in the absence of the intervention, lies somewhere between 0 and -1.6. If we take the example of primary school language, our point estimate is an increase of 1.64 SD (Table 3). Our extrapolation from Kuhfeld et al. (2020) suggest a loss of 0.6-1 SD in language skills for this age group over 6.5 months. If that is the true counterfactual for our students, then the causal effect of the intervention would be in the range of (1.64+0.6)-(1.64+1) SD, or 2.24-2.64 SD. If, however, students had already lost so much of their learning that there

[15] These 200 days include weekends and non-teaching days, as the school year would.

was nothing left to lose, then the true counterfactual is a learning loss of 0. In that case, the true causal effect of the intervention is our point estimate itself, +1.64 SD.

Could students have made learning gains over this period, in the absence of the intervention? With schools closed, and no access to private tuition or other learning options, it is unlikely that many of the children in the sample would have achieved positive learning gains over the period. There are no doubt some exceptions in the 100,500 children enrolled in the intervention: however, the vast majority would have seen a continued decay in their academic skills while they remained cut-off from education.

7 Discussion

7.1 Results in Context

Our results showcase the impact of a unique learning intervention implemented during Covid-19 school closures. The intervention targeted children with limited access to internet and alternative avenues of learning. While a 1.87 SD increase in test scores is large compared to educational interventions studied prior to the pandemic, such magnitudes are not unheard of.[16] However, when interpreting these results it is important to keep in mind that most education interventions evaluated prior to 2020 have been marginal to some existing school system. The intervention we study supported students in an institutional vacuum.

The effect sizes are nevertheless substantial. Several unique features of the intervention might be driving the results. Angrist et al. (2022) find that parental engagement in a child's education improves learning outcomes during school closures, even in the low literacy context of Botswana. As highlighted in Section 3, many of the intervention tasks invited participation of parents. Children shadowed their mothers all day at home and in the fields to document her activities for the task "what mothers do"; they went with their parents to the local weekly market for a photo-story task; and to the local grocer to learn math concepts. For many of the parents, who had not attended school themselves, this was their first time engaging with their child's education. Anecdotal evidence from the field suggests that parents were grateful for the learning support and felt their children were neglected

[16] A recent randomized controlled trial evaluating a multi-faceted education intervention in the Gambia showed 3.2 SD improvements over 3 years (Eble et al. (2021)); while over a single year a local-language primary school program in Cameroon measured 1.44 SD improvements in overall test scores for first grade students (Laitin et al. (2019)).

by the government teachers. They voiced excitement over understanding first-hand their child's effort and learning level.

Children were also learning in an unstructured environment, out of the rigid structure of classrooms and textbooks, and at their own pace. Forests, ponds, farms, homes, and markets became learning spaces, where children practiced math and science, increased their awareness around gender, climate change, and biodiversity. Evidence from health and psychology points to the benefit of unstructured learning, especially outdoor play time, on the well-being of pre-school and young primary grade children (see Brussoni et al. (2017) and Lee et al. (2020)).

One of the objectives of the intervention was to motivate children to become self-directed learners. Tasks were designed to engage a child alone: they were exploratory in nature, and they invited children to use the internet and resources available locally. Evidence-based research on the benefits of self-directed learning is still nascent. Brandt (2020) provides a review of this literature and posits that self-directed learning has four dimensions for children's growth - self regulation, motivation, personal responsibility, and autonomy. More research is needed to understand to what extent the large gains in student test scores from the intervention studied here are a result of the self-directed learning process.

A key pillar of the LLX intervention was establishing a meaningful two-way interaction between teachers and students through physical visits. This is noteworthy in today's policy context, as more and more countries are leaning towards incorporating e-learning solutions into their education systems. In India, for example, the Union Education Minister Mr. Dharmendra Pradhan has argued that technology-driven approaches and initiatives such as virtual schools, digital university, and education TV channels are key to solving access to quality education (see Times Now (2022) and The Indian Express (2022)). While the use of digital technology in education can certainly enhance the learning process, it cannot obliviate the need for face-to-face teacher-student interaction. This is especially true for remote and rural environments, where inequalities in digital access are pronounced, or for children who are first-generation school-goers.

Our finding that low achievers had disproportionately larger learning gains over the course of the intervention is particularly relevant in this context. Previous evidence has found that low achieving children compensated less for school closures than did their higher-achieving peers (Grewenig et al. (2021)), aggravating inequality in educational outcomes.

