UK International Development
Partnership | Progress | Prosperity

I-SAPS Institute of Social and Policy Sciences
Informing Policies, Reforming Practices

Enhancing the Efficacy of

Teaching & Learning in Early Years

Through Technology-enabled Solutions

Enhancing the Efficacy of

Teaching & Learning in Early Years

Through Technology-enabled Solutions

Enhancing the Efficacy of

Teaching & Learning in Early Years

Through Technology-enabled Solutions

Published by:
Institute of Social and Policy Sciences (I-SAPS)
12, Mauve Area, G-8/1, Islamabad, Pakistan.
P.O. Box: 1379, Islamabad.
Tel: +92-51-111-739-739; Fax: +92-51-2289425
Email: info@i-saps.org; Website: www.i-saps.org

Table of Contents

List of Abbreviations

AI	Artificial Intelligence
ASER	Annual Status of Education Report
ATET	Average Treatment Effect on the Treated
BTAG	Bridging Technical Assistance for Governments
COP	Communities of Practice
COT	Class Observation Tool
CPD	Continuous Professional Development
DiD	Difference-in-Difference
ECCE	Early Childhood Care and Education
FCDO	Foreign Commonwealth & Development Office
GGES	Government Girls Elementary School
GGHS	Government Girls High School
GGPS	Government Girls Primary School
GHS	Government High School
GPS	Government Primary School
LP	Lesson Plan
ML	Machine Learning
NAT	National Achievement Test
OECD	Organisation for Economic Co-operation and Development
OLPC	One Laptop per Child
PEC	Punjab Examination Commission
PPS	Probability-Proportional-to-Size Sampling
SED	School Education Department
SLO	Student Learning Outcomes
STEAM	Science, Technology, Engineering, Arts & Mathematics
STR	Student-Teacher Ratio
UNESCO	United Nations Educational, Scientific and Cultural Organisation

Executive Summary

Punjab is facing a significant learning challenge at the foundational level owing to the high Student-teacher ratio (STR), multigrading, teaching to assessment, focus on rote memorisation, an extensive number of Student Learning Outcomes (SLOs) and limited mechanisms to implement personalised learning catering to the learning abilities and levels of each child. The Foundational Learning Pilot aimed to enhance efficacy of teaching & learning in early years through technology-enabled solutions powered by Artificial Intelligence (AI) and Machine Learning (ML). A quasi-experimental design was implemented in Grade 1 of 50 target schools, comprising 30 treatment schools and 20 control schools. The sample size was selected to reflect different STR, with 10 treatment schools also having a community volunteer.

An innovative ed-tech teaching solution "little lab" was customised and shared with teachers to track student progress and provide customised, need-based support. The Little Lab's Recommendation Engine is at the cornerstone of its AI offering, designed to collect and analyse data for each child, with the primary goal of personalising and tailoring lesson plans to individual student needs. The platform captured performance data of 2050 students within 30 treatment schools and 20 control schools. Among these, 1268 students were in the treatment group and 782 in the control group. At the start of the pilot, a pre-assessment was conducted through the platform covering student evaluation through observation by assessors. Separately, teachers were observed and assessed on their teaching practices using classroom observation tool (COT). Based on the results from pre-assessment, lesson plans were developed and provided to teachers, tailored to students' levels in each school. These lessons helped teachers adjust their teaching practices and providing need-based support to students. After six weeks of implementation, a post-assessment of students and teachers was conducted and analysed.

The effectiveness of the intervention was measured using a difference-in-difference (DiD) model, comparing pre- and post-intervention outcomes in treatment and control groups. Qualitative feedback was collected from teachers regarding platform utility, effectiveness of the lesson plans and technology uptake.

The pilot demonstrated a positive impact on student learning outcomes. Key findings are presented below:

1. **Improved Learning Outcomes:** The results demonstrated a positive impact of piloted intervention with percentage share of students in Blooms (highest of the four learning levels) increasing from 51.6 % at the baseline (before intervention) to 69 % at the endline (after the intervention) overall. Further analysis revealed that percentage share of students in Blooms for:

- English language & literacy increased from 37 % in baseline to 53 % in endline,

- Numeracy & Mathematics concepts increased from 52 % in baseline to 64 % in endline, and
- STEAM increased from 31% in baseline to 58% in endline.

Overall (for all three treatment subgroups combined), the share of children at highest level of learning has increased for 19 out of 20 development objectives after intervention.

2. **Impact of Teaching Quality on Student Learning**: Analysis of the relationship between teaching quality and student learning showed positive impact with every one-unit increase in COT score bringing +0.281 improvements in literacy, +0.084 in numeracy and +0.235 in STEAM.
3. **Impact of Internet usage at home on Student Learning**: The relationship between Internet usage (taken as proxy for access, familiarity and usage of technology) by teachers with learning levels of their students reveal that if teachers have access to Internet, learning levels of their students increased by +0.81 for literacy, +0.696 for numeracy and +0.167 for STEAM.
4. **Community Involvement:** The involvement of community volunteers proved beneficial in managing large classes and supporting teachers. The schools with community volunteers exhibited larger impacts overall with 19 % share of children at Blooms level for literacy, 21 % for numeracy, and 34 % for STEAM.
5. **Technological Integration:** The treatment subgroup that implemented maximum number of lessons recommended showed increase in the learning levels of students, over and above the treatment effect by +1.001 for literacy and +1.181 for STEAM.
6. **Perception Surveys & Qualitative feedback:** Data collected from teachers, headteachers and volunteers through perception surveys and qualitative feedback highlighted teachers appreciated the interactive lesson plans and the support provided by the platform, noting increased student engagement and enhanced teaching efficacy. The challenges included internet connectivity issues, technology illiteracy, classroom and time management issues, and retention of community volunteers.

The pilot successfully demonstrated the potential of technology to transform foundational learning. Based on the results, recommendations have been made to implement an improved programme, provide professional development for teachers, engage community volunteers to support classroom teaching, and develop communities of practice.

1

Introduction

1.1 Background

Pakistan is grappling with a significant learning challenge at the foundational level of education. The current educational outcomes in the country, including its largest province Punjab, highlight a troubling scenario. According to the Annual Status of Education Report (ASER) 2021, only 55% of Grade 5 students in Punjab can read a story in Urdu, and just 50% can solve a two-digit subtraction problem (ASER, 2021). Moreover, the National Achievement Test (NAT) scores reflect that a considerable portion of students in Punjab do not meet the expected standards in core subjects (ASER Pakistan). Similarly, results from the Punjab Examination Commission (PEC) underscore the widespread struggle with basic academic skills, revealing systemic issues in early education (PEC, 2021)[1]. These figures indicate a severe gap in foundational literacy and numeracy skills, which are crucial for further academic success and personal development.

A few primary factors contribute to this learning crisis. Firstly, the primary education curriculum in Pakistan is burdened with an extensive number of SLOs, making it challenging for both teachers and students to concentrate on mastering essential skills. In contrast to international benchmarks, such as those in the UK and Finland, which feature more streamlined and focused curricula, Pakistan's curriculum can overwhelm educators and students alike, leading to superficial learning rather than a deep understanding of subjects. For comparison, the Finnish national core curriculum emphasises fewer, but more comprehensive learning objectives. For instance, in subjects like mathematics and science, the curriculum focuses on deep understanding and practical application rather than rote memorisation. Typically, the Finnish curriculum outlines about 6-10 broad learning objectives per subject per grade level, focusing on the development of transversal competences across subjects[2]. In contrast, Pakistan's curriculum tends to include a higher number of SLOs per subject. For example, the national curriculum for Grade 5 Mathematics in Pakistan includes around 150 specific SLOs, which cover a wide range of topics from basic arithmetic to introductory geometry and data handling. This approach aims to cover a broad spectrum of knowledge but can sometimes lead to superficial understanding due to the extensive content to be covered within a limited timeframe. This comparison highlights the Finnish approach of focusing on fewer, deeper learning outcomes to enhance comprehension and application, whereas the Pakistani system covers a wider

[1] https://pec.edu.pk/publications
[2] https://www.oph.fi/en/statistics-and-publications/publications/new-national-core-curriculum-basic-education-focus-school

array of topics more quickly, potentially at the expense of depth.

Secondly, the student-teacher ratio (STR) in many schools across Punjab is extremely high, often exceeding 40:1 (ASER Pakistan). This imbalance makes it nearly impossible for teachers to provide individualised attention and to cater to the diverse learning needs of each student. Research consistently shows that smaller class sizes are associated with better student engagement and higher academic achievement (Blatchford et al., 2011). In addition to that, prevalence of multigrade teaching significantly hinders the implementation of effective teaching strategies, contributing to disengagement and poor performance among students (UNESCO, 2019).

Thirdly, the prevalent practice of teaching to assessments in Pakistan's educational system exacerbates the problem. There is an excessive focus on rote memorisation and preparing students for exams, rather than fostering a deeper understanding of the subject matter. This approach not only limits the development of critical thinking, problem-solving skills, and creativity but also places undue stress on students and teachers. In contrast, educational systems that emphasise formative assessments and holistic learning outcomes, such as those in Singapore, produce students who are better prepared for real-world challenges (OECD, 2018). The current emphasis on testing in Pakistan undermines the potential for nurturing well-rounded, intellectually curious, and adaptive learners.

Lastly, limited community engagement in public sector education poses significant challenges, and its improvement can lead to substantial benefits for educational outcomes. Engaging the community fosters a supportive environment for students, enhances learning experiences, and helps schools address their resource constraints. Volunteers from the community can assist teachers, particularly in large classes, by supporting activity-based learning and reducing the teachers' workload. This engagement is not only low-cost but also leverages the strengths and resources of the community, leading to better educational outcomes[3,4].

Addressing these issues is crucial for providing need-based support to children improving early childhood education outcomes in Pakistan. By reducing the number of SLOs, lowering the student-teacher ratio, shifting the focus from rote learning to a more comprehensive and understanding-based approach, and engaging community volunteers, public sector can create a more conducive learning environment that fosters both academic and personal growth in young learners.

1.2 Enhancing Foundational Teaching with Technology

Research has shown that a holistic approach to education is far more beneficial, particularly during a child's early years. A fundamental principle in effective early education is the implementation of personalised learning, which caters to the learning abilities and levels of every child, recognising that they develop and learn at their own individual pace (Arnott, 2021; Bautista et al., 2016). This approach has been shown to be effective in improving learning outcomes and promoting social-emotional development. Given the challenges faced by Pakistan's educational

[3] https://www.gse.harvard.edu/ideas/usable-knowledge/23/03/case-strong-family-and-community-engagement-schools
[4] https://www.idra.org/resource-center/improving-educational-impact-through-community-and-family-engagement/

system, particularly in Punjab, technology-enabled solutions, powered by Artificial Intelligence (AI) and Machine Learning (ML), hold significant promise for enhancing the efficacy of teaching and learning in early years.

Technology-enabled solutions can offer following advantages:

Personalised Learning

AI and ML can analyse vast amounts of data on student performance and learning patterns to create individualised learning plans. These plans can be tailored to meet each student's unique needs, helping to address the diverse learning abilities within a classroom. By adapting lessons and activities based on real-time data, teachers can provide targeted support where it is needed most, ensuring that no student is left behind (Luckin et al., 2016). This enables timely interventions and more effective remediation strategies, which are crucial for foundational learning (Zawacki-Richter et al., 2019).

Adaptive Learning Platforms

Technology can facilitate the use of adaptive learning platforms that adjust the difficulty of tasks based on the learner's performance. This ensures that students remain engaged and challenged at an appropriate level, which can lead to improved retention and understanding of material. Adaptive platforms can also provide instant feedback, helping teachers reinforcing concepts more effectively (Chen et al., 2020).

Interactive and Engaging Content

Technology can enhance the delivery of educational content through interactive and engaging resources. AI-powered tools can create engaging learning experiences, making lessons more dynamic and interesting. This can help maintain student motivation and improve overall engagement in the learning process (Heffernan & Koedinger, 2012).

Teacher Support and Professional Development

Technology can also support teachers by providing customised professional development resources and tools that enhance their instructional practices. For instance, AI-driven analytics can highlight effective teaching strategies and suggest areas for improvement, fostering continuous professional growth. This ensures that teachers are better equipped to meet the challenges of modern education (Darling-Hammond et al., 2017).

By leveraging technology-enabled solutions, it is possible to address some of the key challenges in the province.

Large Class Size

AI and ML powered tools can help manage large classes by providing teachers with efficient ways to track and support each student's progress, enabling more personalised learning experiences despite high student-teacher ratios.

Lack of Personalised Learning Experiences

Technology can facilitate the delivery of personalised learning experiences tailored to students' individual needs, ensuring that each child receives the appropriate level of challenge and support.

Excessive Focus on Rote Learning

AI and ML can promote a more holistic approach to education by supporting the development of critical thinking and problem-solving skills through interactive and adaptive learning tools.

1.3 BTAG's Intervention to improve the foundational learning outcomes

In response to the challenges mentioned in section 1.1, and the potential of technology-enabled solutions including AI and ML as described in section 1.2, Foreign Commonwealth Development Office (FCDO)'s supported Bridging Technical Assistance for Governments (BTAG) piloted an intervention in Punjab aiming at enhancing the efficacy of teaching and learning at foundational level.

For this purpose, an innovative ed-tech teaching solution "little lab" was used. The platform provides ready-made lesson plans and curriculum with engaging materials and resources complemented with holistic, easy-to-use assessment tools that guide teachers' lesson delivery and track every child's progress. The curriculum and lesson plans are aligned with 20 development goals, outlined in figure 1. The curriculum is powered by the Trehaus Method[5], focusing on nurturing the Whole Child. Children develop character skills that build the 'Heart', be equipped with knowledge of the 'Head' to navigate the world and learn the necessary values and skills to empower them to use their 'Hands' to give back to society.

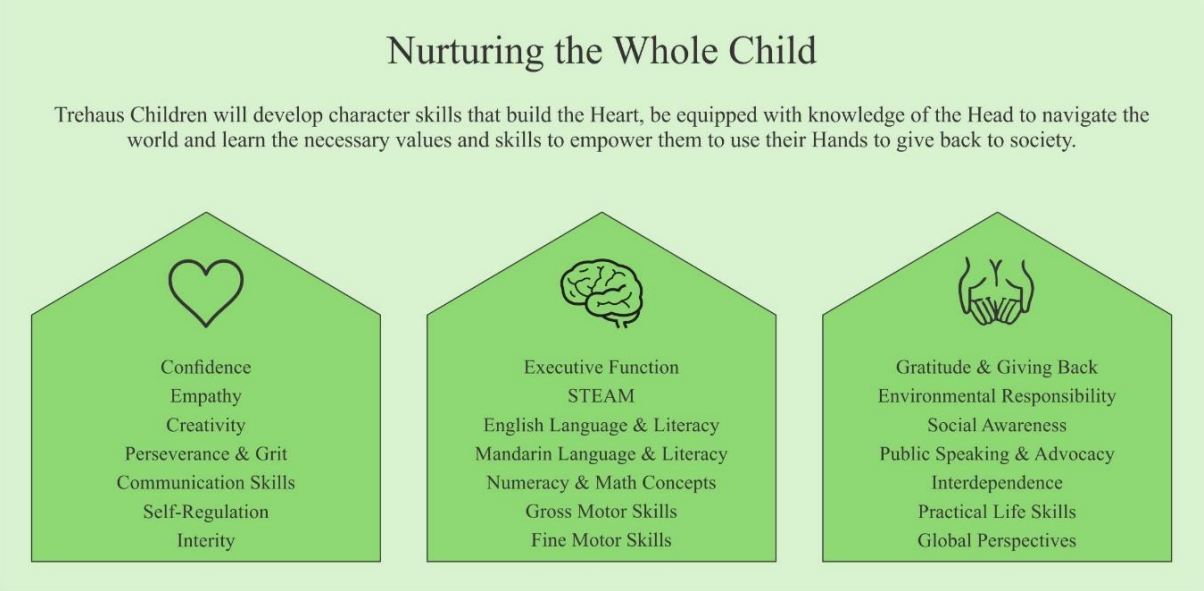


Figure 1: 20 Development Goals

The solution also generates child portfolios to make teaching easier and customised to the needs of children. This platform, powered by the Trehaus Method, helps teachers and administrators select lessons and projects that meet the unique learning needs of their classroom. The platform begins with a series of evaluation questions to assess the needs of their students and then makes recommendations on lessons and projects that meet the learning needs and developmental goals of the students.

Little Lab's Recommendations Engine is at the cornerstone of its AI offering. This Recommendation Engine is designed to collect and analyse data for each child, with the primary

[5] https://www.trehaus.co/

goal of personalising and tailoring lesson plans to individual student needs. This feature represents a significant step towards adaptive learning and personalised education within the framework. The adaptive recommendation system not only serves to enhance the learning experience for individual students but also provides valuable data on the efficacy of evolving, AI-assisted educational strategies. As the platform's data set grows, so does the potential for more nuanced and effective recommendations, positioning Little Lab at the forefront of data-driven, personalised educational technology innovation.

The Little Lab's Recommendation Engine is powered by its initial data set which matches the needs of children to the lessons and projects on the platform. As Little Lab continues to grow its data set, the algorithm will get smarter and smarter at assisting teachers to find the best lessons and projects for their classroom.

Little Lab Platform Utilisation in Lollypop Pre-School Bandung, Indonesia

Lollypop Bandung benefits significantly from Little Lab, which supports the school's curriculum needs through tailored solutions and trainings. The integration of Mandarin and English into the curriculum enhances the learning experience, catering to the diverse linguistic backgrounds of students. This adaptation not only improves student engagement but also highlights Little Lab's capability to meet unique educational challenges effectively.

Lollypop Jakarta utilised Little Lab's platform during the academic year and particularly during summer camps, finding these sessions especially engaging. The tailored curriculum enhanced both student learning outcomes and teacher involvement, significantly enriching the educational experience during these critical periods.

Given the success of little lab interventions and the potential to provide need-based support to teachers and students powered by AI and ML, a quasi-experiment was designed. The pilot was implemented in 50 schools in Model Town Lahore with varying class strength. In selected schools, community volunteers were engaged to support teachers manage their class and teach them effectively.

Pilot Objectives

The programme aimed to achieve the following objectives:

1. Assess the effectiveness of AI- and ML-powered technology enabled solutions to improve teaching practices and student learning outcomes.
2. Encourage and strengthen active participation from community in the educational process by engaging volunteers to support teachers in classroom teaching & management.
3. Explore the logistical, operational and systemic challenges associated with the integration of technology in classrooms to provide personalised and adaptive learning.
4. Develop teaching & learning materials that focus on holistic child development through project-based learning and is tailored to the needs of the students.
5. Equip teachers and volunteers with knowledge and skills to effectively utilise the platform and resources to improve their instructional methods.
6. Promote collaboration among teachers, encourage peer learning and support networks for teachers to share best practices, challenges, and solutions related to integrating technology in classrooms.
7. Use pilot results and lessons learned to develop recommendations for scale-up model that can be expanded to more schools and regions.

8. Generate insights and evidence from the pilot programme to inform policy decisions.

1.4 Project Report

The primary purpose of this report is to document the results from the intervention. The report aims to provide a comprehensive detail regarding the programme's design, implementation, and outcomes to understand its effectiveness in addressing the challenges associated with student achievement and technology integration in classroom. The analysis seeks to identify best practices, areas for improvement, and recommendations to inform scale up plan.

The first section of the report gives detailed account of background and context, and the rationale and objectives of the pilot. Section 2 covers literature review and gives an overview of global and local interventions that uses technology enabled solutions to improve effectiveness of teaching & learning. Section 3 describes the detailed methodology that was adopted to collect and analyse data to assess the effectiveness of the intervention. Section 4 describes implementation steps of the pilot programme. Fifth section gives details on analysis of the data collected, key findings and results including impact on student outcomes, effect of teaching practices as well as qualitative feedback collected from the teachers. Section 6 highlights lessons learned and developed recommendations based on the findings and proposes a way forward.

