NUMERACY AT SCALE FINDINGS BRIEF

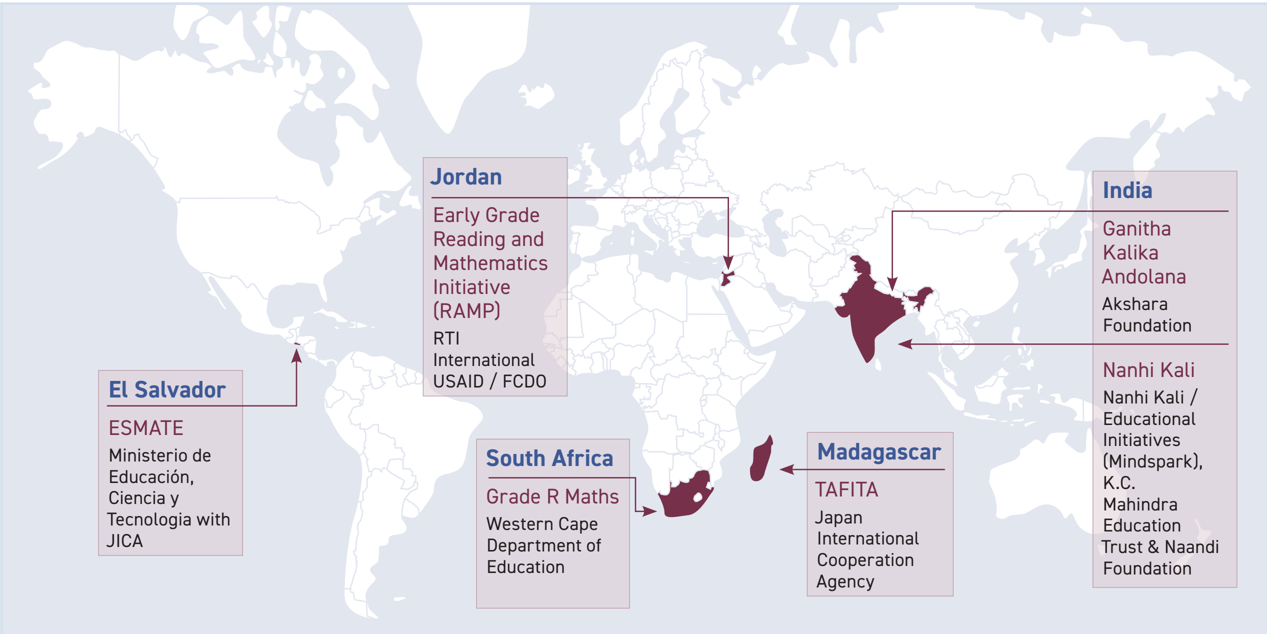
Nanhi Kali in India

Introduction to Numeracy at Scale

The Learning at Scale study was designed to explore programs that have a demonstrated impact on foundational learning outcomes at scale. The goal of this research is to identify and examine successful aspects of these programs to provide policy makers and development practitioners with evidence-based strategies for improving instruction and learning outcomes across contexts. The research is being led by RTI International and is part of the Center for Global Development education research consortium, funded by the Bill and Melinda Gates Foundation.

While the first phase of Learning at Scale focused on literacy, the second phase, Numeracy at Scale, is focused on (1) identifying instructional strategies that are essential for improving numeracy outcomes at scale in low- and middle-income countries; and (2) learning about the characteristics of the education systems within which successful scaled-up numeracy programs operate. To this end, the study team identified and analyzed six programs across five countries that had rigorous evidence of impact on numeracy learning outcomes and which were operating at scale or which showed the potential for scale in an entire region or country (see Figure 1).

Figure 1. Numeracy at Scale partners



The six Numeracy at Scale programs represent a variety of designs, from providing instruction to at-risk girls via interactive software to a national-scale numeracy initiative integrated into all public primary schools. Despite their differences, these programs share a large number of common elements (see Figure 2).