Combining high quality digital learning materials with personalised, attentive teacher-student contact could be a way of implementing Mr. Dharmendra Pradhan's vision without worsening educational inequality across the digital divide.

7.2 Cost effectiveness

The total budget that the NGO ASPIRE put towards the LLX intervention between January-September 2021 was 101,390,625 INR (1,389,052 USD in January 2021). This covered the honorarium given to the 2700 volunteer teachers, the salary cost of the 700 ASPIRE teachers and their supervisors, training, and teaching-learning material expense. During the six months, the 35,000 LL children were also utilizing some of the learning material and staff time of the 700 ASPIRE teachers and the supervisors. The volunteer teachers and their training expenses were exclusively for the 100,500 children. It is difficult to separate the time devoted by the ASPIRE teachers to the two groups.

Assuming the budget goes exclusively to the LLX children, it would give a per-child cost of 1009 INR (13.82 USD); assuming it is shared evenly across all project children (LL+LLX) gives a per-child cost of 748 INR (10.25 USD). The 10.25-13.82 USD per child cost range, combined with our primary estimate of 1.87 SD improvement per child, translate to a cost-per-SD improvement of 5.48-7.39 USD (alternatively, 13.53-18.25 SD per 100 USD).[17]

In the context of pre-pandemic learning interventions, these cost effectiveness estimates are quite astonishing (see, e.g., Kremer et al. (2013)). There are two important points to keep in mind when interpreting these numbers. First, the NGO ASPIRE already had an established presence in the areas where the intervention was rolled out. These cost estimates are for the additional costs to the organisation from the intervention, not the total costs of ASPIRE's programming while becoming established, and continuing to operate in other ways during this time. The costs estimates are therefore at the margin, assuming an established presence: they would be appropriate for, e.g., a school system considering adopting this type of intervention rather than a NGO setting up a program from scratch.[18]

[17] Equivalent figures for 2021 rupees are: 400-540 rupees per SD; 18.51-25.00 SD per 10,000 rupees.

[18] The availability of motivated and educated youth volunteers is another aspect of the intervention which should be extrapolated with caution: in non-pandemic times, the outside options of these volunteer teachers may be more attractive, and the cost:quality ratio of staff would likely be less favorable for the program. However, in April 2022, the NGO started a new intervention for improving foundational literacy for grades 1-5 and hired 7000 volunteer teachers at the same rate. Many of these were young men who were unemployed or looking only for part time opportunities as they are engaged in agriculture. Some volunteer teachers were retired public servants. The outside option for educated women is in general quite low in this area as many of them are married locally or do not wish to migrate for employment.

Second of all, this is a not a pre-pandemic education intervention working on the margins of an existing school system: this intervention provided some amount of ongoing education during a time of institutional failure. While some aspects of the intervention, particularly those promoting self-directed learning and individual agency, could well have large learning impacts as a supplementary intervention on top of government schooling (as, indeed, ASPIRE's pre-pandemic Learning Enrichment Project was designed to do), this study is not evaluating such a program. Given the absence of any other study opportunities at the time, the effectiveness of the intervention should not be too surprising.

8 Conclusion

In a scramble for normalcy under Covid-19 lockdown, parents, teachers, civil society, and governments sought to ensure continuity in education in the face of unprecedented challenges. The variety of policy innovations which emerged in response to school closures provide a wealth of insights into 'what works' in education. Unfortunately, the very conditions which gave rise to these innovations makes it difficult to rigorously evaluate them. As an education NGO with an established grass-roots presence, ASPIRE was uniquely positioned to design and implement a large scale intervention to support children during school closures. While the crisis conditions under which the intervention took place precluded the collection of data on a control group in a non-program area, monitoring data from the intervention help us paint a picture of how it affected children.

Our study estimates the learning gains achieved by children over the 6.5 month Lockdown Learning Expansion intervention. We apply a before-after analysis to matched data from nearly 10,000 students who, absent this program, would have had no access to education. We estimate an average improvement in test scores of 1.87 SD. While the gains are similar for boys and girls, they are larger for marginalised or vulnerable groups, including Scheduled Tribes and children with particularly low test scores at baseline. Using our headline estimate as the treatment effect, the intervention delivered improvements in learning at a cost of 5.48-7.39 USD per SD (13.53-18.25 SD per 100 USD).