The report will provide policy makers and government officials insights into the effectiveness of technology-based solutions and inform policy decisions related to integrating technology in classrooms to improve teaching practises and student learning outcomes. It will also help School Education Department (SED) to understand the challenges and potential of implementing such initiatives. For development partners, this will help identify opportunities for collaboration, support, and funding to enhance the efficacy of teaching and learning using technology-enabled solutions.

2

Literature Review

The use of technology in education has been increasingly recognised for its potential to transform learning experiences, particularly at the foundational level. Global research highlights how technology-enabled solutions, including Artificial Intelligence (AI) and Machine Learning (ML), can significantly enhance educational outcomes by supporting personalised learning, adaptive instruction, and providing data-driven insights that inform teaching strategies. These technologies analyse individual student data to tailor learning experiences according to each student's needs and abilities. For instance, AI-powered platforms can recommend specific resources, adjust the difficulty of tasks, and provide real-time feedback, thus ensuring that students remain engaged and challenged at appropriate levels. Studies have shown that such personalised approaches can lead to improved retention, understanding, and overall academic performance (Luckin et al., 2016). Additionally, platforms like DreamBox and Knewton use AI and ML to adapt educational content in real-time, analysing students' interactions and performance to modify the difficulty and type of content presented, ensuring effective learning (Chen et al., 2020).

Globally, initiatives such as Khan Academy exemplify the benefits of technology in education. Khan Academy offers practice exercises, instructional videos, and a personalised learning dashboard, enabling learners to study at their own pace both inside and outside the classroom. Covering a wide range of subjects, Khan Academy supports self-paced learning and provides resources that cater to different learning styles and levels (Khan Academy, 2021). The scale of Khan Academy is extensive, with millions of users worldwide, including over 100,000 teachers and tens of millions of students. The impact evaluation of Khan Academy's programs shows a notable improvement in student scores, with some studies reporting up to a 30% increase in math proficiency (Khan Academy, 2021).

Similarly, in several African countries, Bridge International Academies use technology to deliver high-quality education at low cost. Teachers use tablets to access lesson plans and record student data, which is then analysed to improve teaching practices and student outcomes, significantly enhancing literacy and numeracy skills among students in underserved communities (Bridge International Academies, 2020). As of 2020, Bridge International Academies served over 500,000 students across multiple countries. The pilot programmes have demonstrated significant improvements, with some regions reporting a 15-20% increase in literacy and numeracy scores after just one year of implementation (Bridge International Academies, 2020).

These large-scale, technology-driven educational models differ significantly from traditional small-scale experiments, where new teaching methods and tools are tested on a smaller, more controlled group of students. These typically involve

experimental setups with limited participants and shorter durations, providing valuable insights but often facing challenges in scalability. In contrast, initiatives like Khan Academy and Bridge International Academies operate on a larger scale, offering solutions that are designed to be scalable and adaptable to diverse educational contexts. These large-scale implementations provide a broader data set, allowing for more comprehensive impact evaluations and the ability to refine and optimize the technology based on a wide range of user interactions. The duration of pilot programmes for these initiatives varies, typically ranging from one to three years, depending on the scope and objectives of the project. Long-term evaluations are essential to assess sustained impact and address any emerging challenges. While technology has the potential to revolutionise education, it is crucial to consider these limitations and strive for solutions that ensure equitable access and effective implementation across diverse educational contexts.

However, these initiatives also face limitations and challenges. The reliance on technology necessitates robust infrastructure, which can be a barrier in regions with limited internet access or unreliable power supplies. Additionally, there is a need for continuous professional development for teachers to effectively integrate these technologies into their teaching practices. The cost of devices and software can also be prohibitive for some schools and communities. Furthermore, large-scale programs may encounter issues with data privacy and the need for substantial technical support to maintain and update the technological tools used.

In developing countries, technology-based educational interventions have proven crucial. One such example is the One Laptop per Child (OLPC) initiative, which provides children with low-cost, durable, and connected laptops. The programme aims to enhance learning by providing access to digital educational resources and fostering collaborative learning environments. Evaluations of OLPC have shown improvements in student engagement and digital literacy, although the impact on traditional academic outcomes varies (Kraemer, Dedrick, & Sharma, 2009).

In Pakistan, Taleemabad has emerged as a notable digital education platform designed to deliver primary education content through digital animations accessible on both television and a mobile application. Since its launch in 2015, Taleemabad has reached over 1 million users, primarily in remote and underserved areas, with its application downloaded over 500,000 times. Offering over 500 animated lessons aligned with the national curriculum, it has demonstrated a 20% improvement in test scores among students compared to traditional methods (Taleemabad, 2022). The platform's engaging digital animations make learning interactive and enjoyable, fostering better retention and understanding. However, Taleemabad faces several challenges: the digital divide limits access for those without reliable internet or digital devices; the content is currently focused on primary education, necessitating expansion to higher secondary levels; integrating digital education requires significant teacher training; and cultural resistance from parents and educators accustomed to conventional methods can impede adoption. These challenges highlight the ongoing need to bridge gaps in digital access, expand educational content, and integrate traditional and digital teaching methods for a broader impact.

Furthermore, community engagement through the involvement of relatively low-salary volunteers has played a pivotal role in the success and sustainability of educational projects. These volunteers, motivated by a genuine desire to contribute to their community, bring a unique perspective and dedication that significantly enhances the project's impact. Their presence not only provides additional support to teachers but also fosters a sense of ownership and collaboration within the community. The

effectiveness of community engagement through low-salary volunteers lies in their ability to provide personalised attention and support to students, especially in resource-constrained settings. These volunteers, often drawn from the local community, possess a deep understanding of the cultural context and the needs of the students, enabling them to tailor their assistance to address specific challenges faced by the learners. Their presence also helps in building trust and rapport between the school and the community, leading to increased parental involvement and support for educational initiatives.

In conclusion, integrating AI and ML into early childhood education presents a transformative opportunity to address existing challenges and enhance learning outcomes. By adopting technology-enabled solutions, educational systems can provide more personalised, effective, and inclusive learning experiences, ultimately fostering better academic and social-emotional development for young learners. Recognising and leveraging the invaluable contributions of community volunteers can further strengthen these efforts, ensuring long-term sustainability and community empowerment.

3

Technical Approach and Methodology

Our technical approach is informed by prevalent learning gaps in public schools in Punjab and how technology can support mitigate them. The approach is informed by the literature review focusing on international and local best practices applicable to our context.

The research methods that were employed to gauge the effectiveness of the intervention are detailed below:

3.1 Research Design

Pre-Assessment and Post Assessment

A Pre-test and Post-test Research Design was used to track changes for both treatment and control groups to track movement on variables that are relevant to the objectives of the study (See Figure 2). Methodologically speaking, a Difference-in-Difference Model (DiD) was used to estimate the treatment effect of the intervention by observing difference of changes in treatment and control groups over time.

Variables of Interest

Outcome Variables

Student's Ranking on the 20 Development Goals, with a special focus on English language & literacy, Numeracy & Mathematics, and STEAM.

Robustness Checks

The DiD model was tested for robustness by adding

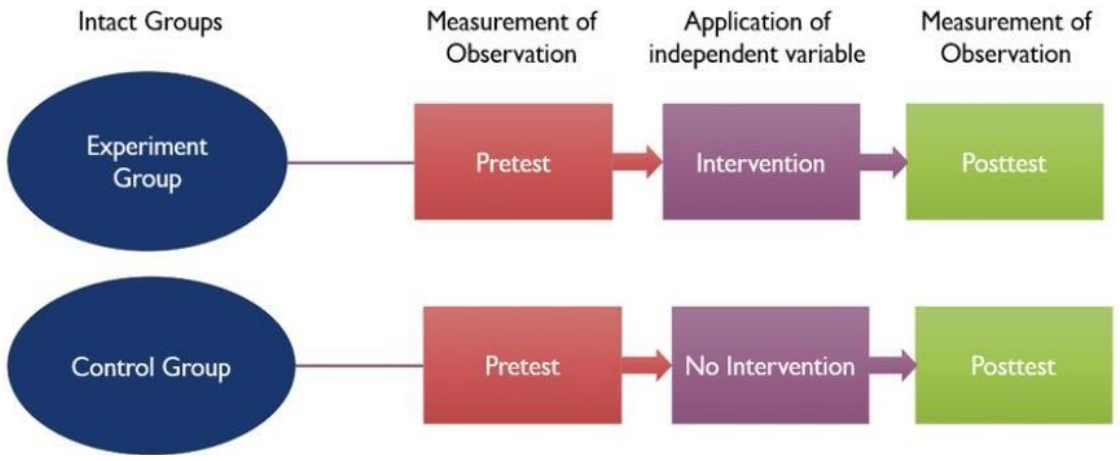


Figure 2: Difference-in-difference model for pilot evaluation

a. Classroom Observation scores that measured the quality of teaching
b. Usage of internet by teachers at home
c. Usage of AI powered recommendations
d. Data on ages of the students

Sampling Plan

A multi-stage sampling strategy was employed, followed for each of the three sub-interventions.

Stage 1

Eligible schools were identified using the following criteria.

i. 20 schools that have teacher student ratio within the range 1:20 to 1:39.
ii. 30 schools that have teacher student ratio within the range 1:40 to 1:60.

Of the identified school, treatment and control schools were selected using stratified random sampling method. (Note: Strata were defined as such to ensure balance on school region and school type across control and treatment groups) This exercise was undertaken for each of the three sub-intervention designs:

i. 10 Treatment, 10 Control Schools (Sub-intervention 1 i.e., intervention in schools with teacher-student ratio between 1:20 to 1:39)
ii. 10 Treatment, 10 Control Schools (Sub-intervention 2 i.e., intervention in schools with teacher-student ratio between 1:40 to 1:60)
iii. 10 Treatment, 10 Control Schools same as Sub-intervention 2 (Sub-intervention 3 i.e., intervention in schools with teacher-student ratio 1:40 to 1:60 & Community Volunteers)

Stage 2

All Grade 1 teachers in the target control and treatment schools were selected across both treatment and control groups for each of the three sub-interventions.

Stage 3

A sample of Grade 1 students from the control and treatment schools were sampled using a probability- proportional-to-size sampling (PPS) method.

Data Collection

Section 3.1 (iv) lists out the details on the data collection methods that were used to gather data on the variables of interest identified in section 3.1 (iii).

A. **Student Measurement (20 Development Goals)** – Student measurements on the 20 Development Goals that track holistic child development were tracked both before and after the treatment in control and treatment schools for the sampled Grade 1 students.
B. **Classroom Observation Tool** – Classroom Observations was undertaken both before and after the treatment in all of the control and treatment schools for all Grade 1 teachers.
C. **Perception Survey of Teachers** – A perception survey of teachers was conducted after the treatment in treatment schools for all Grade 1 teachers. The perception survey captured teachers' perception regarding curriculum effectiveness, technology uptake and platform utility.
D. **School Level Survey** – A school level survey was administered in all the control and treatment schools. Among other things the survey captured information on: School Name, Region, Enrolment, Teacher-Student Ratio, No. of Teachers in school, age and qualification of teacher, use of computer and internet at home.

Analysis

This section outlines the different types of analysis that were undertaken as part of the impact evaluation of each of the three sub-interventions.

Holistic Child Development

In order to estimate the effect of the intervention on holistic child development, levels[6] of students on scale for each of the 20 Development Goals was tracked and analysed to estimate the effect of the intervention.

A DiD estimate using an ordered logistical regression was employed. The following model was used to estimate the average treatment effect on the treated (ATET):

- $Y_g{}^{ist}$ is value of categorical level for student *i* in school *s* at time *t* on the development goal *g*; and takes the value of 1, 2, 3 or 4.

$$\log\left(\frac{\pi}{1-\pi}\right) = \beta_0 + \beta_1 \times Treat_{ist} + \beta_2 \times Time_{ist} + \beta_3 \times Treat_{ist} \times Time_{ist} + \beta_k \times Covariates_{ist} + \varepsilon$$

$$\text{Where} \quad \Pr(Y_g) = \pi \qquad (1)$$

The variable $Treat_{ist}$ takes the value of 1 if a school received the intervention and 0 otherwise. The variable $Time_{ist}$ takes the value of 0 before intervention measurement and 1 for after intervention measurement. The coefficient (β_3) captures the average difference between control and treatment groups and is our measure of the impact. In addition, ε is the error term.

The coefficients of ordered logistical regression equation (1) give the log odds and are converted into odds-ratios using the following computation:

$$\left(\frac{\pi}{1-\pi}\right) = (10)^{\beta}$$

Classroom Observation

The following model was used to estimate the effect of the intervention on the Grade 1 teachers.

$$C_{ist} = \beta_0 + \beta . Treat_{ist} + \beta_2 . Time_{ist} + \beta_3 . Treat_{ist} \times Time_{ist} + \beta_k . Covariates_{ist} + \varepsilon$$

Where C_{ist} is outcomes variable's measure for teacher *i* in school *s* at time *t*. The variable $Treat_{ist}$ takes the value of 1 if a school received the intervention and 0 otherwise. The variable $Time_{ist}$ takes the value of 0 before intervention measurement and 1 for after intervention measurement.

The coefficient (β_3) captures the average difference in scores between control and treatment groups and is our measure of the impact of intervention on classroom observation score using the DiD methodology[7]. In addition, ε is the error term.

[6] There are 4 assigned levels: Sprouts, buds, blossoms, blooms

[7] *Parallel Trends Assumption:* Our difference-in-difference estimates rely on the parallel trends assumption. It requires that in the absence of treatment, the difference between the 'treatment' and 'control' group is constant over time. (See https://www.publichealth.columbia.edu/research/population-health-methods/difference-difference- estimation)

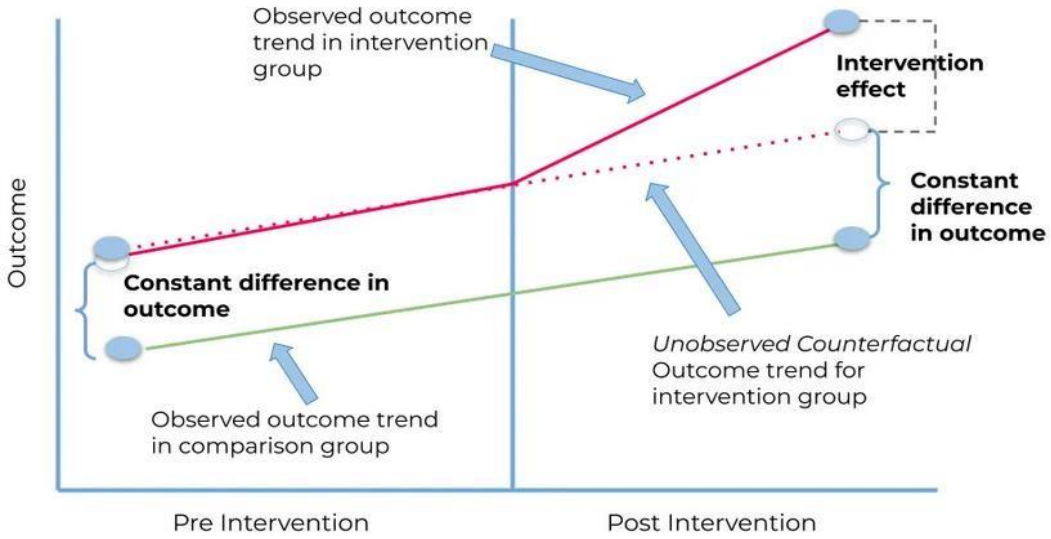


Figure 3: Intervention Effect Measurement

Teacher Perception Surveys

A perception survey of teachers was conducted at the end of the intervention for all Grade 1 teachers in treatment schools. Results were captured and analysed focusing on teachers' perception regarding platform utility, technology uptake and effectiveness of the lesson plans.

4

Pilot Implementation

The intervention aimed to enhance the efficacy of teaching and learning in early years through technology-enabled solutions, particularly focusing on AI and ML. To achieve this, an AI-enabled tool was deployed across 30 schools in Punjab. This quasi-experimental design was set up to compare the effectiveness of technology-enhanced learning in treatment schools against traditional methods in control schools.

4.1 Identification of Schools

The schools were selected within tehsil Model Town of Lahore, ensuring proximity to the training centre for ease of access, as per sampling plan detailed in section 4.1.

i. 20 schools were identified having teacher student ratio between 1:20 to 1:39
ii. 30 schools were identified having teacher student ratio between 1:40 to 1:60

The project also engaged 30 teachers and 10 trained community volunteers to support the implementation.

i. **Sub-Intervention 1:** 10 Treatment, 10 Control Schools with teacher student ratio between 1:20 to 1:39
ii. **Sub-Intervention 2:** 10 Treatment, 10 Control Schools with teacher student ratio between 1:40 to 1:60
iii. **Sub-Intervention 3:** Another 10 Treatment schools, with teacher student ratio between 1:40 to 1:60 & community volunteer.

Before launching the pilot, discrepancies between the official data and actual on-ground data were noticed. These discrepancies were rectified, and the schools were regrouped accordingly given in table-1. The intervention involved a total of 2053 grade 1 students within 30 treatment schools and 20 control schools. Among these, 1268 students were in the treatment group and 785 in the control group.

List of schools is attached as annexure-A.

Table 1 summarises the actual sample sizes at the each of the aforementioned stages:

Intervention	No. of Sampled Schools	No. of Teachers (Grade 1)	No. of Sampled Students (Grade 1)
Sub-Intervention 1	20 (10 Control & 8 Treatment)	18	455
Sub-Intervention 2	20 (10 Control & 15 Treatment)	25	1180
Sub-Intervention 3	20 (10 Control & 7 Treatment)	17	305

Table 1: Sample size for the intervention

The type, region and level wise breakdown of 50 schools is given below:

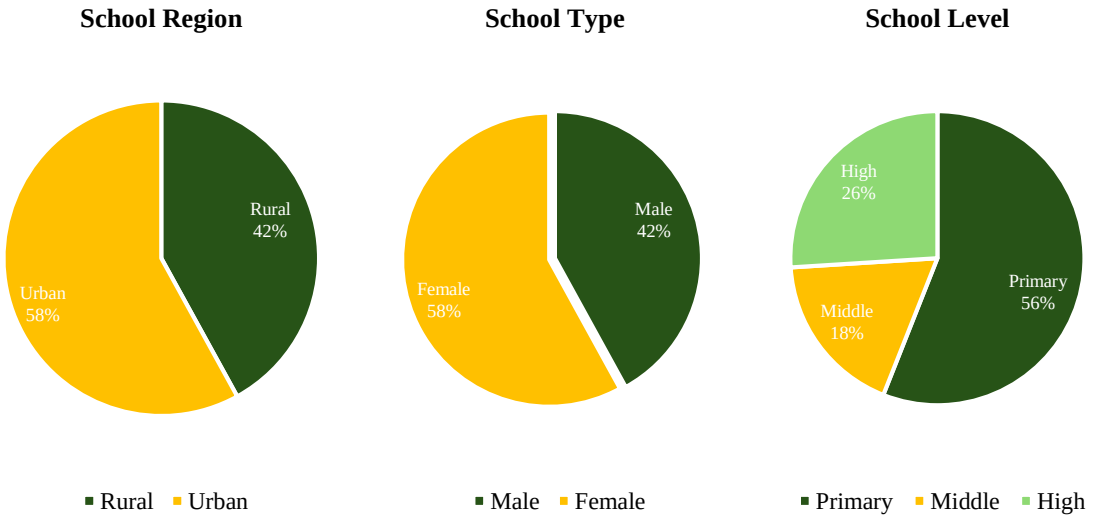


Figure 4: School data disaggregated by a) Region, b) Type and c) Level

Additionally, there was significant variation in the age range of students in both treatment and control schools. In treatment schools, the ages of students ranged from 4 to 15 years, with the majority being 7 years old, as shown in Figure 5. In control schools, students' ages varied from 3 to 14 years, with most students 7 or 8 years old, as illustrated in Figure 6. This wide age range and the higher average age for Grade 1 are largely due to late enrolments, causing many students to miss several years of early education.