Figure 2. Common elements across successful large-scale numeracy programs

Instructional Practice

- Targeted / differentiated instruction
- Time for students to practice skills
- Procedural and conceptual knowledge
- Student discussion of math concepts
- Continuous assessment
- Use of manipulatives
- Group / pair work

Materials and Teacher Support

- Local-language materials
- Teaching aids for students
- Teacher's guide / lesson plans
- External coaches
- Teacher communities of practice

System and Structural Support

- Coaches meet in groups
- Training for head teachers
- Face-to-face teacher training
- Structured training materials
- Trainings focused on modeling and practice
- Government monitoring
- Dashboard for results / data sharing
- Monitoring data used for decision-making

Even with these common elements, these programs provide evidence of multiple pathways to success. For example:

- All programs provided teachers[1] with training and support, but the approaches that teachers found most impactful for student learning varied.
- In all programs, teachers incorporated independent and group work and focused on building both procedural and conceptual understanding, but their use of materials and student discussion varied.
- Head teachers were trained and relied on the use of data for decision-making in five of the programs, but they differed across programs in how they provided (or sought) support for struggling teachers.
- Coaches or mentors were engaged across programs, but their roles, expectations, and level of support varied greatly.

The remainder of this brief provides an overview of the Numeracy at Scale research methodology generally and explores the findings from one of the programs studied—Project Nanhi Kali in India.

Numeracy at Scale Research Methodology

The Numeracy at Scale study investigated three main research questions:

1. What classroom ingredients (such as teaching practices and classroom environment) lead to learning in programs that are effective at scale?
2. What methods of training and support lead to teachers adopting effective classroom practices?

1 Instruction was provided primarily through the tablet-based Mindspark application for Nanhi Kali.

3 What system-level support is required to deliver effective training and support to teachers and to promote effective classroom practices?

In addition, cross-cutting questions, based on previous research on mathematics teaching and learning, focused on whether and how teachers emphasized conceptual understanding, the role of representations or conceptual models, and the use of manipulatives or other hands-on activities.

In each country, the study teams carried out a mixed-methods study. See Figure 3 for an overview of the study design.

The data collection for Project Nanhi Kali was unique, compared to other Numeracy at Scale study sites, in that (1) the qualitative component focused only on students and (2) the classroom observations included large-group and individual child observations. For classroom observations, the focus was on students using tablets and the supports they received from community associates. Figure 4 shows the respondents from the data collected for Project Nanhi Kali in India.

Figure 4. Nanhi Kali (India) study respondents

Respondent	Total
Quantitative	
Schools	79
Community associates	79
Headmasters	79
Students	57
Program officers / staff	5
Qualitative	
Students[3]	44

Figure 3. Numeracy at Scale study design

Quantitative:

- 80–130 schools per country
- In each school:
  - Math lessons observed
  - Interviews of teachers, head teachers, trainers, teacher meeting facilitators, and/or coaches
  - Mathematical Knowledge for Teaching survey[2]

Qualitative:

- 10 schools (subsample)
- In each school:
  - Math lessons observed for 3 days
  - Open-ended interviews of teachers
  - Cognitive interviews with students
- Semi-structured interviews with program staff and Ministry of Education officials, including those responsible for teacher training, school supervision, and curriculum and materials

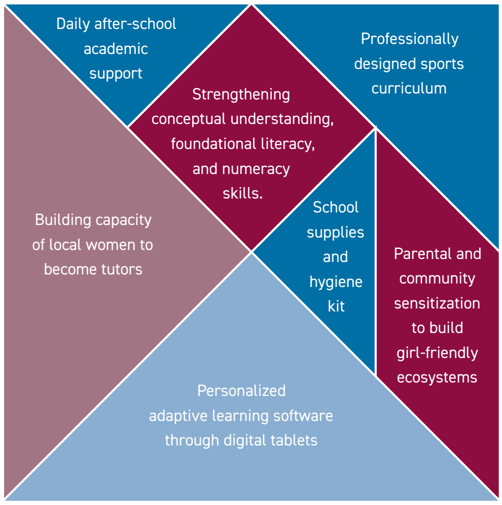
2 The Mathematics Knowledge for Teaching survey is a short survey (23 items) that measures primary-grade teachers' knowledge of mathematical concepts and their pedagogical content knowledge. For more information, see Wendi Ralaingita, Aizada Mamytova, and Yasmin Sitabkhan, "Capturing Teachers' Mathematical Knowledge for Teaching" (2023), https://shared.rti.org/content/mathematical-knowledge-teaching-survey-cies-2023-presentation.