This paper has a number of limitations. First, our reliance on a before-after design provides a weaker causal attribution of change than we would like. While we argue that, in this particular context, a counterfactual of 0 change is actually fairly conservative, this is not the same as being able to follow a control group. Questions remain about the true counterfactual evolution of assessment scores.

Second, while the intervention was offered to all children who met basic eligibility criteria, it was not a universal program. In particular, children who were part of ASPIRE's LEP program prior to the pandemic (among the weakest students) were excluded, as were those who had access to private tuition or other education opportunities (likely to be among the better performers). Those who did participate were therefore not representative of the full population: our results cannot be interpreted as population mean effects.

Finally, the intervention we study is a complex one: it brought new resources and educational approaches, engaged parents and communities. By encouraging initiative and self-directed learning, and by showcasing the talents of students that might never have been noticed before, it also had the potential to build agency and academic self-esteem. While this complexity surely contributed to its effectiveness, it makes it difficult to piece out the most important channels of effect. Our data have little to say about which aspects of the intervention were critical to success. This also makes it difficult to extrapolate the successes measured here to other contexts.

ASPIRE's highly cost-effective Lockdown Learning Expansion has a number of important lessons for policy. First, it offers a model of physical + digital learning which could be rolled out at scale during future periods of institutional disruption. It also offers insights into how the digital divide could be breached, supporting those students who are at risk of being left behind by the increasing reliance on digital learning technologies. This is a pressing issue for policy makers who face an equity-efficiency trade-off in their mission of improving education quality in low-income settings.

Our findings point to a number of directions for future research. First, focusing on this specific intervention, if would be useful to know more about the heterogeneity of improvements. While the monitoring data contains only minimal information on the individual students, linking this data with school records or other longitudinal data could provide insights on who the intervention is targeting most effectively.

Second, the LLX was designed as a self-directed learning intervention which specifically aimed to build children's self-esteem, curiosity, soft skills (such as communication, critical thinking, problem solving, public speaking), climate and gender sensitivity, and civic engagement. The assessment papers for LLX were confined to measuring academic performance on tested subjects. Research which can assess the broader development goals of the intervention would contribute considerably to our understanding of such interventions.

Looking ahead to the challenge of building back skills after a period of school closures, research on effective ways of engaging students with learning delays or age-grade mis-matches will be critical. Many aspects of the intervention studied here can also be applied to enrich the existing school curriculum, or can be delivered in intense summer camps to boost skills ahead of the school year. The experience of NGOs such as ASPIRE in this area could be further leveraged to test some of these elements in different settings.

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A Appendix

A.1 Data and extensions

In the main text, improvements in math scores are shown for primary and upper primary together. Table 8 disaggregates these into the two levels separately: both show very similar changes over time.

Table 8: **Math results: disaggregation**

	(1) Full Sample	(2) Primary	(3) Upper Primary
Post	1.540***	1.545***	1.534***
	(0.0722)	(0.0785)	(0.0916)
Girls	0.0193	0.0280	0.00738
	(0.0148)	(0.0170)	(0.0240)
OBC	-0.159	-0.102	-0.217
	(0.0951)	(0.111)	(0.110)
SC	-0.374**	-0.371**	-0.372**
	(0.109)	(0.115)	(0.129)
ST	-0.431***	-0.421**	-0.437**
	(0.104)	(0.120)	(0.115)
Observations	18926	10376	8550

Note: Each column reports estimates from a separate fixed-effects regression with normalized math score (in standard deviations) as the outcome variable. Column (1) includes the full sample, (2) primary only, (3) upper primary only. Controls: gender, grade level, and social category. Standard errors in parentheses clustered at the block level; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The table is discussed in Section 6.1.

Tables 9 & 10 replicate the main analysis with child fixed effects. The estimated change in grade scores, both overall and by subject, are virtually identical.

Tables 11 & 12 replicate the main analysis with percentage score as the outcome variable, rather than normalised score in standard deviation units.

Table 9: **Main results: child fixed effects**

	(1) Full Sample	(2) Primary	(3) Upper Primary
Post	1.874***	1.747***	2.029***
	(0.0798)	(0.0835)	(0.0997)
Observations	18933	10383	8550

Note: Each column reports estimates from a separate fixed-effects regression with total score (in standard deviations of the baseline score) as the outcome variable. Column (1) includes the full sample, (2) primary only, (3) upper primary only. Child fixed effects absorb all time-invariant covariates. Standard errors in parentheses clustered at the block level; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The table is discussed in Section 6.1.