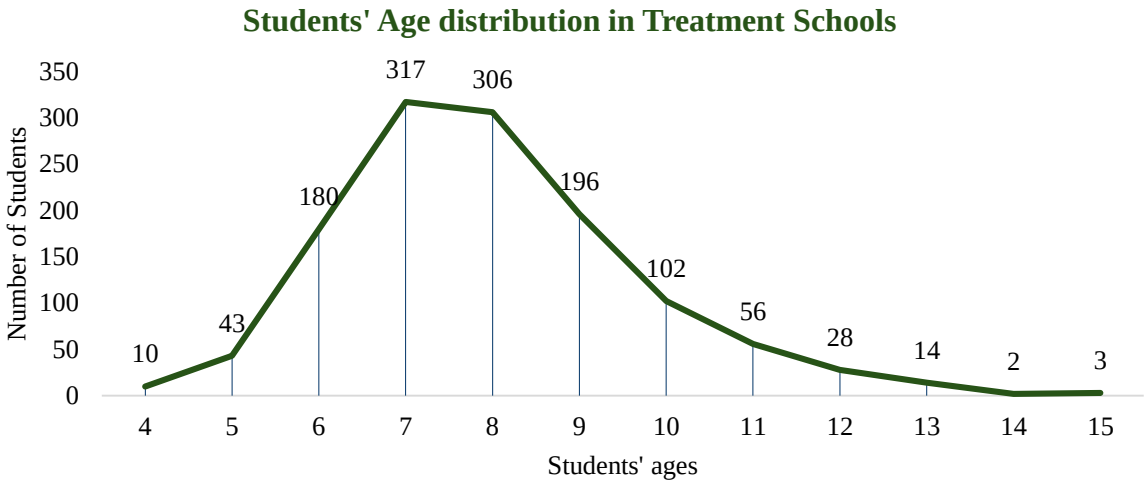


Figure 5: Distribution of students with respect to their ages in treatment schools

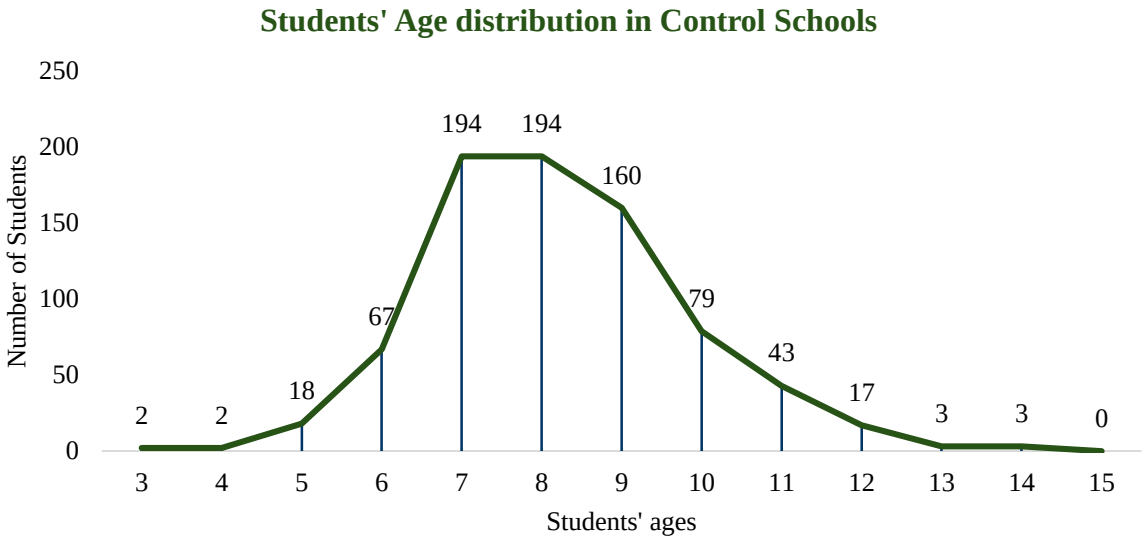


Figure 6: Distribution of students with respect to their ages in control schools

4.2 Development of a Mechanism to Track Student Development

To monitor and track student development throughout the intervention, BTAG, in collaboration with an international consultant, implemented a specialised application named Little Lab[8]. Little Lab is an innovative ed-tech teaching solution for foundational years harnessing transformative technology to inspire and equip teachers with the knowledge, training and tools they require to make teaching engaging, meaningful and differentiated. In a virtual environment, the platform provides ready-made lesson plans and curriculum with engaging materials and resources complemented with holistic, easy-to-use assessment tools that guide teachers' lesson delivery and track every child's progress. The solution also generates child portfolios to make teaching easier and customised to the needs of children.

By leveraging technology for detailed, real-time tracking of student progress, the application supports a more responsive and adaptive educational strategy. This ensures that each child receives the necessary attention and resources to succeed, ultimately driving better learning outcomes and contributing to the overall success of the intervention.

To meet the specific needs of the research objectives, several key modifications were made to the existing platform:

1. **Large Class Size Accommodation:** The platform was extensively customised to efficiently handle large class sizes. This involved optimising the user interface to display and manage a high volume of student data without compromising performance. Backend improvements were also implemented to ensure smooth operation under increased load, including enhanced database indexing and query optimization.

[8] app.littlelab.com

2. **Multi-language Support with Urdu Translation:** Recognising the linguistic diversity of the target population, comprehensive language translation capabilities were integrated, with a particular focus on Urdu support. This feature allows users to seamlessly switch between languages, ensuring that language barriers do not impede access to educational content. The translation system covers all aspects of the platform, including user interfaces and lesson materials.
3. **Offline Access to Lesson Plans**: To address potential connectivity issues and provide flexibility in resource distribution, feature was developed allowing users to easily print lesson plans. This functionality ensures that educators and students can access critical instructional materials even in environments with limited or unreliable internet access. The print-friendly formatting was carefully designed to maintain the integrity and clarity of the lesson content when transferred to a physical medium.
4. **CSV Import for Bulk Student Enrolment**: To streamline the administrative process of managing large class sizes, a CSV (Comma-Separated Values) import feature was implemented. This addition enables administrators or teachers to efficiently enrol a large number of students simultaneously by uploading a formatted spreadsheet. This feature significantly reduces the time and effort required for manual data entry, particularly beneficial for institutions dealing with high student volumes or frequent intake periods.
5. **Attendance Tracking Feature:** A comprehensive attendance tracking system was integrated into the platform to monitor student participation effectively. This feature allows educators to easily record and manage attendance for large classes, providing valuable data for both administrative purposes and research analysis.
6. **Little Evaluator Assessment Tool:** In collaboration with the curriculum design team, the Little Evaluator was developed and integrated. Little Evaluator is an innovative assessment and evaluation method tailored to the research needs. This feature was specifically designed to facilitate the efficient capture of both baseline and endline data, providing a comprehensive framework for measuring student progress and the effectiveness of the educational interventions.

The Little Evaluator significantly enhanced the research capabilities by providing:

- Efficient baseline data capture at the beginning of the study
- Ongoing formative assessments throughout the research period
- Comprehensive endline data collection to measure overall impact
- A robust framework for comparing intervention effectiveness across different groups.

By integrating the Little Evaluator into the platform, a powerful tool was created that not only served the immediate research needs but also offered the potential to inform future educational practices and policy decisions. The data collected through this tool provided a rich source of information for analysing the efficacy of the educational intervention and identify areas for further improvement or investigation.

Detailed student data, including names and birth dates of all grade 1 students in the 50 participating schools, was obtained from the Punjab Monitoring and Implementation Unit (PMIU) and physically verified by the team to ensure its accuracy. Each student was registered on the platform with their date of birth, ensuring accurate and individualised tracking.

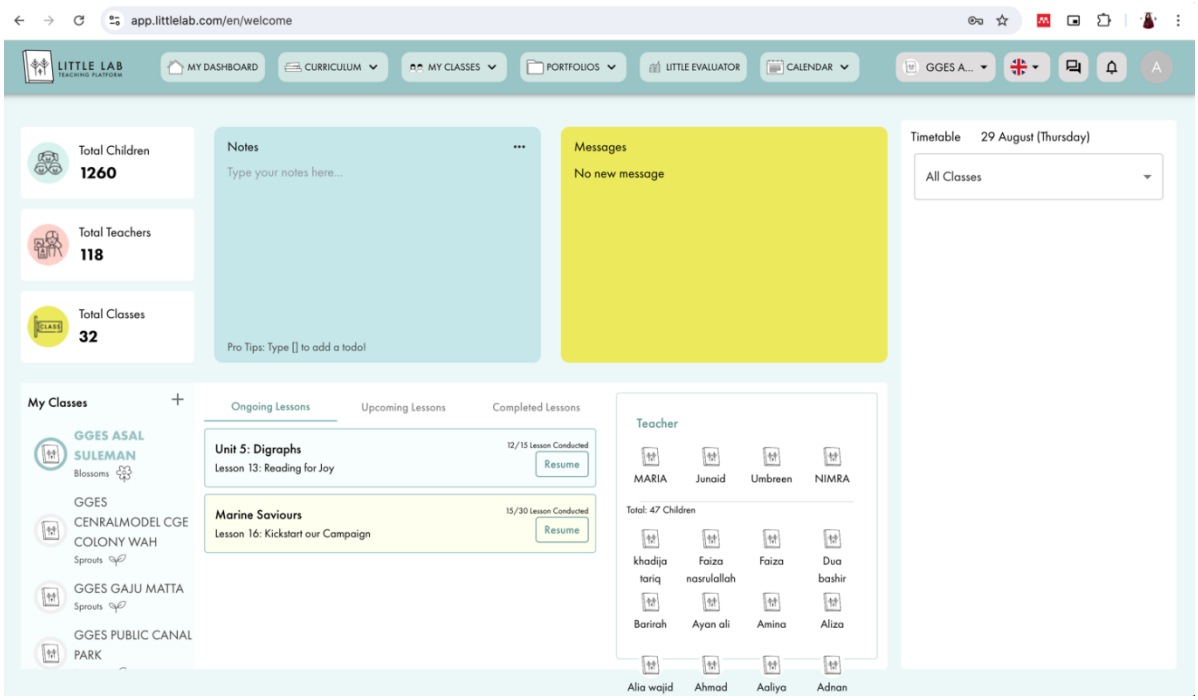


Figure 7: Dashboard allowing admin to track teachers' progress and children's performance

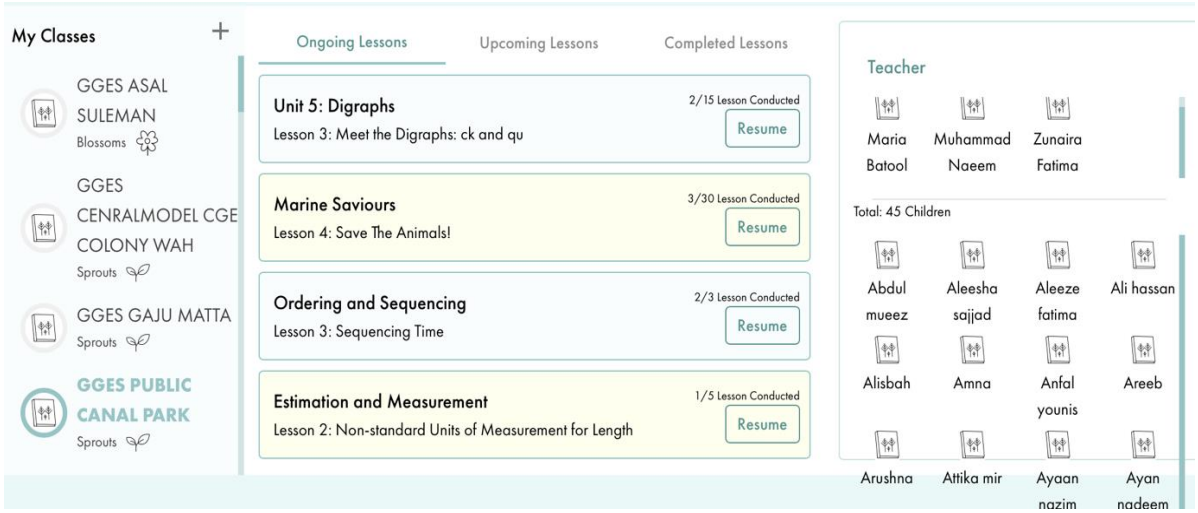


Figure 8: Screenshot of platform showing ongoing lessons

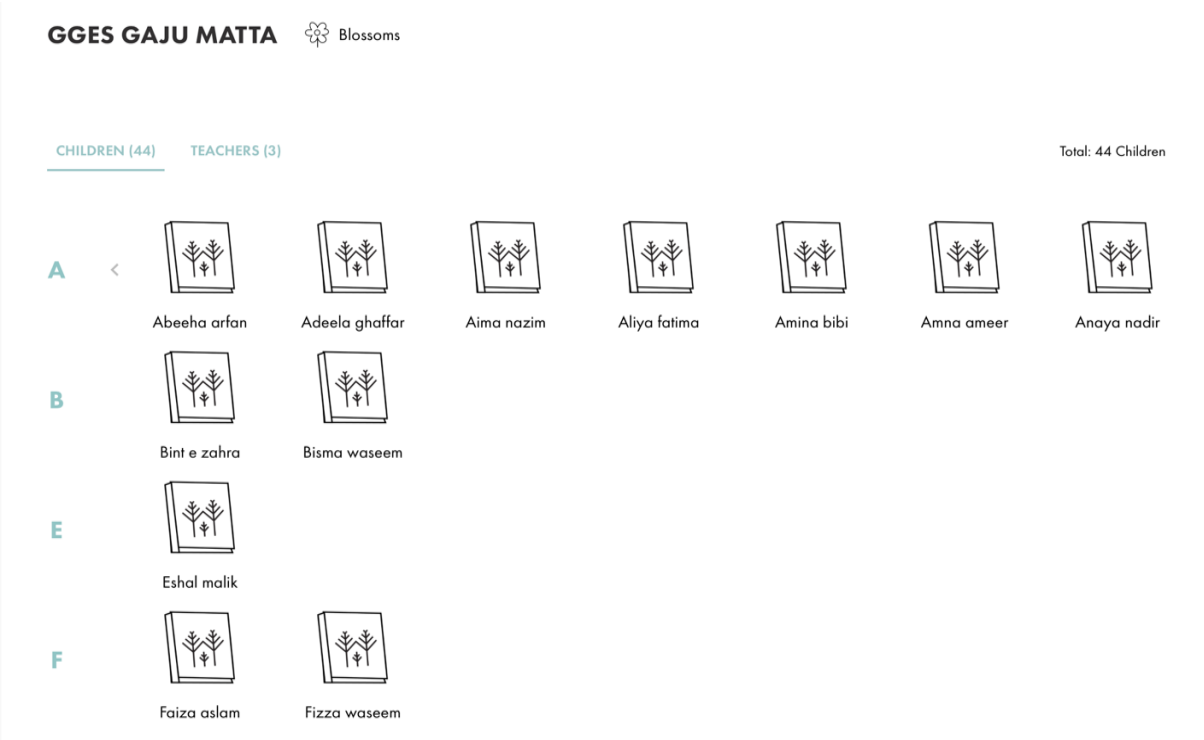


Figure 9: Screenshot of platform showing students in a class

4.3 Selection of Volunteers

To assess how community engagement enhances the educational process and provides a low-cost solution to augment classroom support, volunteers were identified and engaged to support teachers in 10 treatment schools. BTAG with support from Quaid-e-Azam Academy for Educational Development (QAED) nominated a committee consisting of Assistant Education Officers (AEOs) and Headteachers (HTs) of selected schools who identified community volunteers to serve as teacher assistants throughout the pilot programme.

The following criteria were established for the selection of volunteers:

- **Willingness and Motivation:** Candidates demonstrated a strong desire to support teachers and students in the teaching and learning process.
- **Educational Qualification:** A minimum qualification of matriculation or intermediate level was required.
- **Technological Proficiency:** Familiarity with technology was preferred to facilitate the integration of the AI-enabled tools used in the intervention.

A total of 18 volunteers were selected initially. Out of which, 10 volunteers were engaged to support teachers and students by providing additional assistance to teachers and personalised attention to the students.

4.4 Training of Teachers and Volunteers

Grade 1 teachers from 30 treatment schools and volunteers from 10 schools were trained to be equipped with the knowledge and skills required to effectively implement the intervention. To ensure effective training of teachers and volunteers, a session was conducted by Singapore-based expert

education trainers for QAED's facilitators on January 3rd, 2024. The facilitators were equipped with the necessary skills and knowledge to deliver high-quality training sessions to both teachers and volunteers. This was followed by a comprehensive four-day training session for teachers called the Trehaus Teacher Training Academy (TTA), conducted by the same expert trainers with support from QAED's facilitators, from January 4th to 7th, 2024, at district QAED Kot Lakhpat. Subsequently, volunteers received their training from January 6th to 8th, 2024. The training sessions encompassed a wide range of topics. Day 1 focused on the principles of the Trehaus Method, best elements of Early Childhood Education, Growth Mindset. The trainers discussed how teachers can build positive relationship with children, how a child brain's function and principles to respectful care and respectful communication. Day 2 focused on play-based learning, whole child approach and role of teacher in developing the whole child and delivering an integrated curriculum. The trainers provided an opportunity to teachers to discuss their own experiences, share challenges and propose solutions. Day 3 started with a discussion on fundamentals of project-based learning, role of a teacher in project-based learning, differentiation and reflective practice. These topics link theories to practice and engage learners in reflective practice as part of the Trehaus Method Training in the Trehaus Teacher Training Academy (TTA) facilitated by Singapore-based early education leaders and specialists.

On January 6th, a joint platform training session was held for both teachers and volunteers to ensure cohesive understanding and application of the AI-enabled tools. On last day of training, key concepts covered in the training were revisited and all participating teachers and volunteers attempted the post-training assessment.

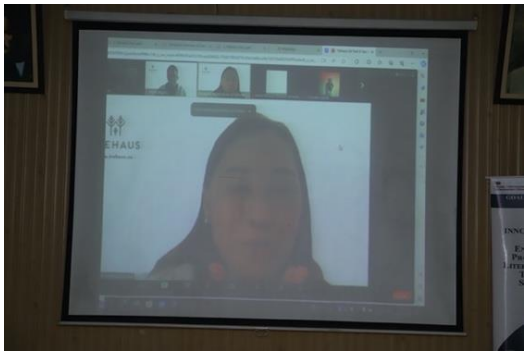


Figure 10: TTA sessions in progress

Figure 11: QAED's facilitators actively engaging participants

Figure 12: Participants understanding Little Lab Platform

Figure 13: Volunteers participating in platform training

”

The training was very informative and the trainers were very good. The training was conducted in a positive and interactive manner. The trainers explained to us in great detail how Project and Play based learning approaches would allow us to teach our students more effectively. We face multiple challenges in our schools but I believe that activity-based learning can help us improve the learning outcomes of our students.

“

Aasma Arshad Ali
Grade.1 Teacher, GGPS Township Lahore

”

I found the training to be very useful and found the discussion on the 'Developmentally Appropriate Milestone Tracking System' to be the most meaningful for me. I am really excited to use this application to manage the learning of my students. The lessons on learning through play and the holistic development of children further solidified my belief that teaching requires teachers to not only have a deep understanding of subject content but to also be able to identify, understand and address the individual needs of their students.