3 Student qualitative data were not available for inclusion in this brief.

Project Nanhi Kali Overview

Project Nanhi Kali, funded by the K. C. Mahindra Education Trust and other donors, started in 1996 as an after-school education program for girls in primary grades. In 2005, the Naandi Foundation was brought on to jointly manage the program, and implementation expanded to include girls in secondary school up to grade 10. The program provides education support in three academic subjects (vernacular language, mathematics, and English as a second language) in grades 1 through 10, as well as science in grades 6 through 10. The program also includes a sports curriculum and provides each participant with a school supply kit annually. Over the years, the program has expanded across India and has reached more than 500,000 girls to date. Project Nanhi Kali currently operates in nine states and has 185,759 girls enrolled. Since 2019, the program has partnered with Educational Initiatives to deliver personalized instruction through an adaptive learning software called Mindspark that is pre-loaded onto tablets. Figure 5 shows the main elements of Nanhi Kali.[4]

Figure 5. Nanhi Kali: Core support elements



The program takes place in academic support centers (ASCs) that are set up within government schools. ASCs tend to be multigrade and have a maximum of 30 girls. Depending on the size of the school, one school may have several ASCs. The program runs approximately two hours a day, six days a week. For girls in grades 1 through 10, the program focuses on teaching three subjects—vernacular languages (two days per week), mathematics (two days per week), and English as a second language (one day per week). Sports and fitness are taught one day a week. As part of the design, the program employs "community associates"—women from local villages who speak the local languages and dialect—to oversee the ASCs.

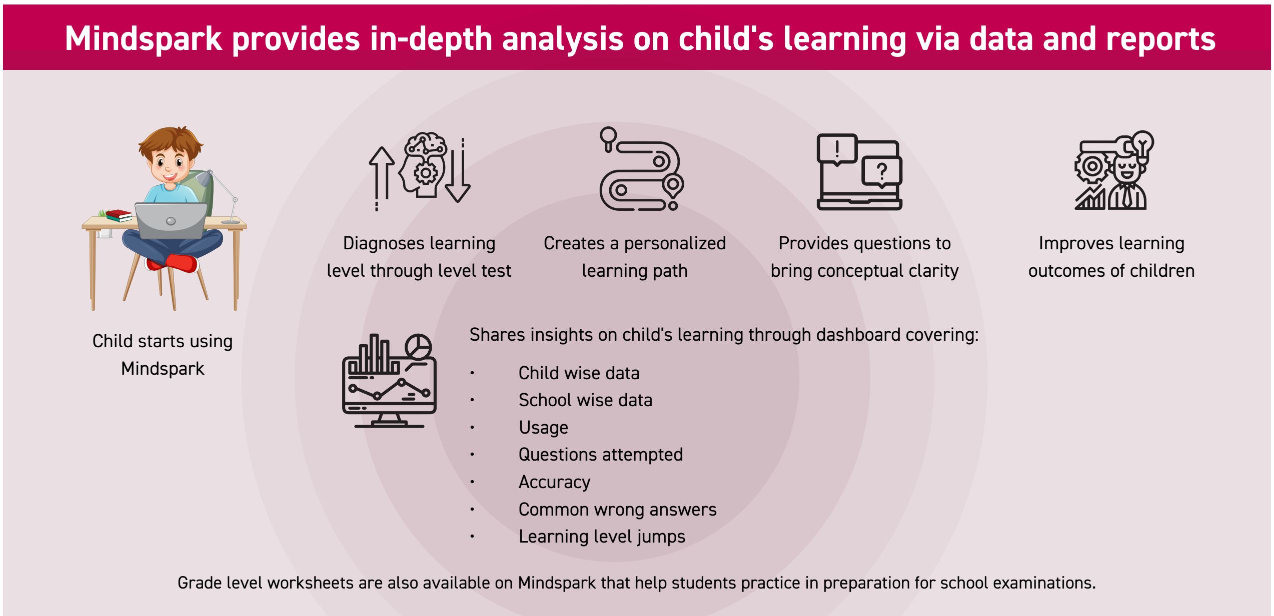
Nanhi Kali Approach to Teaching Mathematics