Table 10: **Subject results: child fixed effects**

	(1) Math	(2) Language	(3) Writing	(4) English	(5) Science	(6) Materials	(7) Calendar	(8) Maps	(9) Covid
Post	1.540***	1.641***	1.480***	1.560***	1.666***	1.253***	1.418***	2.098***	1.242***
	(0.0721)	(0.0884)	(0.0920)	(0.0865)	(0.102)	(0.0606)	(0.0821)	(0.0822)	(0.131)
Observations	18934	10384	8550	8550	8550	8549	8550	8550	8537

Note: Each column reports estimates from a separate fixed-effects regression with total score (in standard deviations of the baseline score) as the outcome variable. Child fixed effects absorb all time-invariant covariates. Standard errors in parentheses clustered at the block level; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The table is discussed in Section 6.1.

Table 11: **Main results: in percentage score**

	(1) Full Sample	(2) Primary	(3) Upper Primary
Post	42.35***	44.26***	40.03***
	(1.770)	(2.117)	(1.968)
Observations	18925	10375	8550

Note: Each column reports estimates from a separate fixed-effects regression with total score (in percentage points) as the outcome variable. Column (1) includes the full sample, (2) primary only, (3) upper primary only. Controls (not shown): gender, grade level, and social category. Standard errors in parentheses clustered at the block level; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The table is discussed in Section 6.1.

Table 12: **Subject results: in percentage score**

	(1) Math	(2) Language	(3) Writing	(4) English	(5) Science	(6) Materials	(7) Calendar	(8) Maps	(9) Covid
Post	47.71***	40.01***	31.92***	35.54***	40.35***	41.13***	50.88***	59.80***	25.67***
	(2.237)	(2.157)	(1.985)	(1.972)	(2.462)	(1.990)	(2.946)	(2.345)	(2.701)
Observations	18926	10376	8550	8550	8550	8549	8550	8550	8537

Note: Each column reports estimates from a separate fixed-effects regression with total score (in percentage points) as the outcome variable. Controls (not shown): gender, grade level, and social category. Standard errors in parentheses clustered at the block level; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The table is discussed in Section 6.1.

Table 13: **Balance: non-response vs sample, primary school**

Variable	(1) Test-takers Mean/SE	(2) Non-response Mean/SE	T-test Difference (1)-(2)
General	0.023	0.019	0.003
	(0.006)	(0.016)	
OBC	0.200	0.202	-0.002
	(0.023)	(0.052)	
SC	0.103	0.125	-0.022
	(0.020)	(0.022)	
ST	0.674	0.654	0.020
	(0.042)	(0.066)	
Math 0-10	0.391	0.442	-0.052
	(0.021)	(0.077)	
Math 11-40	0.279	0.202	0.077
	(0.014)	(0.045)	
Math 41-60	0.128	0.192	-0.065*
	(0.007)	(0.035)	
Math 61-75	0.075	0.087	-0.011
	(0.006)	(0.021)	
Math 76+	0.128	0.077	0.051
	(0.015)	(0.039)	
Lang 0-10	0.399	0.394	0.005
	(0.025)	(0.074)	
Lang 11-40	0.383	0.356	0.027
	(0.016)	(0.054)	
Lang 41-60	0.108	0.173	-0.065**
	(0.009)	(0.026)	
Lang 61-75	0.053	0.038	0.015
	(0.006)	(0.017)	
Lang 76+	0.056	0.038	0.018
	(0.011)	(0.019)	
Grade 3	0.364	0.356	0.009
	(0.007)	(0.057)	
Grade 4	0.310	0.288	0.021
	(0.006)	(0.050)	
Grade 5	0.321	0.346	-0.025
	(0.010)	(0.068)	
Grade 6	0.005	0.010	-0.005
	(0.005)	(0.010)	
Girls	0.498	0.490	0.007
	(0.007)	(0.044)	
N	5192	104	
Clusters	20	13	
F-test of joint significance (F-stat)			359.342***

Notes: The value displayed for t-tests are the differences in the means across the groups. 'Math' and 'Lang' are scores on the two parts of the assessment, here broken into grade percentage bands. The value displayed for F-tests are the F-statistics. Standard errors are clustered at the block level. All missing values in balance variables are treated as zero.***, **, and * indicate significance at the 1, 5, and 10 percent critical level. The table is discussed in Section 4.