“

Shafaq Fatima,
Grade 1 Teacher, GPS Alirazabad Lahore

4.5 Identification of Assessors

To ensure a robust and reliable pre- and post-assessment process in both control and treatment schools, BTAG collaborated closely with the SED and QAED to select assessors. It was ensured to select assessors with the necessary skills and a genuine willingness to conduct thorough evaluations. Potential assessors were required to fill out a form provided as Annexure-B, helping the BTAG team and QAED to shortlist the most capable individuals. The final pool of assessors consisted of school teachers, Assistant Education Officers (AEOs) and a few university students, selected based on their skillset, experience and familiarity with the local educational context. A total of 50 assessors were carefully selected and each of them was assigned one school to conduct pre assessment before the start of the intervention and post assessment at the end.

4.6 Training of Assessors

To ensure the accuracy and consistency of the assessments, a comprehensive one-day training session for all 50 assessors was conducted on March 7, 2024, at the district QAED in Kot Lakhpat. This training was crucial to equip the assessors with the necessary skills and knowledge to conduct the assessments effectively. The session was delivered by the international

Figure 14: Assessors' training in progress

consultant facilitated by QAED's trainers ensuring that the content was both relevant and of high quality. The facilitators from QAED played a pivotal role in the training, providing additional support and ensuring that all assessors could fully understand and navigate the assessment platform. The training covered various essential aspects, including the overview of the Trehaus method, technicalities of the assessment platform, the methodology for conducting the assessments, and strategies for conducting assessment activities. Practical demonstrations were used to enhance the learning experience, ensuring that the assessors could confidently apply what they learned. The facilitators ensured that any queries or concerns were promptly addressed, providing a thorough understanding of the assessment process. The training session prepared the assessors to perform their roles effectively, thereby ensuring the credibility of the data collected during the pre-assessment phase.

4.7 Conduct of Pre-Assessment

Following the 1-day training of assessors, a five-day assessment was conducted in schools from March 11 to March 15, 2024. The "Little Evaluator" module was utilised for the Pre-Assessment phase. This module provides authentic and playful lessons designed for assessors to evaluate the children's development levels. The assessment was observed while teachers and children actively participated in the activities. Each lesson was structured to take approximately 30 minutes to complete. 13 lesson plans units (19 lessons included) were developed covering development goals outlined in figure 1.

The assessors accessed the lesson plans from little lab platform, downloaded them and shared with teachers before the assessment so that they could prepare the lessons, ask questions and arrange for the required resources. While the teachers delivered lessons, assessors filled out the students' evaluation moments and recorded in the little lab platform using their unique login details on little lab accessed on their smart phones/laptops/tablets. AEOs were asked to conduct two classroom observations of the grade 1 teachers in all 50 schools using the COT in practice in public primary schools in Punjab, attached as Annexure-C. The students and teacher evaluation, together, ensured a consistent and thorough evaluation processes across all schools.

BTAG team and QAED's representatives conducted monitoring visits to ensure smooth conduct of the assessment, resolve any issues and provide ongoing support to teachers and assessors.

Figure 18: Students demonstrating their work

Figure 18: Students engaged in assessment activities

Figure 18: Students showing creative work during assessment

Figure 18: Assessors observing students during pre-assessment

4.8 Development of lesson plans

Once the Pre-Assessment data were gathered, the following steps were conducted to analyse the data and understand the children's levels in Development Goals prior to the pilot launch.

Steps to Determine Each Child's Level in Developmental Goals

Step 1: Determine Levels for Goals with Sub Goals and Elements

For Developmental Goals with sub-goals and elements (e.g., English, Math, Executive Function, and Motor Skills), these steps were followed:

1. **Assign Weightage**: The weightages were assigned to each sub-goal and element within our English, Math, Executive Function, and Motor Skills goals. Higher weightages were assigned to skills primarily taught in schools to accurately assess the children's levels based on their previous learning experience at school.
2. **Calculate Weighted Scores**: A weighted score was calculated for the development goals.
3. **Transform Goals into Levels**: Once the weighted scores were obtained, these were transformed into levels based on predefined criteria. Four different levels were defined presented in Table 2.

Level 1	Sprouts
Level 2	Buds
Level 3	Blossoms
Level 4	Blooms

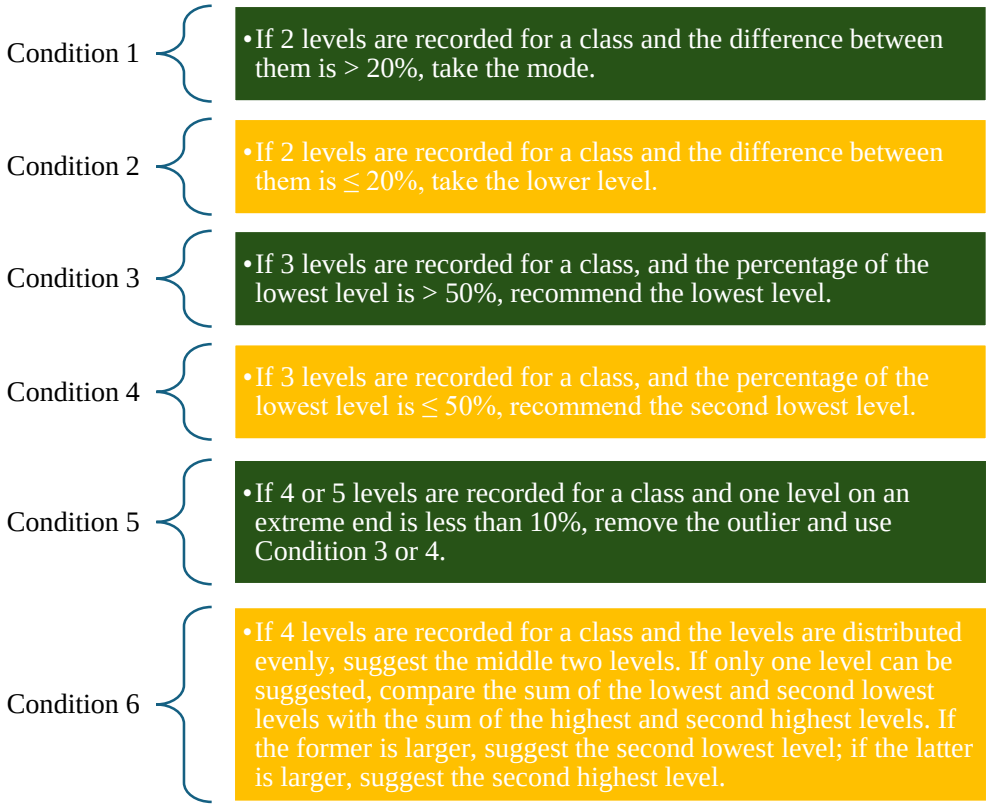
Table 2: Four different assigned levels

Step 2: Determine Levels for Goals without Sub Goals

For Developmental Goals without sub-goals, levels were directly determined based on raw data.

Steps to Determine Each School/Class's Level in Each Development Goal

1. **Aggregate Individual Levels**: The levels of each child in the class were collected.
2. **Determine the Level of the Class**: The following conditions were used to determine the class level:



The results from the pre-assessment were thus gathered. The results provided comprehensive information about each school's levels across various Developmental Goals. Based on the gathered data, lessons were assigned to match the children's levels in the Heart, Head, and Hands areas. The following Developmental Goals were included in the lessons:

Heart: Confidence, Creativity, Empathy, Perseverance & Grit, Communication Skills, Self-Regulation, Integrity

Head: Executive Function, Numeracy & Math Concepts, English Language & Literacy, STEAM, Gross Motor Skills, Fine Motor Skills

Hands: Global Perspectives, Environmental Responsibility, Public Speaking & Advocacy, Gratitude & Giving Back, Practical Life Skills, Interdependence, Social Awareness

Little Lab is a proponent of the ethical building of AI systems. To accomplish this, it is crucial to have human oversight and involvement into the Recommendations Engine employed by the platform. This is especially important when applying this recommendations engine to student populations with different demographic details than the Little Lab's initial training data set. As such, a dedicated curriculum team has oversight and involvement in the recommendations engine's output and provides an added layer of support in the selection of lessons and projects at each of its pilot schools.

During the pilot implementation in Punjab, Pakistan, the Trehaus team utilised its Recommendations Engine to help the teachers and administrators select lessons and projects for their classrooms. Its curriculum team was heavily involved in the oversight of these recommendations and provided additional support in project and lesson selection for these classrooms.

As Little Lab continues to grow its data set, the strength and autonomy of the Recommendations Engine will continue to grow as it builds more diverse demographic representation into its models and continues to test the strength of the model's output.

Little Lab plans to continue to grow how the platform utilises AI by incorporating GenerativeAI to create new lessons and project content, which will allow for additional customisation of lessons to the interests of the students in each classroom.

4.9 Launch of the pilot

Teachers were directed to start the recommended lesson plans from April 15, 2024. BTAG team and QAED's representatives kept on overseeing teachers' performance on the platform regularly. Teachers and volunteers were provided ongoing support in the following ways:

i. **Monitoring and Support visits to schools:** To ensure effective implementation of the pilot, AEOs were given an orientation of the pilot and were directed to support teachers during their regular school visits. Additionally, informed by the teachers' performance data on the platform, the teams visited treatment schools, observed classroom activities, provided on-the-spot support to teachers, and collected feedback on the challenges and successes of the intervention.

ii. **Regular meetings with teachers and volunteers:** To maintain a consistent flow of communication and address emerging issues promptly, regular meetings were held with teachers and volunteers. Online meetings were conducted twice every week, allowing participants to discuss progress, share experiences, and troubleshoot problems specific to the

lesson plans and platform. Additionally, one physical session was held mid-way through the pilot, focusing specifically on identifying challenges and collaboratively developing solutions. These meetings fostered a supportive environment and facilitated continuous improvements throughout the pilot phase.

iii. **Informal WhatsApp Community:** To promote peer support and collaborative learning among teachers, a WhatsApp group was formed. Through this platform, teachers and volunteers were able to connect, share resources, ask questions, and provide mutual support. The Community of practice developed through these activities proved invaluable in addressing day-to-day challenges, sharing best practices, and enhancing the overall effectiveness of the program.

Figure 19: Sajid Ali delivering recommended lesson plan at GHS Bahari Colony Green Town with the help of a community volunteer

Out of 10, only 7 volunteers continued supporting teachers till the conclusion of the pilot. The remaining three left because they found better job opportunities as the pilot only offered short-term engagement and no financial incentive.[9]

4.10 Conduct of Post-Assessment

Due to the unexpected school closure amidst extreme hot weather, teachers were directed to conclude the pilot earlier than expected. This resulted in the preponement of the post assessment, which was conducted from 22nd to 24th May, 2024, similar to pre-assessment. Similar to pre-assessment, Little Evaluator Module was utilised with 19 lessons observed by the same assessors. Separately, AEOs conducted classroom observations using COT.

The pilot ran its course for around 6 weeks.

[9] The community volunteers were provided with travel arrangements and incentives, which included recognition, training, and certification.

4.11 Assessing the Effectiveness of the Pilot

A detailed analysis of the post assessment was conducted based on the analysis framework. Student performance in both control and treatment schools was recorded and analysed before and after the intervention to assess differences in achievement across various intervention groups. The impact of teaching practices, volunteer engagement, student age, and technology uptake on student performance was also examined. Online perception surveys on effectiveness and utility of the lesson plans, platform and technology uptake were administered with all teachers in treatment schools. Qualitative data was also collected from teachers and volunteers. Results were analysed and are presented in section 5.

Figure 20: : Students engaged in post-assessment activities

5

Results & Analysis

To assess the effectiveness of the intervention, a variety of strategies were employed throughout the duration of the pilot. These strategies aimed to provide valuable insights into the effectiveness of the pilot and develop recommendations and way forward. The subsequent section provides an analysis of the findings.

5.1 Pre-Post Analysis within Treated Groups

This section provides the pre-post impact analysis for students in all treatment groups by comparing share of children at the highest level of learning before and after the intervention. Overall, there is a positive impact of piloted intervention with percentage share of students in Blooms (highest of the four learning levels) increasing **from 51.6% at the baseline (before the intervention) to 69% at the endline (after the intervention).**

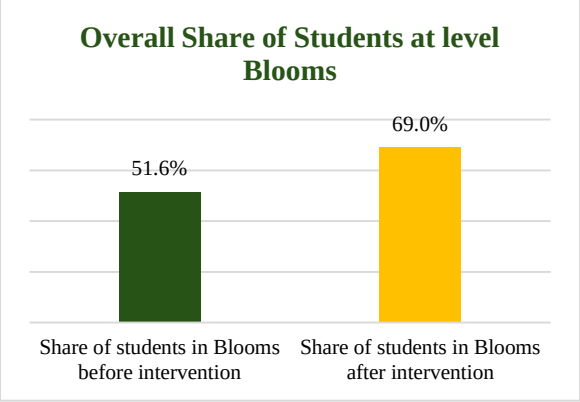


Figure 21: Overall share of students at the highest level (blooms) in baseline and endline

Disaggregation by our three key variables of interest (i.e., Literacy, Numeracy, and STEAM) also show that the treatment has been positively impacted depicted by an increase in share of students at the highest learning levels for all three development goals. Specifically, the share of students at the highest learning level in:

- English language & literacy increased from **37 % in baseline to 53 % in endline,**
- Numeracy & Math skills increased from **52 % in baseline to 64 % in endline**, and
- STEAM increased from **31% in baseline to 58 % in endline.**

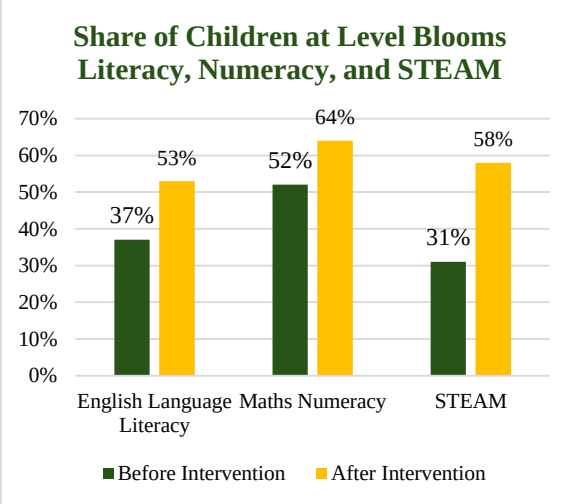


Figure 22: Share of children at highest level (bloom) in English, Math and STEAM

Further analysis of treatment subgroups confirms the overall findings and shows that treatment subgroup number 3 i.e., schools with community volunteers, despite relatively higher enrolments, have seen larger impacts.

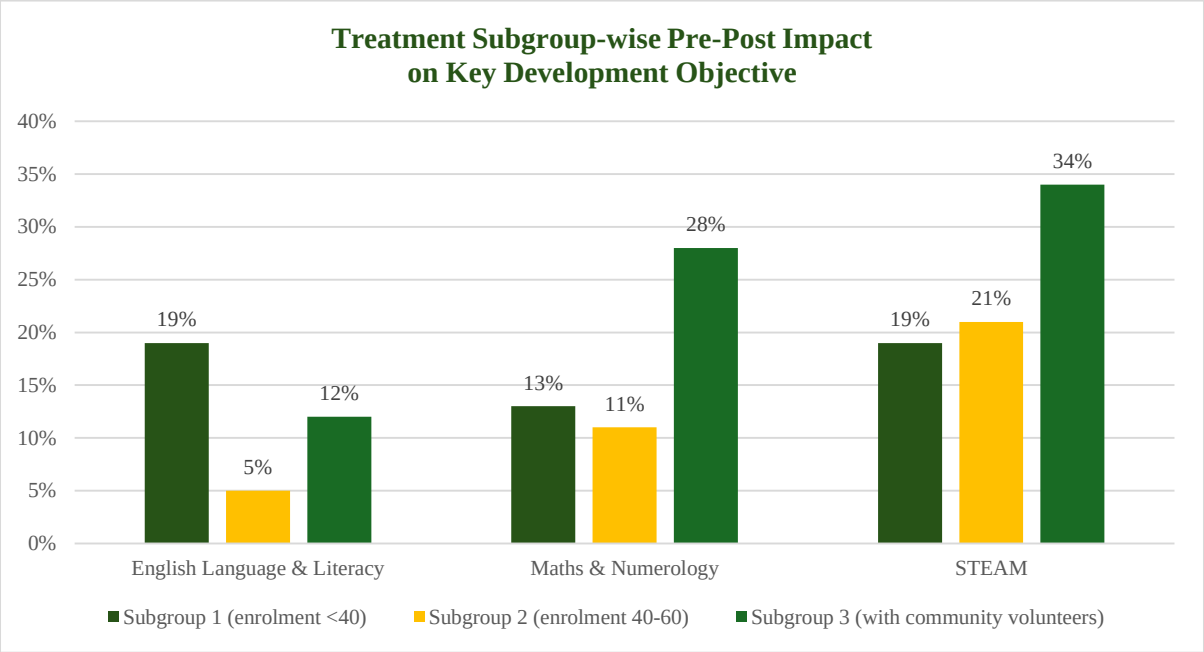


Figure 23: % increase in share of children at blooms for three key development goals for each treatment group

Overall (for all three treatment subgroups combined), the share of children at highest level of learning has increased for 19 out of 20 development goals after intervention. The effect size ranges between 6% for fine motor skills and 43% for communication skills.

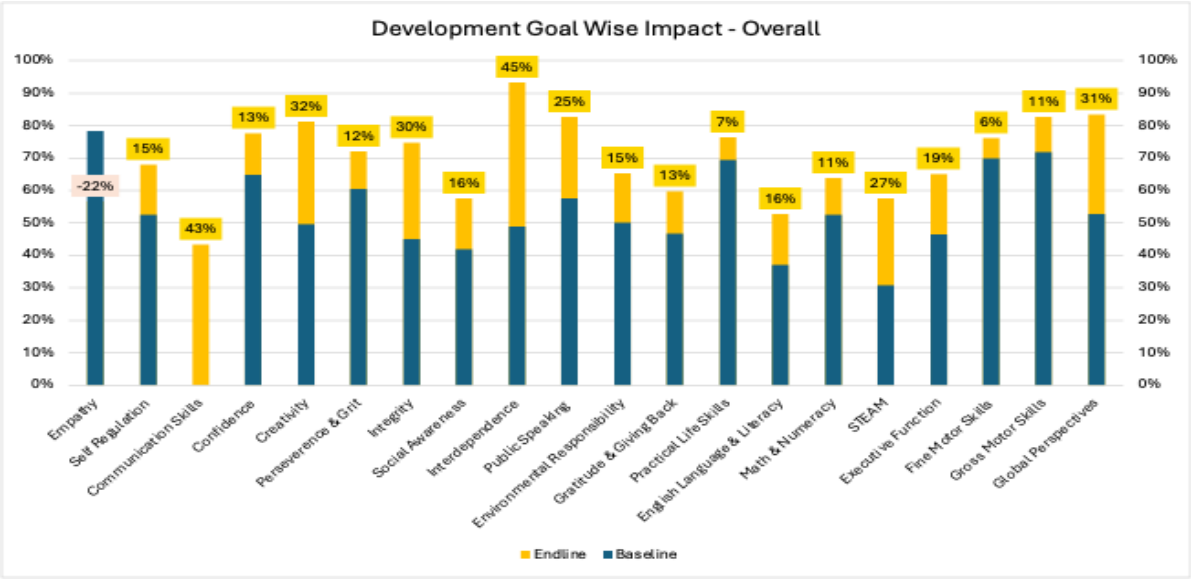


Figure 24: Overall share of children at highest level of learning (blooms) at baseline and endline for every development goal

For treatment subgroup-1 (where enrolment was up to 40), share of children at highest level of learning has increased for all development goals after intervention, except for Empathy, Social Awareness and confidence.