Table 14: **Balance: non-response vs sample, upper primary school**

Variable	(1) Test-takers Mean/SE	(2) Non-response Mean/SE	T-test Difference (1)-(2)
OBC	0.238	0.200	0.038
	(0.024)	(0.063)	
SC	0.104	0.118	-0.014
	(0.019)	(0.037)	
ST	0.628	0.609	0.019
	(0.045)	(0.096)	
Total 0-10	0.427	0.527	-0.100
	(0.024)	(0.063)	
Total 11-40	0.415	0.364	0.051
	(0.019)	(0.057)	
Total 41-60	0.107	0.073	0.034
	(0.010)	(0.022)	
Total 61-75	0.037	0.018	0.019
	(0.005)	(0.013)	
Total 76+	0.014	0.018	-0.004
	(0.003)	(0.018)	
Grade 4	0.000	0.000	0.000
	(0.000)	(0.000)	
Grade 5	0.001	0.009	-0.008
	(0.001)	(0.010)	
Grade 6	0.391	0.364	0.027
	(0.007)	(0.056)	
Grade 7	0.336	0.273	0.063*
	(0.008)	(0.032)	
Grade 8	0.271	0.336	-0.065
	(0.007)	(0.048)	
Grade 9	0.001	0.018	-0.017
	(0.001)	(0.018)	
Girls	0.499	0.427	0.072*
	(0.008)	(0.036)	
N	4275	110	
Clusters	20	13	
F-test of joint significance (F-stat)			5.858***

Notes: The value displayed for t-tests are the differences in the means across the groups. 'Total' is the total assessment score: here broken into grade percentage bands. The value displayed for F-tests are the F-statistics. Standard errors are clustered at the block level. All missing values in balance variables are treated as zero.***, **, and * indicate significance at the 1, 5, and 10 percent critical level. The table is discussed in Section 4.

A.2 Further intervention details

A.2.1 Examples of Tasks

1. **Science and Invention**

   Target cohort: Grade 4 - 8 students

   Task Description: This week we learn about an invention that is very fascinating: the airplane! Today airplanes are like trains and buses. They have become a common mode of transportation but for hundreds and thousands of years when people looked at birds in the sky, they wanted to fly! This was the case even a little over 100 years ago, when flying by humans was considered impossible. 1896 starts the story of two young boys, who were brothers. They very curious to make new things. They were poor, so the things that they made, they sold in the market to earn a little money. Their curiosity coupled with hard work and perseverance however led them to invent what was the dream of humanity for centuries – a machine that made people fly in the sky!

   After this introduction, a document in local language about the Wright Brothers was shared with children. Children were asked to search the net, draw, and/or do a write-up considering the following points:

   - How did you feel on reading the story of the Wright brothers?
   - What is common between the Wright Brothers and the scientist James Watt from previous week?
   - What did you like most about this story and why?
   - Do you see air crafts fly above your village? What do you feel when you see them?

   Learning Objectives: Improved writing and comprehension skills, Understand the background of the scientists, what qualification is required to be a scientist, difference between invention and discovery, how each discovery and invention made our lives easier, and its impact on our lives.

   Task Impact: (a) Children not only identified the similarities and differences between the Wright Brothers and James Watt but with other scientists as well, (b) Improvement in self-driven learning among children, (c) Freedom to explore dimensions of creative learning, (d) Boost in self-esteem, (e) New ideas or new ways of thinking

Figure 3: **Science and invention: example 1**

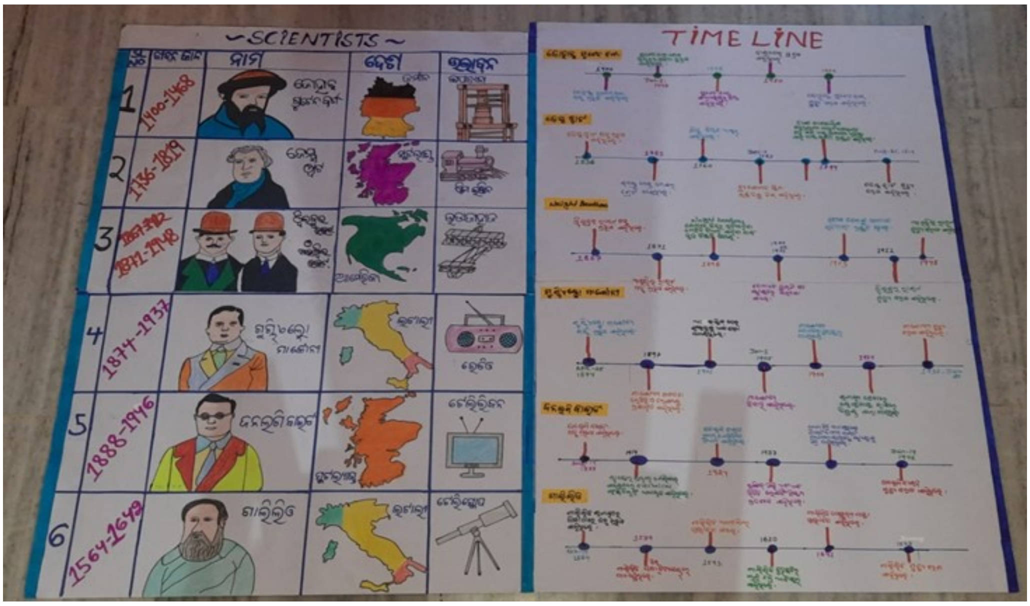


Figure 4: **Science and invention: example 2**

2. **Stories through Photography**

   Target cohort: Grade 5 - 8 students

   Task Description: This was task number 2 in the photography series. Task 1 was taking photos of the weekly local market in groups of 4-5. Task 2 focused on learning to make a photo story. In groups of 3-5, children were asked to read a photo story Thakur (2018) and model their own photo story similarly. The submitted stories were to have 5 photos and a write up about the local market.

   Learning Objectives: The task was geared towards upper primary grades and targeted development of the following skills - handling camera, improved observation skills, documentation to present a clear picture, improved understanding of market trading (who are the sellers and buyers, where does the material come from, how many villages are being served), basic math (list things being sold in the market, their price, quantity), and documenting local tribal culture and practices.

   Task Impact: Students responded enthusiastically to the task. Hundreds of photos and drawings were submitted. When children visited the market and saw plastic pollution and garbage, they reported it back to the teachers. The teachers motivated them to go back to the market and spread awareness about keeping the market clean. Children went back and spoke to the sellers and buyers. Children's responses were shared with editors of People's Archive of Rural India (PARI), where the original photo story was published. PARI invited 4 students to do a photo essay for their website (see Munda et al. (2022)).[19]

3. **Gender and Climate Change**

   Target cohort: Grades 3-8

   Task Description: Children were introduced to Wangari Maathai, winner of the Nobel Peace prize in 2004. They watched the animated short story, *The Hummingbird* narrated by the Kenyan environmental activist and learned about the Green Belt Movement. They were asked to search the net and make a project considering the following:

   - Find Kenya on the map of Africa. Draw the map.
   - Write the Humming bird story. What do you understand from the line "I will do the best I can"?

[19] PARI editors helped the student reporters in translation and editing the story.

- Do you agree that a simple act like planting trees can help a village? Can you, along with your friends, start a drive to plant at least 50 trees in your village, and look after them?
- Do an internet search on 'The Nobel Prize'.

Learning Objectives: Improved writing and comprension skills, Climate change awareness, Understand women's role in United Nations Sustainable Development Goals (SDGs), Focus on women who are change-makers, Develop self-esteem and confidence, Awareness of international women leaders.

Task Impact: In addition to submitting a write-up, many children planted kitchen gardens and local trees in their homes and neighborhoods and are continuing to nurture them.