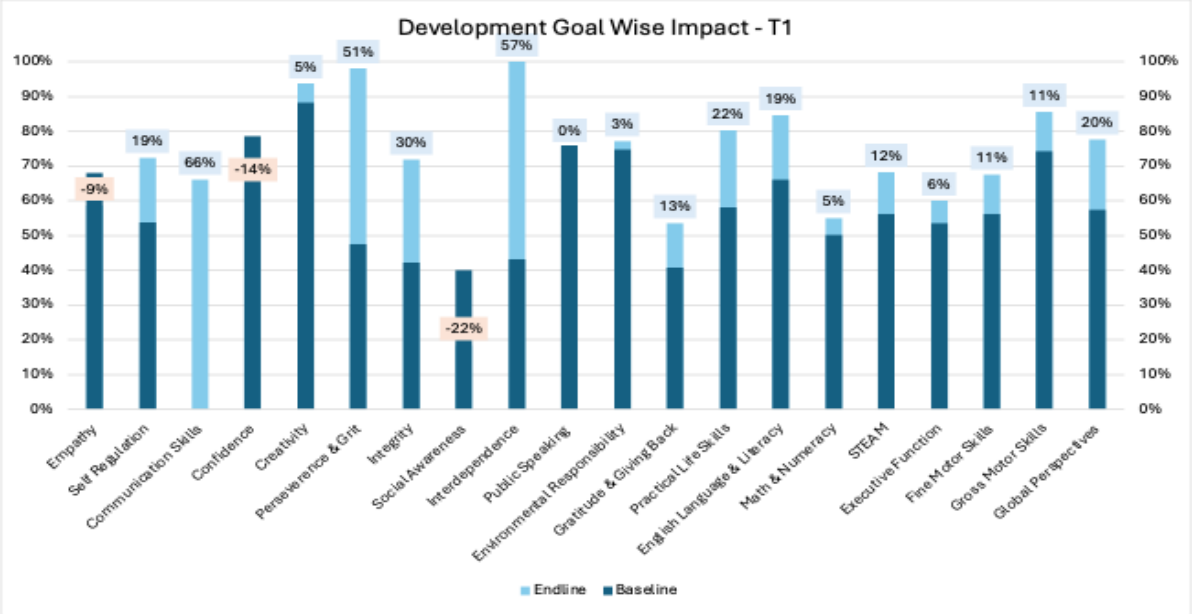


Figure 25: Share of children at highest level of learning (blooms) at baseline and endline for every development goal for treatment group 1

For treatment subgroup-2 (where enrolment was between 40 and 60), share of children at highest level of learning has increased for 18 out of 20 development goals.

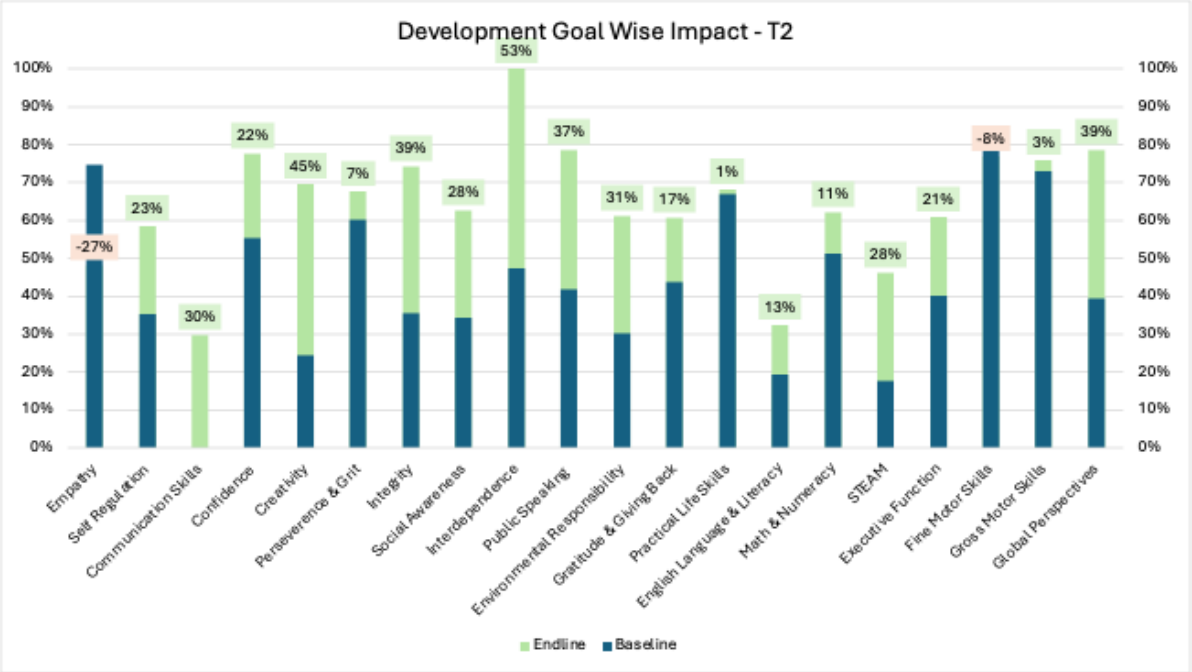


Figure 26: Share of children at highest level of learning (blooms) at baseline and endline for every development goal for treatment group 2

For treatment subgroup-3 (where enrolment was between 40 and 60 and community volunteers were engaged), share of children at highest level of learning has increased substantially for majority of the development goals.

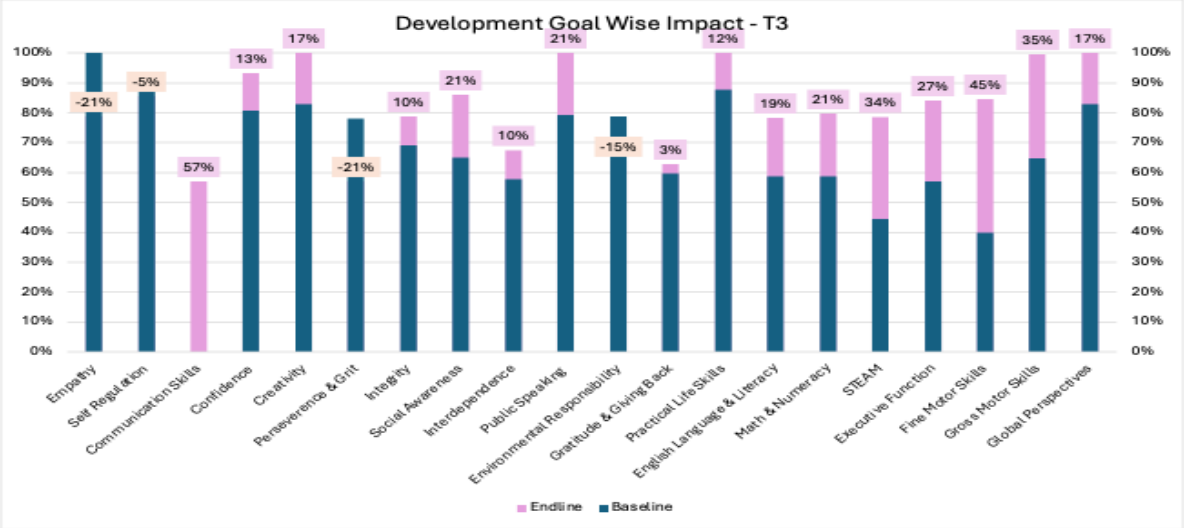


Figure 27: Share of children at highest level of learning (blooms) at baseline and endline for every development goal for treatment group 3

5.2 Regression Analysis for Treatment vs Control

This section presents detailed analysis utilising DiD approach to account for variance across control and treated group prior to intervention and over time. Results from regression analysis provide insights on impact of intervention in comparison to the control group.

Regression analysis has been conducted using DiD approach using student level data of pre and post assessments for both treatment and control groups. This approach helps to isolate the treatment effect on treated group in comparison with control group while controlling for unobserved confounders. The DiD approach is the best suited in this case as it also accounts for any baseline differences between control and treatment group, given common time trend between two groups. By focusing on changes (differences) rather than just levels, the DiD controls for any initial disparities between treatment and control groups that could confound the treatment effect.

Overall, the results from regression show that, on average, the treatment has a **statistically significant impact.**

The regression results also reveal that:

i. On average, learning levels of students in the control group have decreased for Literacy, Numeracy, and STEAM over time when compared with the baseline.
ii. The treatment group, on average, started lower than control.[10] The average learning levels for students in treatment group for Literacy and Numeracy were below compared to the control group at

[10] 86.3% students in the control group were already at learning level 3 or above as compared to 79.6% of the total students in treatment group at the same levels. On the other hand, 20.4% students in treatment group were at learning level 2 or below as compared to only 13.7% students at the same levels in the control group.

the baseline. For STEAM, the difference between treatment and control was statistically insignificant yet negative at the baseline.

We ran five variations of DiD regressions including the base model (Model-1), presented in the tables below. The variations, included

- **Model-2:** inclusion of COT scores to observe how teaching practices impact student learning,
- **Model-3:** inclusion of Internet usage by teachers to observe how the usage of technology by teachers is related with learning of their students,
- **Model-4:** inclusion of AI recommendations as used by teachers to measure any additional impact on students' performance, and
- **Model-5:** inclusion of students' ages to observe how age impacts student's performance.

Model-1 Results

Model-1 looks at the treatment effect by comparing results of treatment groups with control groups. Overall results show statistically significant impact on the treatment groups when compared with control groups.

Sr. No.	Variable (Development Goal)	Time (Difference in Control Group Over Time)	Treatment Group (Baseline Difference of Treatment with Control)	1.Time#1.Treatment Group (Impact of Intervention)	Constant	No. of Observations	R-squared
1	2	3	4	5	6	7	8
(1)	Empathy	0.627***	1.039***	-0.875***	2.578***	3,322	0.152
(2)	Self-Regulation	0.984***	0.531***	-0.749***	2.748***	2,496	0.132
(3)	Communication Skills	0.242***	-0.164***	0.171**	2.717***	3,318	0.037
(4)	Confidence	0.886***	0.800***	-0.683***	2.584***	3,348	0.155
(5)	Creativity	0.753***	0.498***	-0.392***	2.785***	3,434	0.133
(6)	Perseverance Grit	0.980***	0.382***	-0.835***	2.927***	3,197	0.123
(7)	Integrity	0.152***	0.245***	0.163***	3***	3,075	0.053
(8)	Social Awareness	0.419***	0.374***	-0.335***	3***	3,162	0.063
(9)	Interdependence Relationship	0.815***	0.462***	-0.212***	2.815***	2,476	0.224
(10)	Public Speaking Advocacy	0.980***	0.579***	-0.717***	2.691***	3,110	0.113
(11)	Environmental Responsibility	0.468***	0.448***	-0.154*	2.484***	3,101	0.049
(12)	Gratitude	0.634***	0.356***	-0.546***	2.958***	3,024	0.062
(13)	Practical Life Skills	0.637***	0.645***	-0.488***	2.796***	3,273	0.108
(14)	Global Perspectives	1.025***	0.492***	-0.591***	2.725***	3,037	0.177
(15)	Literacy	-0.741***	-0.830***	1.037***	3.672***	3,449	0.072
(16)	Numeracy	-0.216***	-0.644***	0.349***	3.753***	3,488	0.053
(17)	STEAM	-0.299***	-0.0129	0.390***	3.232***	3,234	0.031
(18)	Executive Function	-0.344***	-0.419***	0.554***	3.457***	3,488	0.019
(19)	Fine motor skills	0.240***	-0.258***	-0.237***	3.753***	3,488	0.060
(20)	Gross motor skills	-0.559***	-0.533***	0.823***	3.995***	3,488	0.060

Table 3: Regression Analysis - Model 1

Coefficient on time*treatment i.e., column 5 in the table 3 provides the effect of treatment on treated groups as compared to control group. On average, results show positive and statistically significant impact of

- +1.037 levels improvement in literacy,
- +0.349 levels improvement in numeracy, and
- +0.390 levels improvement in STEAM.

Model-2 Results

Model-2 looks at the relationship between teaching quality and learning levels of students in treatment groups. Teaching quality was measured through teachers' scores on 11 teaching practices of COT. Overall results are presented in table 4.

Sr. No.	Variable (Development Goal)	Time (Difference in Control Group Over Time)	Treatment Group (Baseline Difference of Treatment with Control)	1.Time#1.Treatment Group (Impact of Intervention)	COT Score (Impact of Teaching Practices)	Constant	No. of Observations	R-squared
1	2	3	4	5	6	7	8	9
(1)	Empathy	0.625***	0.833***	-0.782***	0.259***	1.781***	2,235	0.141
(2)	Self-Regulation	0.964***	0.542***	-0.745***	0.0708***	2.517***	1,668	0.132
(3)	Communication Skills	0.424***	-0.0170	-0.0552	0.235***	1.833***	2,185	0.072
(4)	Confidence	0.833***	0.745***	-0.624***	0.156***	2.063***	2,300	0.143
(5)	Creativity	0.740***	0.448***	-0.321***	0.157***	2.307***	2,289	0.181
(6)	Perseverance Grit	1.088***	0.532***	-0.862***	0.276***	1.865***	2,268	0.209
(7)	Integrity	0.310***	0.0792**	0.372***	0.277***	1.968***	2,101	0.146
(8)	Social Awareness	0.512***	0.424***	-0.469***	0.203***	2.245***	2,155	0.105
(9)	Interdependence Relationship	0.921***	0.316***	-0.0972	0.263***	1.865***	1,653	0.289
(10)	Public Speaking Advocacy	1.095***	0.854***	-0.924***	-0.0697***	2.912***	1,922	0.228
(11)	Environmental Responsibility	0.769***	0.414***	-0.348***	0.456***	0.783***	1,949	0.132
(12)	Gratitude	0.688***	0.219***	-0.330***	0.331***	1.709***	2,104	0.150
(13)	Practical Life Skills	0.764***	0.414***	-0.525***	0.355***	1.521***	2,160	0.141
(14)	Global Perspectives	0.739***	0.362***	-0.301***	0.0577***	2.744***	1,895	0.164
(15)	Literacy	-0.761***	-0.823***	1.092***	0.281***	2.701***	2,261	0.132
(16)	Numeracy	-0.157***	-0.485***	0.175***	0.0844***	3.583***	2,300	0.056
(17)	STEAM	-0.334***	-0.229***	0.691***	0.235***	2.440***	2,091	0.138
(18)	Executive Function	-0.297***	-0.511***	0.587***	0.379***	2.173***	2,300	0.089
(19)	Fine motor skills	0.132***	-0.220***	0.0186	0.0385***	3.729***	2,300	0.044
(20)	Gross motor skills	-0.525***	-0.434***	0.600***	-0.0773***	4.281***	2,300	0.043

Table 4: Regression Analysis - Model 2

Model 2 results confirm overall findings from base model (model-1) with all three coefficients being positive and statistically significant, concluding that the intervention has a positive impact on learning of students. Column-6 in table 4 provides relationship between teaching quality and student learning. It shows that every one-unit increase (i.e., +1 in average COT score) brings an average

- +0.281 levels improvement in literacy,
- +0.084 levels improvement in numeracy, and
- +0.235 levels improvement in STEAM

Model-3 Results

Model-3 looks at the relationship between Internet usage[11] (taken as proxy for access, familiarity and usage of technology) by teachers with learning levels of their students. Overall results further confirm the findings on impact of intervention.

Sr. No.	Variable (Development Goal)	Time (Difference in Control Group Over Time)	Treatment Group (Baseline Difference of Treatment with Control)	1.Time#1.Treatment Group (Impact of Intervention)	Internet (Impact of Teachers using Internet at home)	Constant	No. of Observations	R-squared
1	2	3	4	5	6	7	8	9
(1)	Empathy	0.549***	1.123***	-0.827***	0.446***	2.066***	2,548	0.183
(2)	Self-Regulation	0.908***	0.342***	-0.560***	0.562***	2.287***	1,916	0.161
(3)	Communication Skills	0.364***	-0.0554	0.0623	0.619***	2.070***	2,544	0.086
(4)	Confidence	0.786***	0.731***	-0.584***	-0.0436	2.616***	2,696	0.126
(5)	Creativity	0.796***	0.631***	-0.537***	0.423***	2.339***	2,679	0.159
(6)	Perseverance Grit	0.975***	0.460***	-0.862***	0.714***	2.233***	2,565	0.170
(7)	Integrity	0.250***	0.202***	0.184***	0.602***	2.431***	2,301	0.103
(8)	Social Awareness	0.393***	0.347***	-0.186***	0.473***	2.550***	2,425	0.112
(9)	Interdependence Relationship	0.691***	0.499***	0.0349	0.546***	2.307***	1,926	0.338
(10)	Public Speaking Advocacy	1.125***	0.795***	-1.119***	0.938***	1.793***	2,506	0.211
(11)	Environmental Responsibility	0.318***	0.538***	-0.173*	0.259***	2.253***	2,497	0.047
(12)	Gratitude	0.552***	0.306***	-0.365***	0.0295	2.921***	2,410	0.058
(13)	Practical Life Skills	0.568***	0.668***	-0.392***	0.411***	2.432***	2,566	0.146
(14)	Global Perspectives	1.137***	0.609***	-0.851***	-0.0677	2.725***	2,433	0.169
(15)	Literacy	-0.711***	-0.635***	0.782***	0.810***	2.898***	2,675	0.106
(16)	Numeracy	-0.290***	-0.582***	0.445***	0.696***	3.069***	2,714	0.091
(17)	STEAM	-0.344***	-0.0551*	0.393***	0.167***	3.115***	2,522	0.035
(18)	Executive Function	-0.350***	-0.334***	0.439***	0.751***	2.742***	2,714	0.052
(19)	Fine motor skills	0.290***	-0.116***	-0.315***	0.420***	3.302***	2,714	0.079
(20)	Gross motor skills	0.549***	1.123***	-0.827***	0.446***	2.066***	2,548	0.183

Table 5: Regression Analysis - Model 3

Column-6 in table 5 provides relationship between internet usage by teachers and student learning. It shows that if teachers use internet at home, learning levels of their students, on average, increase by:

- +0.81 levels for literacy,
- +0.696 levels for numeracy, and
- +0.167 levels for STEAM

[11] This group consists of students of teachers who use Internet at home. 26 out of 30 teachers (86.67 %) reported using Internet at home.

Model-4 Results

Model-4 includes the usage of AI recommendations by teachers to capture the additional impact on treated group[12]. The model used a triple interaction term to isolate the impact of AI usage on treated group in comparison with control group and rest of the treated group over time. However, some coefficients on certain interaction terms are omitted from the table 6 to maintain focus on key factors of interest, ensuring clarity and relevance.