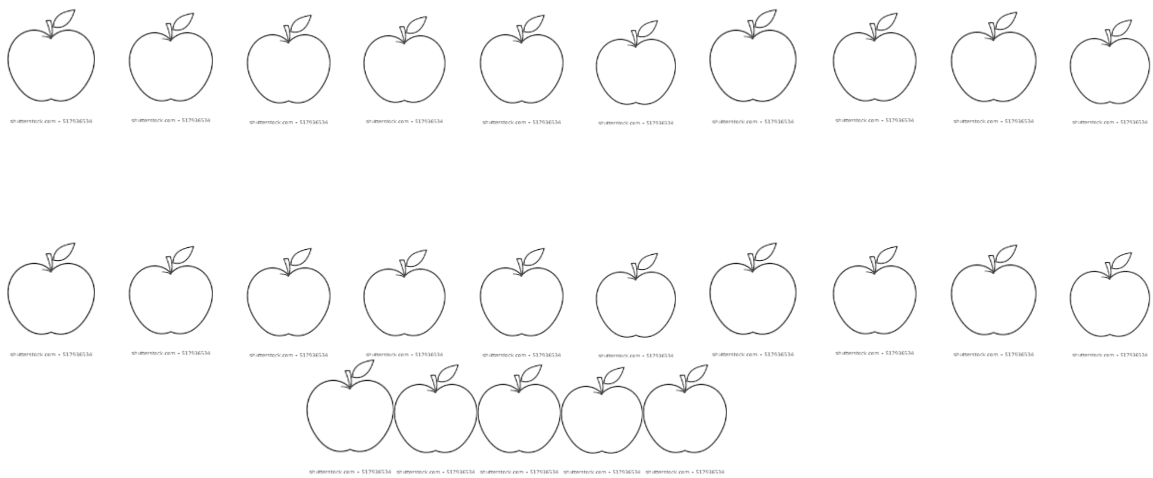
A.2.2 Assessment papers

The assessment papers were administered in local languages. Here they have been translated into English by our research team.

Primary Grade Assessment: Math

Name: **Grade:** **Date:** **Total Marks: 100**

1. How many apples are below? Answer: ______ (1x1=1)



2. 25 is even or odd number? (2x1 = 2)

3. Write the number eighty-nine. (4x1 = 4)

4. 23 _____ 50 (put appropriate symbol (<, > or =) between these numbers) (8x1 = 8)

5. 65, 56, 28, 82 arrange these numbers from smallest to biggest (16x1 = 16)

6. Solve the following problem (16x1 = 16)

  4 7

+ 3 8

7. 6. Solve the following problem (16x1 = 16)

  7 0

- 3 3

8. Fill in the blanks (2x1= 2)

   a) After Friday, _________ comes.

b) The month of _________ comes before the month of October.

9. Complete the blanks by looking at the sample below (1x3 = 3)

10. Complete the blanks by looking at the sample. (2x4 = 8)

2	5	8		14			23	26	

11. Read the following and answer (12x1 = 12)

Jagdish's garden has 38 mango trees and 26 lemon trees. So how many trees are there in total in Jagdish's garden?

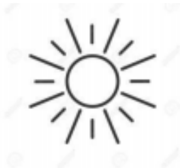
12. If the cost of one pencil is Rs 5, how much money will be required to buy 6 pencils? (12x1 = 12)

Primary Grade Assessment: Language

Subject: Hindi/Odia

Name: **Grade:** **Date:** **Total Marks: 100**

1. Write down the names of the pictures in the boxes below (2x5 =10)

2. Create words from the letters given below (2x5 =10)

ग (Ga)____________, च (Cha)________, ड (Da)___________, न (Na) ____________,

श (Sha)_______________

3. Fill in the blanks with the given word below. (4x5 =20)

गौरैया (Gauraiya=Sparrow), पूरब (Purab=East), फूल (Phool=Flower), प्यूपा (Pupa), चील (Cheel=Eagle)

1. ______ se titli janm leti hai | The butterfly takes birth from _______.
2. Suraj ______ disha se ugta hai | The sun rises from the _______ direction.
3. Madhumakkhi _____ se ______ par ghoom kar ras ek-kattha karti hai | Bees roam from_______ to ______ to collect nectar.

4. ______ se prithvi se vilupt ho gaya hai | ______ has disappeared from the earth.

5. _____ cheen cheen ki awaaz karti hai | ____ makes the sound ‘cheen cheen’.