Sr. No.	Variable (Development Goal)	Time (Difference in Control Group Over Time)	Treatment Group (Baseline Difference of Treatment with Control)	1.Time#1.Treatment Group (Impact of Intervention)	AI (Impact of AI Usage by Teachers)	Constant	No. of Observations	R-squared
1	2	3	4	5	6	7	8	9
(1)	Empathy	0.786***	1.170***	-1.118***	2.098***	2.534***	3,322	0.194
(2)	Self-Regulation	1.046***	0.735***	-1.020***	1.393***	2.711***	2,496	0.174
(3)	Communication Skills	0.447***	-0.222***	0.0276	1.858***	2.688***	3,318	0.110
(4)	Confidence	1.081***	1.009***	-0.913***	2.234***	2.541***	3,348	0.263
(5)	Creativity	0.897***	0.464***	-0.544***	1.577***	2.763***	3,434	0.181
(6)	Perseverance Grit	1.081***	0.282***	-0.899***	0.946***	2.919***	3,197	0.164
(7)	Integrity	0.363***	0.266***	-0.0745	2.360***	3***	3,075	0.157
(8)	Social Awareness	0.494***	0.401***	-0.501***	1.994***	3***	3,162	0.120
(9)	Interdependence Relationship	0.887***	0.482***	-0.311***	0.847***	2.795***	2,476	0.234
(10)	Public Speaking Advocacy	0.977***	0.505***	-0.648***	-0.262***	2.656***	3,110	0.131
(11)	Environmental Responsibility	0.747***	0.381***	-0.324***	2.331***	2.426***	3,101	0.121
(12)	Gratitude	0.886***	0.323***	-0.845***	2.720***	2.954***	3,024	0.234
(13)	Practical Life Skills	0.771***	0.622***	-0.585***	1.262***	2.774***	3,273	0.143
(14)	Global Perspectives	1.135***	0.435***	-0.633***	0.808***	2.693***	3,037	0.201
(15)	Literacy	-0.633***	-0.861***	0.961***	1.001***	3.638***	3,449	0.087
(16)	Numeracy	-0.192***	-0.715***	0.393***	-0.0355	3.727***	3,488	0.064
(17)	STEAM	-0.217***	0.0110	0.224***	1.181***	3.256***	3,234	0.074
(18)	Executive Function	-0.109*	-0.391***	0.377***	2.260***	3.400***	3,488	0.069
(19)	Fine motor skills	0.265***	-0.254***	-0.301***	0.435***	3.727***	3,488	0.069
(20)	Gross motor skills	-0.617***	-0.476***	0.918***	-0.776***	3.994***	3,488	0.087

Table 6: Regression Analysis - Model 4

Overall, as did the other variations, this model also confirms the findings in terms of impact of intervention in positively affecting student learning levels.

[12] This group includes students of the schools within the treatment groups where teachers implemented more than 90 % of the recommended lesson plans. A total of 8 schools were part of this group including GHS Badoki, GPS Kamahan, GHS Theh Panjoo. GGPS Younas Abad, GGES Central Model CGE Colony Wah. GPS Ali Raza Abad Tehsil Model Town, GHS Bahari Colony Green Town and GGPS Islam Pura.

Column-6 in table 6 provides additional impact of AI usage on student learning levels. It shows that by using AI in teaching, the learning levels of students increase, over and above the treatment effect by an average of:

- +1.001 levels for literacy, and
- +1.181 levels for STEAM

However, there is insufficient evidence to statistically establish the impact of AI recommendations usage on numeracy.

Model-5 Results

Model-5 looks at the relationship between students' ages with their learning levels.

Sr. No.	Variable (Development Goal)	Time (Difference in Control Group Over Time)	Treatment Group (Baseline Difference of Treatment with Control)	1. Time#1.Treatment Group (Impact of Intervention)	Age (Impact of Student Age)	Constant	No. of Observations	R-squared
1	2	3	4	5	6	7	8	9
(1)	Empathy	0.627***	1.038***	-0.875***	-0.00705	2.635***	3,321	0.152
(2)	Self-Regulation	0.982***	0.535***	-0.751***	0.0219**	2.570***	2,496	0.134
(3)	Communication Skills	0.242***	-0.165***	0.170**	-0.00378	2.748***	3,317	0.037
(4)	Confidence	0.886***	0.798***	-0.681***	-0.00894	2.657***	3,348	0.155
(5)	Creativity	0.753***	0.494***	-0.389***	-0.0169**	2.923***	3,433	0.134
(6)	Perseverance Grit	0.980***	0.377***	-0.831***	-0.0276***	3.153***	3,197	0.125
(7)	Integrity	0.152***	0.240***	0.166***	-0.0221**	3.182***	3,074	0.055
(8)	Social Awareness	0.421***	0.366***	-0.333***	-0.0325***	3.266***	3,161	0.069
(9)	Interdependence Relationship	0.815***	0.462***	-0.212***	-0.00328	2.842***	2,476	0.224
(10)	Public Speaking Advocacy	0.980***	0.575***	-0.711***	-0.0289***	2.928***	3,109	0.115
(11)	Environmental Responsibility	0.468***	0.444***	-0.150*	-0.0284**	2.717***	3,100	0.051
(12)	Gratitude	0.634***	0.354***	-0.545***	-0.01000	3.041***	3,024	0.062
(13)	Practical Life Skills	0.637***	0.645***	-0.489***	0.00174	2.781***	3,272	0.108
(14)	Global Perspectives	1.025***	0.489***	-0.588***	-0.0216**	2.901***	3,036	0.178
(15)	Literacy	-0.741***	-0.832***	1.037***	-0.00878	3.744***	3,448	0.072
(16)	Numeracy	-0.216***	-0.645***	0.351***	-0.00456	3.790***	3,487	0.053
(17)	STEAM	-0.299***	-0.0113	0.388***	0.00841	3.163***	3,233	0.032
(18)	Executive Function	-0.344***	-0.423***	0.559***	-0.0196*	3.617***	3,487	0.020
(19)	Fine motor skills	0.241***	-0.266***	-0.228***	-0.0428***	4.103***	3,487	0.068
(20)	Gross motor skills	-0.559***	-0.535***	0.825***	-0.0109	4.084***	3,487	0.060

Table 7: Regression Analysis – Model-5

Age of student is not significantly related with most (i.e., 10 out of 20) development goals. For rest, it shows limited effects with small magnitudes. Specifically, it positively affects the self-regulation, while has negative association with creativity, perseverance & grit, integrity, social awareness, public speaking, environmental responsibility, global perspectives, executive function and fine motor skills.

Additionally, no statistically significant relation of school region (urban, rural), school type (male, female) or school level (primary, elementary, high) was observed with learning levels of children. This further confirms that the intervention was equally successful regardless of the age of students, school region, school type and school level.

5.3 Teachers' Perception

Participants' opinions were gathered through various methods to ensure comprehensive feedback. Data was collected from teachers and community volunteers to assess their perspectives on the platform's usability, the integration of technology in teaching practices, the quality of lesson plans, and their alignment with learning objectives. Discussions were organised with teachers, volunteers, headteachers, and assessors to gather qualitative feedback, gain insights into implementation challenges, and develop a way forward. The findings from these surveys and discussions provide valuable data, offering a nuanced understanding of how the intervention was perceived by all stakeholders. These insights are detailed below:

Platform Utility

The "Little Lab Feature Usage Survey" was designed to assess the platform's utility among participants. The survey was administered online and included 31 participants from treatment schools, comprising all teachers and one community volunteer. Key aspects covered included the frequency of using features such as "lesson plans", the "teacher toolbox," the "announcement feature", and the "scheduler", among others. The survey is attached as Annexure-D.

The responses provided valuable insights into platform utilisation. Most teachers reported using the platform, lesson plans and teacher toolbox daily or weekly. Some teachers occasionally uploaded pictures. Detailed results are illustrated in the Figure 28.

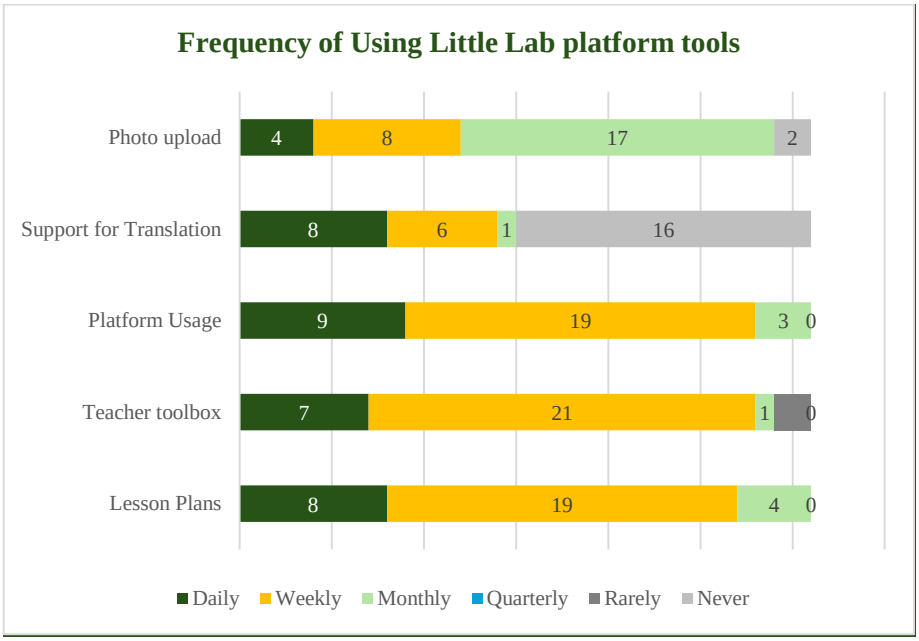


Figure 28: Teachers' usage of platform's functions

Other functions that the platform offered but were used very minimally for this pilot included 'Announcement' feature and 'messenger'.

When asked about their use of the "favourite" feature for lessons, 87 % of respondents answered positively, while 10% indicated they were not aware of this feature, as depicted in the figure 29.

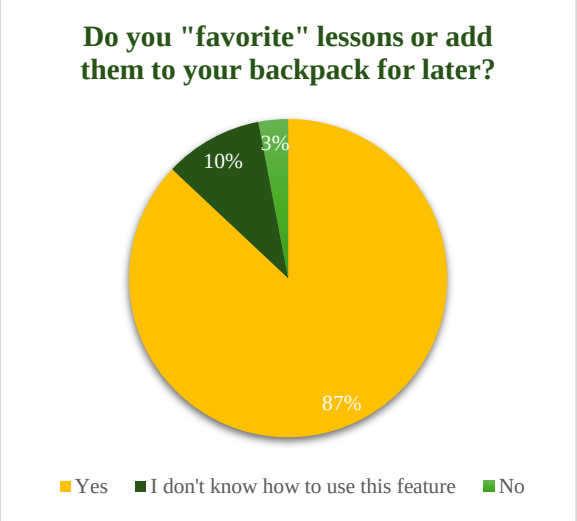


Figure 29:Use of 'favourite' feature in the platform

Additionally, participants were asked to rate their likelihood of recommending the platform to others on a scale from 0 to 10. Out of 31 participants, 14 rated 7 or above, indicating a high likelihood of recommendation. Twelve participants gave ratings between 4 and 6, while four participants rated the platform 3 or less. This reflects some participants' general discomfort with technology, including software and digital tools, which will be further explored in section 5.3 (ii).

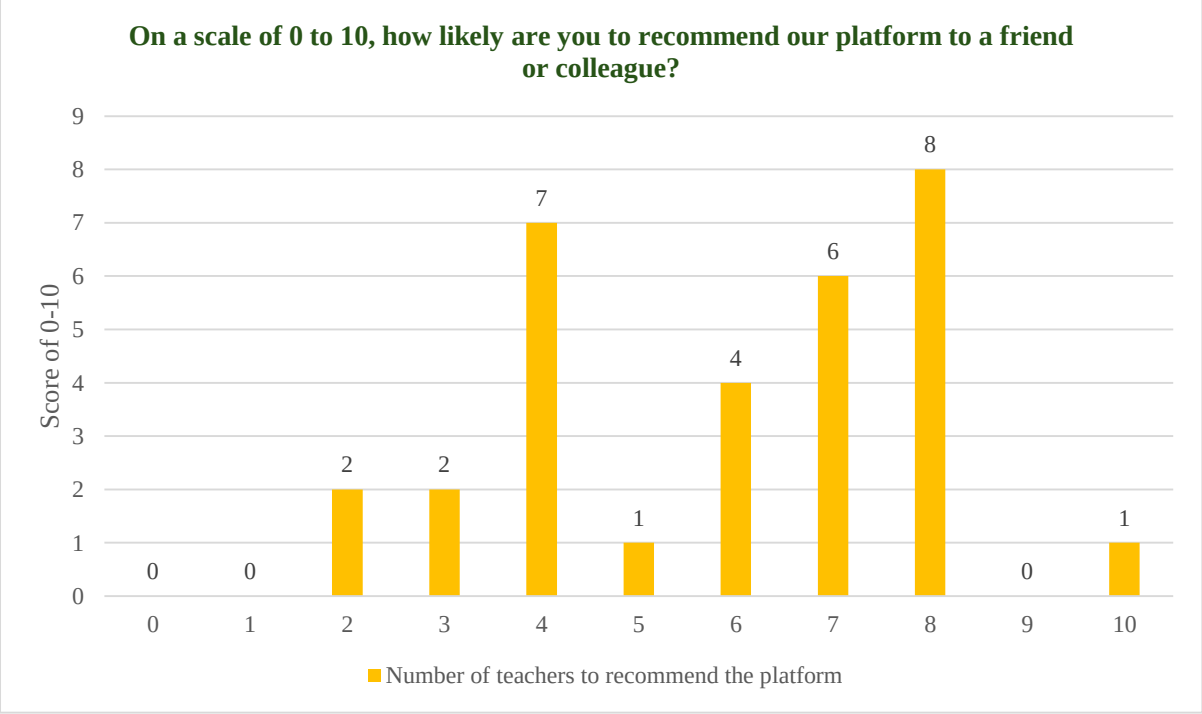


Figure 30: Recommending the platform

Participants also provided suggestions for new features they would like to see integrated into the platform, identifying areas for potential improvement and innovation.

Technology Use

Teachers were invited to share their perspectives on technology integration and its classroom impact. The survey is attached as Annexure-E. Out of 30 teachers from treatment schools, 21 participated in this survey. When questioned about their comfort levels with using technology, 55% of respondents reported feeling comfortable, while 45% indicated discomfort, as depicted in the figure 31.

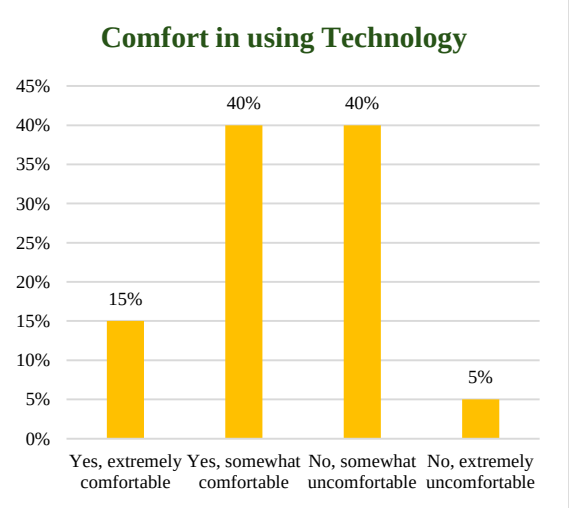


Figure 31: Teachers' comfort in using technology

When asked about their ease of using technology for this particular initiative, 25% reported finding it extremely easy, while 40% found it somewhat easy. Another 30% indicated that it was somewhat difficult, and 5% found it extremely difficult, as illustrated in the figure 32.

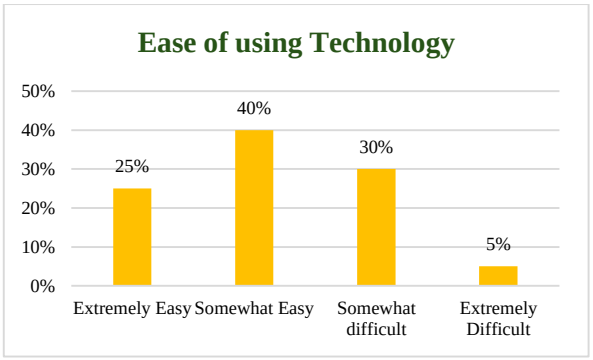


Figure 32: Teachers' ease of using technology

In response to the question regarding usefulness of technology, the majority of teachers reported finding it beneficial, with only 5% indicating that it was not useful at all, as depicted in the figure 33.

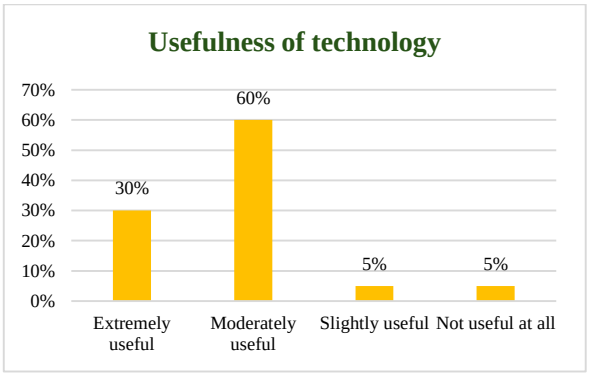


Figure 33: Teachers' perception regarding usefulness of technology

When discussing the impact of teaching practices and processes, the majority of teachers reported moderate improvements in their teaching practices and in addressing student needs. Additionally, there was a significant increase in their motivation to teach.

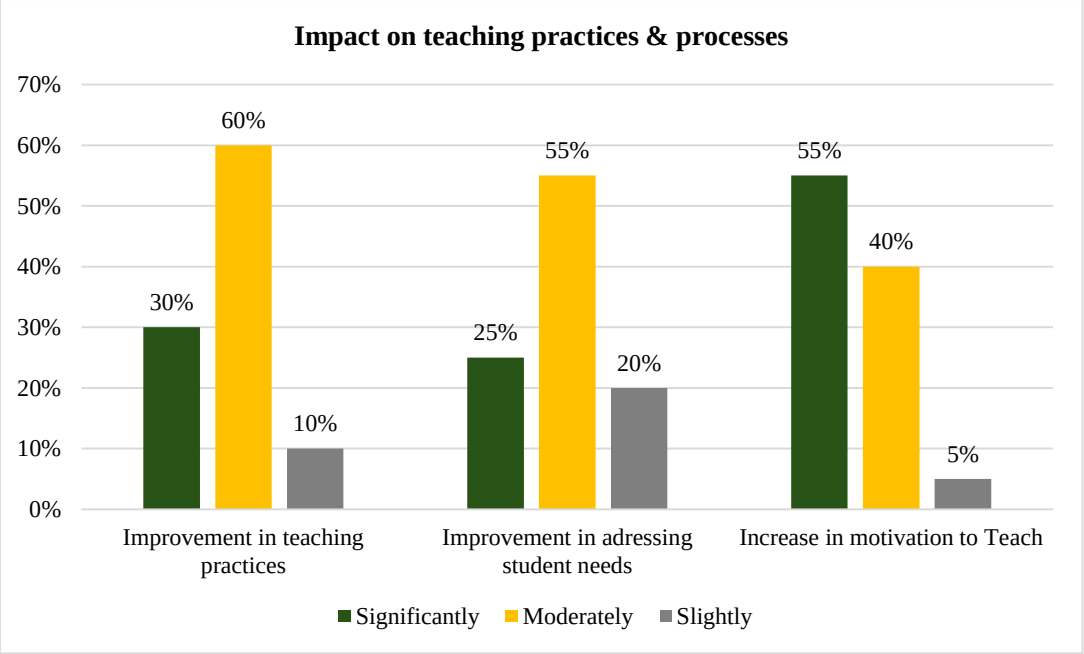


Figure 34: Teachers' perceptions regarding impact of technology

Regarding overall satisfaction with technology usage, the majority, comprising 66.7% (14 out of 21 teachers), reported being somewhat satisfied. Four teachers expressed being extremely satisfied, while three teachers indicated being somewhat dissatisfied. Detailed breakdown is provided in the figure 35.

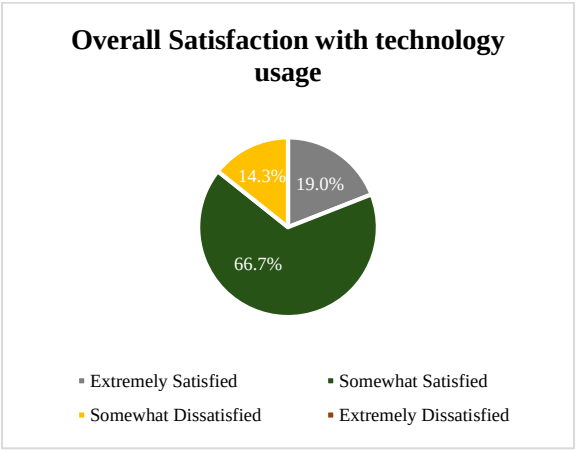


Figure 35: Self-reported satisfaction with technology

Participants also provided feedback on the challenges they faced in the implementation of technology-based solutions and suggested how technology could support teachers (reported in section 5.4).