4. Arrange the following sentences and re-write them properly (4x5 =20)

(क) बजा रहे है बांसुरी गोपाल | Baja rahe hai bansuri Gopal (playing the flute Gopal is)

(ख) अच्छा पढ़ता है बोल कर लोग प्रशांसा करते है उसकी बैकुंठ | Achchha padhta hai bol kar log prashansa karte hai hai uski baikunth (studies he well so People because praise him a lot)

(ग) बहुत गाँव हमारा सुन्दर है | Bahut gaaun hamara sundar hai (very village is beautiful My)

(घ) अच्छा लगता है बना हुआ हमारे के माँ हाथ का खाना | Achchha lagta hai bana hua hamare ke maa haath ka khana (good mother’s food feels My handmade)

(ङ) मीठा है नाररयल का पानी | Meetha hai nariyal ka paani (sweet is coconut water The)

5. Comprehension: Read the following passage and answer the questions below. (4x5 =20)

Pushi aunt’s younger daughter Mini got diarrhoea and she vomited as well. The doctor monkey came as soon he heard the news. Pushi aunt gave him a cup of tea. Doctor checked Mini’s pulse and measured her fever. He said, “Get some warm water.” Pushi aunt heater water in a vessel and brought two mugs of water. The doctor took out a one-arm-long white cloth from his bag. He soaked the cloth in warm water and wiped Mini’s body with it. He gave her some medicines to eat. Pushi aunt made wheat flour rotis (chapati) for Mini to eat medicine. Along with it, she made a drink mixing lemon, sugar and salt. With roti and sugar, she gave Mini lime water to drink. Mini ate the rotis with sugar. In between, she also sipped the lime water. After that, she ate two spoons of medicine according to the doctor’s instructions. After sometime, Mini recovered from her fever.

a) Who got diarrhoea and vomiting?
b) What did the doctor take out from his bag?
c) What did the money tell the old aunt to bring?
d) What did the old aunt make for Mini?
e) How did Mini recover?

6. Write an article about "our village" taking the words given below. (1x20=20)

(घर, रास्ता, तालाब, नलकूप , पहाड़ , नदी , मंदिर, मस्जिद, गिरजा, बगान , मैदान , विद्यालय , आंगनिाड़ी केंद्र , डाकघर, जंगल)

Ghar, rasta, talab, nalkoop, pahad, nadi, mandir, masjid, girja, bagaan, maidaan, vidhyalyay, anganwadi kendra, daakghar, jungle

In English: House, road, pond, tube-well, mountain, river, temple, mosque, church, garden, field, school, anganwadi centre, post office, jungle

Upper Primary Grade Assessment Paper

Name: **Grade:** **Date:** **Total Marks: 100**

I. SHAPES & MATERIALS **(5 + 5 =10)**

1. Write the names of three objects with the shape of a sphere, three of a triangle, two of a square, and two of a rectangle.

Round shape=

Square=

Rectangular=

Triangular=

2. Write the names of two items made from the following materials.

Wood=

Iron=

Glass=

Plastic=

Rubber=

II. SCIENCE **(5 + 5 =10)**

3. Why do we need to cook vegetables like brinjal, bottle gourd, and potatoes? What changes do you see when cooking these vegetables? Write them down.

4. How many days after sowing rice does the seeds germinate? After how many days can you transplant the paddy seedlings? After how many days rice is ready to be harvested?

III. ARITHMETIC **(5+5 =10)**

5. You bought 15 kg of rice worth Rs 30 per kg, 10 kg pulses worth Rs 70 per kg ,and 7 coconuts worth Rs 30 per coconut from your local shopkeeper. How much did you pay the shopkeeper in total?

6. There were five cows, three horses, 10 children and 3 peacocks in a field. If you add the feet of everyone, how many feet will be there in total?

IV. WRITING **(10 + 10 =20)**

7. Write an essay about your mother.

8. Write down the steps involved in making tea.

V. ENGLISH **(10 + 10 =20)**

9. Write 5 words with each of the following letter.

A=

R=

M=

P=

D=

10. Write at least five sentences each about elephant and monkey.

VI. MAPS **(5 + 5 =10)**

11. From the list of states given below, draw an arrow connecting to the state capitals.

Odisha	Jaipur
Kerala	Gandhinagar
Gujarat	Bhubaneswar
Rajasthan	Chandigarh

Madhya Pradesh	Thiruvananthapuram
Punjab	Bhopal

12. Write the names of 5 countries and 5 continents of the world.

VII. CALENDAR (5 + 5 =10)

13. In January 2020, how many Mondays will the month have? Write down the dates.

14. If January 1 is on Friday, then what day will it be on January 31?

VIII. Covid-19 (10)

15. What is coronavirus? What measures can you take to prevent the spread of the virus in your village?