Lesson plans Survey

Lesson plans surveys, attached as Annexure-F, were conducted through online one-on-one calls with teachers from treatment schools. Initially, teachers volunteered, and later, teachers and volunteers were invited randomly to join weekly calls with the curriculum team. Results are presented from 8 teachers who participated in these calls. Teachers were asked to rate their satisfaction with the lesson plans on a Likert scale of 1 to 5.

Responses were varied. Teachers expressed confidence in their ability to teach improved lessons using the recommended lesson plans, with ratings averaging above 4. However, they reported challenges in effectively utilising resources to deliver lessons, reflected in an average score of 2.75 for this aspect. These challenges often stem from the comprehensive nature of the lesson plans, which require resources not readily available in public school environments.

Figure 36 illustrates teacher satisfaction levels with the lesson plans on a scale of 1 to 5.

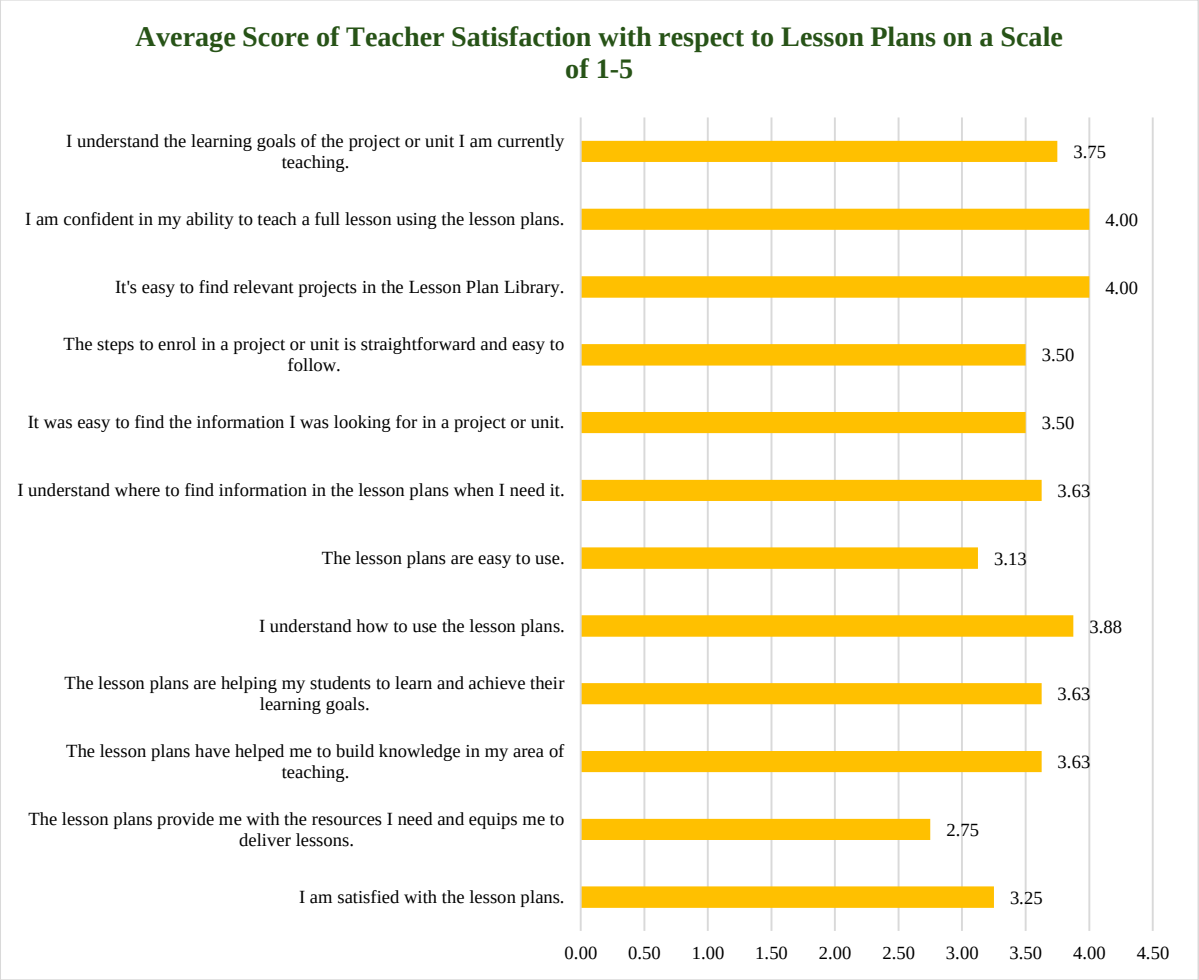


Figure 36: Teachers' self-reported satisfaction with the lesson plans

To supplement this analysis and develop a deeper understanding of the implementation challenges and quality concerns regarding the lesson plans, qualitative feedback was collected on various aspects of the lesson plans.

5.4 Qualitative Feedback

Qualitative feedback was gathered through open-ended survey questions as discussed in section 5.3. These questions aimed at eliciting responses on the platform, technology usage, and quality of the lesson plans, while also collecting suggestions for prospective improvements. Focused group discussions (FGDs) were conducted with all teachers and volunteers who participated in the intervention, addressing targeted questions to gain insights into project implementation. Online meetings with teachers further highlighted a range of experiences and perspectives from teachers involved in the project.

Additionally, during monitoring visits to all treatment schools, observations were recorded, and the team engaged with head teachers, teachers, and assessors to identify areas for improvement and challenges. Discussions also took place on a dedicated WhatsApp group, facilitating collaboration and the development of Communities of Practice (COPs) among teachers and assessors. These discussions were also analysed.

The analysis of the feedback revealed several key areas and nuances, which are detailed below.

Lesson Plans

Below we present feedback related to the design, relevance, and practicality of the lesson plans. Teachers and stakeholders provided insights into the creative and engaging aspects of the lesson plans, as well as highlighted concerns regarding the text and language used in lesson plans and the relevance of content to students' contexts. Additionally, challenges related to the availability and affordability of resources required for implementation of the lesson plans were highlighted. Details are given below:

Enhanced Teaching Efficiency

Teachers expressed appreciation for the platform's provision of well-structured lesson plans that include listed resources with clear instructions and are tailored to the needs of the students. This feature significantly facilitated the organisation of their classes, reducing the time and effort required for lesson planning and preparation. As a result, teachers were able to allocate more focus and energy towards effectively delivering their lessons to students.

Holistic Child Development through creative and engaging Lesson Plans

Teachers unanimously praised the creative and engaging nature of the lesson plans, noting how they made learning enjoyable for children. The activities included in the plans effectively captured students' interest, fostering a dynamic and interactive classroom environment that nurtured a love for learning. Furthermore, teachers expressed appreciation towards the emphasis on creating a physically active and engaging learning environment. Teachers also appreciated the integration of various aspects of child development including creativity, environmental responsibility and motor skills, among others. This facilitated a more effective teaching process, enabling teachers to impart diverse knowledge effectively across different learning domains.

One of the significant advantages of the intervention was its emphasis on project-based learning. With detailed lesson plans that prioritised creative learning through hands-on activities, they engaged students in an attractive and effective manner. Teachers appreciated how it emphasised environmental awareness, teaching children the importance of keeping their surroundings clean. Moreover, student-centred design of the plans ensured that learning aligned closely with each student's achievement level, fostering skill development tailored to individual needs. For a majority of teachers, the math portion stood out for its ability to build strong foundational knowledge, making complex subjects more accessible and enhancing overall study skills. This holistic approach not only educated but also inspired a deeper understanding and appreciation for learning among students.

Language of the LPs

Most of the participants agreed that lesson plans in Urdu would have been easier to understand and implement, given that English is not the first language of all teachers. Even though there was an option to view lessons in Urdu, the option to download them in Urdu wasn’t available. Participants suggested improvements in lesson plan design including reducing text-heavy content and integrating more graphics and visual aids to enhance clarity and ease of implementation for teachers. This could make lesson plans more user-friendly while ensuring meaningful learning experiences for all students.

Assessors highlighted challenges in conducting student assessment through the ‘evaluation moments’ embedded within the lesson plans. Some of these ‘evaluation moments’ were too lengthy and text heavy, making it difficult to implement them effectively, especially with limited assessment time and high STR.

Relevance of the LPs

The goal of Project-Based Learning (PBL) is to immerse learners in meaningful experiences supported by a conducive environment. This approach allows children to build a concrete understanding of concepts through authentic problem-solving experiences and real-world applications. Consequently, project-based lessons require materials beyond basic pencil and paper. The lesson plans recommended bringing concrete and relevant materials (or photographs of items, people, or events) into the classroom, especially when students could not leave the classroom. This supported the conversations, discussions, and investigations that drive children's learning and foster self-directed discoveries within the PBL framework.

To accommodate diverse cultural contexts, the lesson plans were designed to be as inclusive as possible. The recommended materials for activities were largely accessible and often natural resources that could be easily found. Alternatives to suggested items were provided to ensure flexibility in different contexts. Teachers were also supported in guiding children to express connections through drawings when resources were limited. Each lesson included scripts, questions, and supporting imagery where appropriate. For instances where site visits were recommended, alternative classroom-based activities were suggested to meet varying classroom needs. Furthermore, the lesson plans empowered teachers to tailor activities to their specific classroom environments, as well as to the abilities and needs of their students.

Some teachers successfully adapted the recommended materials, substituting items and conducting activities effectively. For example, in cases where children could not bring family photographs, they were encouraged to illustrate their family tree on whiteboards, facilitating both sharing and conversation. Another anecdote shared by a teacher; highlights how she adapted a beach-themed activity for her students:

> *"One of the projects recommended for my class was 'Marine Saviours.' When I began explaining the concept of a beach, the children were confused as they had never seen one. To help them visualise it, I showed them a picture of a beach on my mobile phone. One child mentioned he had seen a beach near his home, but upon further inquiry, it turned out he was refering to a nearby pond. Another student then came up with a creative idea. He told me he wanted to show me something outside, but I had to wait for that. He went outside, dug a small hole in the ground, filled it with water from his bottle, crafted small paper fishes, and placed them in the water. Then he asked me to come and see. I was very surprised and amazed by his creativity. I believe these projects will greatly contribute to building students' creativity and development".*
>
> Qurat ul Ain,
> Grade 1 Teacher, GGPS Islampura

While some teachers effectively contextualised the lesson plans, others suggested that the activities could be more relevant and aligned with the students' realities. They recommended developing lesson plans that are more inclusive of the students' local contexts to ensure that all students can engage meaningfully with the lesson content. Participants raised concerns that some lessons weren't sufficiently customised to the public sector or local contexts. For instance, in the "Marine Saviours" lesson mentioned above, students were required to clean a beach—an irrelevant task in Punjab, where there are no beaches. Similarly, a lesson on "building sandcastles" required sand, which many schools did not have. Other lessons, such as those involving Christmas parties, gingerbread houses,

or piñatas, did not align with the cultural backgrounds of the students, making engagement more challenging.

It is important to note that the lesson plans were designed to nurture students as global citizens, encouraging exposure to other cultures and places. However, future programs should incorporate more sensitivity and training for teachers to navigate cultural differences effectively.

Cost of Resources

While teachers appreciated the activities in the lesson plans, the cost of materials posed a significant challenge. Nearly all activities required resources such as colored printouts of stories, paints, brushes, t-shirts, sponges for each child, LED lights, photos, and flashcards. For example, in the lesson "Be a Party Planner," children were asked to plan a party at home and bring photographs to school. Other lessons required students to bring materials from home, such as fruits or family pictures, which proved difficult to implement, given that many students in public schools come from low socioeconomic backgrounds.

Due to limited Non-Salary Budgets (NSB), schools were unable to allocate funds for procuring these materials. Some teachers relied on resources already available in schools, particularly for Early Childhood Care and Education (ECCE) classes, while others purchased materials out of their own pockets. Most teachers, however, adapted the activities based on the resources at hand. Many successfully implemented the projects using low-cost or no-cost materials, creatively utilising boards, chart paper, and items from their surroundings. This approach ensured that financial constraints did not hinder the execution of creative and effective teaching methods.

Teachers expressed a need for the provision of dedicated resources to better support the execution of such activities.

Technology Integration

Feedback in this category revolves around the use of technology to enhance teaching practices. Teachers reported positive experiences with integrating technology into teaching methods to improve engagement and learning outcomes. However, challenges such as technology illiteracy among teachers, issues with internet connectivity, and platform-related difficulties were also noted as barriers to effective technology integration in education.

Use of technology in improving teaching practices

Participants shared their experience of how the technology has transformed their teaching practices significantly enhanced both their teaching capabilities and students' learning experiences. Lesson plans tailored to individual student needs were delivered using little lab adaptive recommendation system with its AI offering. The intervention helped teachers facilitate students' learning process by providing individual support to children tailored to their needs. It also made it easier for them to track progress of their students and provide more inclusive, and effective learning environment. Such integration of technology showed promising results in improving learning outcomes and student development.

Peer Support

Some senior teachers experienced challenges navigating the platform and sought assistance from their peers to better understand and implement it effectively. WhatsApp groups, along with observation visits by the project team, played a crucial role in addressing these issues. The WhatsApp group provided a platform for

teachers to connect, share challenges, identify solutions, and implement them collaboratively.

> *"As a senior teacher at Theh Panjoo School, I struggle with the new assessment platform's complexities. Fortunately, my colleague Dr. Umar guided me through its functionalities, helping me integrate it into my lessons. Additionally, Tayyab, who is our school staff member, supported me a lot in managing classroom and uploading data. With their support, I could effectively use the platform to enhance the learning environment".*
>
> M. Abbas
> GPS Theh Panjoo

Platform issues and Internet Connectivity

Internet connectivity emerged as a major challenge, particularly for schools located in rural areas. More than 25 % participants complained about the lack of proper connectivity hindering their ability to use the application effectively. Teachers managed to download the lesson plans in their devices and used them in class but other features of the platform could not be used.

The issues with platform were exacerbated when little evaluator was being used during pre-and post-assessment. In addition to connectivity, assessors reported several cases of server being down and not being able to upload evaluation moments timely and accurately. An overwhelming majority of assessors reported that they were unable to capture and upload any evaluation moment – pictures or videos.

Given the connectivity issues faced by majority of teachers and assessors, they recommended that an offline version of the application be made available. This would allow teachers and assessors to access the platform and save information without relying on internet connectivity, ensuring continuity regardless of internet limitations.

Educational Environment and Limited Support

In this section, we present the broader educational environment and the support systems impacting teaching and learning. Participants discussed issues such as limited support from parents, managing large class sizes that affect individualised attention and effective lesson delivery, managing time effectively amidst competing responsibilities, and challenges in retaining volunteers. These factors contribute significantly to the overall experience of the intervention and are detailed below:

Limited support from parents and head teachers

A significant number of teachers (14 out of 30) reported experiencing pressure from parents who preferred that teachers follow Grade 2 textbooks instead of recommended lesson plans. This created a challenging environment for teachers, who had to navigate between meeting parental expectations and delivering the new learning initiatives effectively. Several teachers ended up covering both textbooks and recommended lesson plans simultaneously further aggravating time management issues.

One teacher (PST at GPS Wafaqi Colony) found the head teacher non-cooperative. She felt overwhelmed, unsupportive and questioning her teaching methods.

Examination Duties

Public school teachers are frequently pulled out of their schools to manage additional tasks and responsibilities, negatively affecting their teaching time. During the pilot, 6 out of 30 teachers reported being assigned board examination duties, requiring them to travel to other schools or examination centres for invigilation duties for up to 4 weeks. In their absence, other teachers had to step in, but these replacements lacked the necessary training and responsibility, leading to inconsistent delivery of the lesson plans.

Classroom and Time Management Issues

A significant number of teachers expressed concerns about time management. Given the class size, resources constraint, some citing lengthy lesson plans, teachers found it difficult to complete lesson plans within assigned period while making sure all students were engaged. For some teachers trying to arrange for resources during school hours added a further challenge with regards to completing lesson plans.

Additionally, the high STR complicated achieving the lesson plans' learning objectives within allocated timeframes. While teachers acknowledged that project-based learning and recommended lesson plans helped them manage their large classes, some of them still faced difficulties in providing individual attention due to having more than 50 students in their classes. This affected the pace of their lesson plans as well as engaging all students in activities took longer than expected and exhausted them more.

Support of Community volunteers

The pilot grappled with the issue of retaining volunteers. Initially, 18 community volunteers were selected and trained to support teachers managing their classes and implementing lesson plans effectively. 10 out of these 18 volunteers were directed to support teachers in 10 treatment schools. Only 7 volunteers continued till the conclusion of the pilot. Rest found better job opportunities and moved on, on account of needing more financial stability[13] and job security given that the pilot was only for a few weeks. The teachers of the schools that had volunteers as their assistants highly appreciated their presence and reported that they were helpful in managing classrooms with high student strengths, supporting activities, and increase student engagement.

[13] The pilot supported volunteers by covering travel expenses and offering training, practical experience, and certification to aid their professional growth.

I am managing a class of 49 students delivering 2-3 recommended lesson plans every day with the help of a community volunteer. Before using Little Lab, managing my class strength and keeping students engaged was a challenge. The Little Lab platform transformed my teaching by focusing on project-based learning and demonstrations, making lessons more interesting for the students. Little Lab also simplifies student data collection, helping us track progress and identify areas needing improvement, benefiting both teachers and students. The lesson plans are engaging and creative and cover more than just English and Math by focusing on holistic child development.

Umaira Sarwar
Grade 1 teacher, GGPS Kamahan

I am mostly responsible for managing classroom while the teacher teaches recommended lesson using the Little Lab. I keep students engaged in activities and try my best to provide them need-based support. I am grateful to the teacher and headteacher of the school for giving me this opportunity and I will use the lessons learned here in my future endeavours as well.

Sana Latif
Community Volunteer, GGPS Kamahan

6

Lessons Learned and Recommendations

This section outlines the key insights gained from the implementation of the pilot programme, highlighting both the successes and challenges encountered. The lessons learned reflect analysis of the data, practical experiences of stakeholders and observations that can inform future initiatives. Based on these findings, a set of recommendations has been developed to guide improvements in programme design and develop a way forward.

6.1 Lessons Learned

The pilot demonstrated a positive impact on student learning outcomes through the use of AI-recommended lesson plans tailored to students' needs. The following key lessons were identified, offering valuable insights into the effectiveness and areas for improvement in the program's implementation.

AI and ML powered technology-enabled solutions improving student learning outcomes

The pilot intervention explored how AI and ML powered technology-enabled solutions can improve student learning outcomes at the foundational level. The intervention led to an overall increase in children's learning levels, particularly in literacy (English) and numeracy. Further analysis revealed that schools with the highest uptake of AI recommendations experienced an even greater impact on student performance, demonstrating the potential of AI and ML-powered solutions in addressing the province's learning crisis at the foundational level.

Most ed-tech tools rely on child-screen interactions, which is discouraged in early years. This intervention provided educators with AI-generated lesson plans tailored to individual student needs through the Little Lab adaptive recommendation system, reducing the time teachers spent planning and delivering lessons based on students' diverse needs. This resulted in enhancing teaching efficacy, especially for classrooms with students at varying levels.

Additionally, our analysis found a correlation between access to and usage of technology (measured by internet usage) and student learning outcomes. As internet access and usage increase across demographics, there is considerable potential for technology to further support educational advancement.

Students' Portfolio Development

The intervention emphasised the importance of developing individual student portfolios as a powerful method for providing customised, need-based support to students. This approach facilitates better teaching practices and improves teaching quality. The platform used in this pilot captured performance data for 2,050 students. Through unique logins and IDs, teachers could monitor the progress of their students, while

administrators had access to the performance levels of all schools. Teachers could track student progress and learning via the developed portfolios, and headteachers could view student portfolios, curriculum pacing, and learning progress, allowing them to provide timely feedback and support to teachers. At the school and classroom levels, student portfolios can assist in regrouping students according to their abilities, ensuring more focused learning and support.

If such a system were adopted by the government, it could enable the SED to manage student performance portfolios more effectively. The data from these portfolios could be used to inform decisions regarding curriculum development, textbook content, and teacher training programs, ensuring quality education and completing the feedback loop with need-based support.

The intervention also highlighted challenges related to the significant age disparity among students, which makes teaching at the right level difficult, contributing to learning poverty. This underscores the importance of portfolio development based on students' abilities, performance, and knowledge, as it helps teachers provide instruction that is appropriately tailored to each student's level.

Professional Development and Capacity Building of teachers

Our analysis revealed that teaching quality has a direct and positive impact on student learning outcomes, as evidenced by the relationship between classroom observation scores and student performance levels.

The pilot involved 50 teachers and 2,050 students. Among the participating teachers, there was considerable variation in their adoption of the lesson plans and technology. Some teachers seamlessly integrated the technology and lesson plans into their classrooms, while others faced challenges such as resource limitations, insufficient support, and technological barriers. This variation in readiness impacted the effectiveness of the intervention, with 45% of teachers reporting discomfort with using technology.

These findings underscore that time and effort are required to ensure teachers become comfortable with using technology. It is crucial to provide comprehensive training, continuous motivation, and to emphasise how technology can enhance classroom teaching and improve student learning outcomes. The pilot also revealed that teachers needed guidance and support in specific areas, including implementing lesson plans using low-cost or no-cost resources, contextualising activities to ensure relevance, and managing text-heavy lessons through targeted training and capacity building.

Peer Support and Professional Teachers' Network

While the majority of teachers reported that the use of technology significantly transformed their teaching practices, enhancing both their capabilities and students' learning experiences, some faced challenges due to a lack of technological literacy. In these instances, peer support proved invaluable. Teachers received assistance through WhatsApp groups, peer mentoring, and ongoing guidance, which played a crucial role in helping them navigate and effectively implement the technology-based solutions.

There were several examples of teachers going above and beyond to support and guide their colleagues, demonstrating the power of collaboration. These experiences underscore the importance of fostering professional networks among teachers, where they can connect, share challenges, celebrate successes, and learn from one another.

The pilot highlighted the potential of creating structured platforms for teachers to continuously engage in professional development and mutual

support. Such networks not only facilitate the sharing of best practices but also contribute to a culture of collective problem-solving and innovation in the classroom. Establishing these professional networks on a broader scale would ensure that all teachers, regardless of their individual technology skill levels, are equipped to adapt to evolving educational tools and methods.

Volunteer Engagement

Analysis by treatment sub-groups revealed that schools with community volunteers experienced a greater increase in student learning levels. Additionally, teachers of such schools reported that the presence of community volunteers supported classroom teaching and enhanced student engagement, particularly in schools with high STR. This highlights the significance of the role community volunteers can play in supporting classroom teaching and improving student learning outcomes.

However, only 7 volunteers remained engaged throughout the intervention, which reduced the sample size for the third sub-intervention. The departure of other volunteers was attributed to their pursuit of better job opportunities, as the pilot was only planned for less than two months and offered no financial incentives. This underscores the importance of considering longer-term commitments and financial incentives to maintain volunteer participation and maximise the impact of community engagement in educational interventions.

Challenges faced during pilot implementation

Several challenges were faced during the project implementation including:

Quality of Lesson plans

Teachers and assessors highlighted issues with lesson plans including the difficult language, text-heavy plans, difficulty in establishing relevance of the lessons and managing the resources needed to implement the lesson plans.

Small sample size

Due to time and resource constraints, the project was limited to a small sample of 50 schools, with 30 of these being treatment schools, affecting generalisability of the findings.

Pilot Duration

The pilot was cut short due to early school closures caused by extreme hot weather, resulting in the intervention running for around 6 weeks only.

Offline Unavailability of the Application

The application used for the pilot required data connectivity to upload any data. This constraint affected the flexibility and accessibility of the application for teachers as well as the assessors.

Volunteer Retention

Retaining community volunteers proved challenging due to the pilot's short duration and lack of financial incentives.

Teacher challenges

Teachers faced several difficulties, including limited support from parents, examination duties, and technology illiteracy, which hindered the effective implementation of the intervention.

6.2 Recommendations

Based on the lessons learned from the pilot, several recommendations have been formulated which aim to address the identified challenges, and propose a way forward. These recommendations are detailed below:

Implement an Improved Programme Based on Lessons Learned from the Pilot

To effectively gauge the impact of the intervention and address the challenges identified in the pilot, it is recommended to implement an extended pilot with a longer duration and a broader scope. This expanded pilot should be carefully informed by the results of the initial study to build on its successes and address its shortcomings.

Lesson plans should be revised based on pilot findings to ensure they are contextually and culturally relevant. The revised plans should focus on utilising low-cost or no-cost resources to make them more accessible. It is also crucial to simplify the language and reduce text density to ensure that the materials are easier for both teachers and students to understand and use effectively.

The assessment tools should be simplified to make them more practical and user-friendly. Given the large class sizes, evaluation moments should be condensed to streamline the assessment process. The descriptors used in the assessment tools should be simplified, and the language should be made more accessible with reduced text. This will help ensure that the tools are easy to fill out objectively and efficiently, thereby improving the accuracy and usability of the assessment process.

The implementation of this improved programme will provide a more robust and reliable proof of the effectiveness of AI and ML powered technology-based solutions in supporting student achievement. Based on the findings from the revised pilot, a scale-up plan will be developed. This plan will be shared with the government and implemented through long-term technical assistance, paving the way for broader application and sustained impact.

Engage Community Volunteers to Support Classroom Teaching

To enhance classroom teaching, particularly in schools with high STR it is recommended to recruit community volunteers with funding from NSB allocations[14]. The pilot results underscored the positive impact of community volunteers on student learning outcomes, demonstrating their value in supporting and enriching the educational environment.

Given the financial constraints associated with hiring additional teachers, especially in schools with STRs of 1:60 or higher, engaging community volunteers presents a cost-effective alternative. Hiring a new teacher incurs significant costs, with new recruits often earning at least PKR 37,000 per month, not including the additional capital expenditure required for setting up another classroom.

In contrast, recruiting community volunteers with a modest stipend is a more financially feasible option. Providing a stipend ensures that volunteers are motivated and valued, while still being a more affordable solution compared to hiring full-time teachers. This approach not only alleviates budgetary pressures but also improves teaching quality by supplementing the efforts of existing educators.

[14] The SED already has a policy that allows headteachers to recruit teacher assistants using NSB funds.

Implementation Strategy

To effectively integrate community volunteers, it is essential to develop a structured recruitment and training process. This includes:

1. **Recruitment:** Identify and recruit volunteers from the local community who have a vested interest in education and possess relevant skills or experience.
2. **Training:** Provide comprehensive training to ensure that volunteers understand their roles and responsibilities and are equipped to support classroom teaching effectively.
3. **Support and Supervision:** Implement a support and supervision framework to help volunteers integrate smoothly into the classroom environment and address any challenges that arise.

Provide Continuous Professional Development (CPD) and Training Opportunities for teachers

To enhance teaching effectiveness, it is crucial to offer comprehensive CPD and training opportunities, especially focusing on project-based and activity-based learning methods. These approaches are particularly beneficial for younger children, who thrive on interactive and hands-on learning experiences. Teachers should receive specialised training that emphasises practical strategies and techniques for utilising low-cost or no-cost materials. This training should also include effective methods for managing classroom activities to maintain student engagement and promote active learning.

Given the increasing integration of technology in education, it is essential that training also covers technology-based solutions. This aspect of the training should aim to improve teachers' comfort and proficiency with educational technology, providing them with strategies for integrating technology into their teaching practices to support and enrich the learning experience. Additionally, the training should address common technological challenges and offer practical solutions to ensure the smooth implementation of tech-based learning tools.

Develop Communities of Practice (COP) for teachers

Establishing communities of practice for teachers is crucial for enhancing professional development and teaching effectiveness in line with the offered CPD programme. These communities should provide a platform for educators to share challenges, discuss solutions, and collaborate on best practices. By facilitating regular meetings and online forums, teachers can exchange ideas, support one another, and address common issues. Supporting these communities with resources and expert guidance will strengthen teaching practices and foster a collaborative environment, ultimately improving student learning outcomes and promoting continuous professional growth.

These recommendations aim to address the challenges identified during the pilot, optimise the effectiveness of future interventions, and create a more supportive and resourceful educational environment, ultimately enhancing both teaching quality and student learning outcomes.

7

Conclusion

The Foundational Learning Pilot has underscored the significant potential of technology-enabled solutions powered by AI and ML in addressing the learning challenges at the foundational level. The pilot programme, implemented in 50 schools in Punjab, including 30 treatment schools and 20 control schools, revealed that tailored lesson plans and personalised support provided by the AI recommendations significantly enhanced teaching efficacy and student engagement. The intervention, which utilised the "Little Lab" platform, showed a marked improvement in student learning outcomes, including significant gains in literacy (English), numeracy, and STEAM.

The positive correlation between teaching quality and student learning and an additional increase in student achievement with the involvement of community volunteers, highlights the effectiveness of targeted intervention. However, challenges such as quality of lesson plans, internet connectivity issues, and volunteer retention were noted, suggesting areas for further development.

The pilot's success provides a robust foundation for scaling up the intervention, with recommendations for implementation of an improved programme, enhanced teacher training, and the development of supportive communities of practice. These recommendations aim to build a more effective and sustainable approach to improving foundational learning, ensuring that all students receive the support they need to achieve their full potential.

Annexures

Annexure A: List of Schools

Treatment Group	Control Group
GPS Barkat Pura Raiwind Road Teh Model Town	GGES Jehangir Park Chungi Amer Sidhu
GPS Nabi Pura No. 2 Gulberg III (Ex-MCL)	GGES Ladhe Ke Bhullar
GGES Neelam Block Iqbal Town (Ex-MCL)	GGES Model Huma Block Iqbal Town
GGES Asal Suleman	GGHS Ali Raza Abad Tehsil Model Town
GGES Cenral Model CGE Colony Wahdat Road Lahore	GGHS Model Wahdat Colony
GGES Gaju Matta	GGHS Nisaran-E-Islam Central Jail(Newly Upgraded)
GGES Public Canal Park	GGPS Sector A-II Township (Ex-MCL)
GGES Tibba Kachha	GGPS Atari Saroba
GGES Wafaqi Colony (Ex-MCL)	GGPS Mohammad Pura Raiwind
GGHS Ganga Ice Factory Gulberg	GGPS Mumtaz Nabi Pura Gulberg-III
GGHS Public Model Block-B Gulberg-II (Ex-MCL)	GGPS Pandoki
GGHS Township A-2 (Newly Upgraded)	GGPS Shahzada
GGPS Atto Asal	GHS Gaju Matta
GGPS B-1 Township (Ex-MCL)	GPS Aslam Junior Model B-II Township
GGPS Ghulam Ghos Wala (Air Line Socity)	GPS Bhabhra (Ex-MCL)
GGPS Haveli Tarkana Wali	GPS Block No. 5 Sector B-I Township
GGPS Islam Pura	GPS Gulwehra
GGPS Pindi Rajputan	GPS Gurumanget
GGPS Younas Abad	GPS Khund
GHS Badoki (Newly Upgraded)	GPS Nasib Abad
GHS Bahari Colony Green Town (Newly Upgraded)	
GHS Jevan Hana Ex-Mcl (Newly Upgraded)	
GHS Pandoki	
GHS Qurban Line Tehsil Mode Town	
GHS Theh Panjoo (Newly Upgraded)	
GPS Ali Raza Abad Tehsil Model Town	

GPS Kahna Nau No.2	
GPS Kamahan	
GPS Nangar	
GPS St Lawarence No Ii Nawaz Sharif Colony	

Control subgroup 1 (Student strength < 40)

1	GGPS Mumtaz Nabi Pura Gulberg-I	15
2	GPS Gurumanget	23
3	GPS Bhabhra (Ex-MCL)	25
4	GGPS Atari Saroba	27
5	GGHS Model Wahdat Colony	30
6	GGPS Sector A-II Township (EX-	31
7	GGES Ladhe Ke Bhullar	35
8	GGPS Mohammad Pura Raiwind	36
9	GPS Nasib Abad	37
10	GPS Block No. 5 Sector B-I Town	39

Treatment subgroup 1 (Student strength <40)

1	GGPS Younas Abad	28
2	New GGPS Neelam Block Iqbal Town	29
3	GHS Badoki (Newly Upgraded)	30
4	GGPS Islam Pura	35
5	GPS Barkat Pura Raiwind Road Te	35
6	GPS Nangar	36
7	GGPS B-1 Township	38
8	GHS Jevan Hana Ex-MCL	39

Control sub-group 2 (student strength 40-60)

1	GPS Khund	41
2	GGHS Nisaran-E-Islam Central JA	41
3	GPS Aslam Junior Model B-Ii Township	43
4	GGPS Pandoki	43
5	GGPS Shahzada	49
6	GPS Gulwehra	50
7	GGES Model Huma Block Iqbal Town	50
8	GGES Jehangir Park Chungi Amer	53
9	GGHS Ali Raza Abad Tehsil Model	58
10	GHS Gaju Matta	59

Treatment subgroup 2 (student strength 40-60)

1	GGES Cenral Model Cge Colony Wah	40
2	GPS Ali Raza Abad Tehsil Model	40
3	GPS Nabi Pura No. 2 Gulberg III	40
4	GGES Tibba Kachha	41
5	GGHS Ganga Ice Factory Gulberg	44
6	GGES Public Canal Park	45
7	GPS Kahna Nau No.2	45
8	GPS St Lawarence No Ii Nawaz Sh	45
9	GGES Asal Suleman	47
10	GGES Gaju Matta	47
11	GGPS Ghulam Ghos Wala (Air Line	48
12	GGHS Public Model Block-B Gulberg	49
13	GGHS Township A-2 (Newly Upgrade)	51
14	GGPS Atto Asal	55
15	GHS Bahari Colony Green Town	56

Treatment sub-group 3 (with volunteers)

1	GHS Pandoki	30
2	GHS Qurban Line Tehsil Model Town	37
3	GGPS Haveli Tarkana Wali	44
4	GGES Wafaqi Colony (Ex-MCL)	47
5	GGPS Pindi Rajputan	47
6	GPS Kamahan	49
7	GHS Theh Panjoo	51

Annexure B – Assessors' Form

Your Name _____ Your designation _____

Department _____ Contact number _____

Email address (mandatory) _____

1. Are you available for training and assessment during the dates mentioned above?

2. Which school would you prefer to conduct the assessment? Please refer to the list of schools mentioned earlier and mention at least three schools in order of preference.

i. _____ ii. _____ iii. _____

3. Do you have any previous experience of teaching? If yes, what grades and for how many years?

4. Do you have any previous experience of conducting assessment? If yes, please explain.

5. What is your motivation behind conducting this assessment activity?

6. Do you have a laptop, a tablet or a smart phone that you can bring during the training and use it to conduct the assessment?

Signatures _____

Annexure C – Classroom Observation Tool

	Score (5 is high)					
Lesson Facilitation	n/a*	1	2	3	4	5
1. The teacher explicitly articulates the objectives of the lesson and relates classroom activities to the objectives.						
2. The teacher's explanation of content is clear and correct.						
3. The teacher makes connections that relate to students' daily lives or other content knowledge.						
4. The teacher models by enacting, thinking aloud or showing a final product expected of the students.						
Checks for understanding						
5. The teacher uses questions, prompts or other strategies to determine students' level of understanding.						
6. The teacher monitors most students during individual or group work.						
7. The teacher adjusts teaching to the level of the students.						
Feedback						
8. The teacher provides specific comments to help students clarify misunderstandings and understand successes.						
Critical Thinking						
9. The teacher asks thinking questions.						
10. The teacher provides thinking tasks.						
Classroom Culture						
11. The teacher responds to students' needs.						

* NA = Not applicable. Selecting this option means you did not observe the practice in the lesson and it was not required.

Annexure D – Little Lab Feature Usage Survey

Questions	Daily	Weekly	Monthly	Rarely	Never
How often are you using Lesson Plans on the platform?					
How often do you use the "teacher toolbox"?					
How often do you use ‘Photo upload’ in the Learning Moment?					
If you use the multi-language support for translation, which languages are you utilizing? Check all that apply	English	French	Chinese	Urdu	Not using
Do you "favourite" lessons or add them to your backpack for later?	Yes	No	I don't know how to use this feature		
Are you using the multi-language support for translation? If yes, then which	Yes	No			
On a scale of 0 to 10, how likely are you to recommend our platform to a friend or colleague?					
What type of features do you wish to see on the Little Lab platform?					

Annexure E - Teachers' Self-Reported Perception Regarding Technology Usage

Technology Uptake and Comfort Level

1. How feasible was it for you to use technology in classroom teaching?

   Extremely easy ☐

   Somewhat easy ☐

   Somewhat difficult ☐

   Extremely difficult ☐

2. How useful do you think technology has been to support your classroom teaching?

   Extremely useful ☐

   Moderately useful ☐

   Slightly useful ☐

   Not useful at all ☐

3. Are you comfortable using technology in classroom teaching regularly?

   Yes, extremely comfortable ☐

   Yes, somewhat comfortable ☐

   No, somewhat uncomfortable ☐

   No, extremely uncomfortable ☐

Impact on Teaching Processes and Practices

4. To what extent the technology helped you improve your teaching practices?

   Significantly ☐

   Moderately ☐

   Slightly ☐

   Not at all ☐

5. To what extent the use of technology improved your ability to address individual students' needs?

   - Significantly ☐
   - Moderately ☐
   - Slightly ☐
   - Not at all ☐

6. How much has the technology increased your motivation to teach?

   - Greatly ☐
   - Somewhat ☐
   - Minimally ☐
   - Not at all ☐

7. Overall, how satisfied or dissatisfied are you with using technology as a tool to enhance teaching and learning?

   - Extremely satisfied ☐
   - Somewhat satisfied ☐
   - Somewhat dissatisfied ☐
   - Extremely dissatisfied ☐

Open-Ended Questions

8. What were the main challenges you faced while using the technology in classroom teaching?
9. How can technology help you in improving classroom practices?

Annexure F – Little Lab Lesson Plans Survey

Questions	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	1	2	3	4	5
I am satisfied with the lesson plans.					
The lesson plans have helped me to build knowledge in my area of teaching.					
The lesson plans are helping my students to learn and achieve their learning goals.					
I understand how to use the lesson plans.					
The lesson plans are easy to use.					
I understand where to find information in the lesson plans when I need it.					
It was easy to find the information I was looking for in a project or unit.					
The steps to enrol in a project or unit are straightforward and easy to follow.					
It's easy to find relevant projects in the Lesson Plan Library.					
I am confident in my ability to teach a full lesson using the lesson plans.					
I understand the learning goals of the project or unit I am currently teaching.					
What do you like about the lesson plans? Why?					
What don't you like about the lesson plans? Why?					
What part of the lesson planning process is the most challenging and why?					
What part of using the lesson plans is the most challenging and why?					
What part of planning and teaching with the new lesson plans do you feel good about? Why?					
Do you have any other feedback to share?					

I-SAPS Institute of Social and Policy Sciences
Informing Policies, Reforming Practices

PO Box: 1379, Islamabad, Pakistan.
UAN: (+92-51) 111 739 739; Fax: (+92-51) 2289425
Email: info@i-saps.org; Website: www.i-saps.org