As part of the after-school program, math is taught twice a week for approximately two hours each day. Each session is split into dedicated tablet-based instruction (i.e., tab time) and non-tablet-based instruction (i.e., non-tab time). While half the students are working on tablets, the other half are engaged in non-tab time, which doesn't follow a fixed curriculum but includes subject-related activities such as homework, worksheets, and practice problems generally aligned with what children are learning in school.

During tab time, instruction is delivered via a personalized adaptive learning software called Mindspark, outlined in Figure 6 below.

4 K. C. Mahindra Education Trust, Annual Report 2020–2022

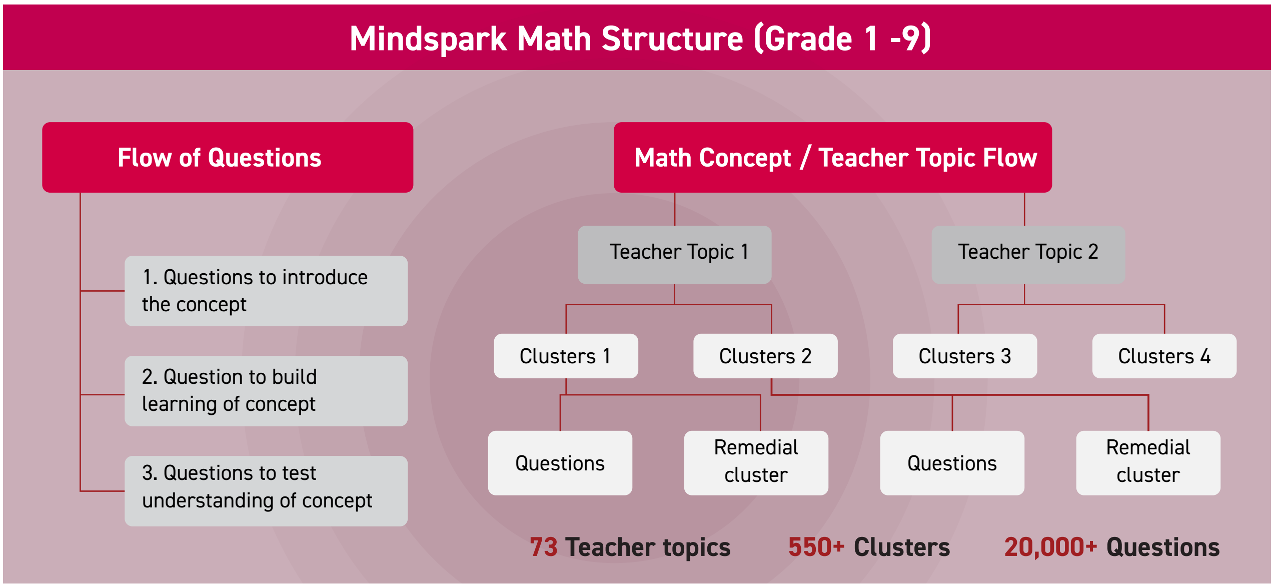
Figure 6. How Mindspark works



Mindspark's primary method of teaching and learning is through questioning rather than delivering instruction through lecturing or modeling (See Figure 7, below). Ultimately, the instructional approach focuses on practice and the application of concepts to help students move toward learning with understanding. The software doesn't teach content according to a child's grade level, so meeting curriculum standards or outcomes are not the driving force behind what children are learning. Rather, children learn at their own level and at their own pace. The software has built-in adaptive flow that uses a child's response to decide if the child needs additional practice on a given topic or subtopic.

Mindspark covers 23 math concepts, which are broken down into "teacher topics" and "clusters." The software uses a variety of question types—including multiple-choice, fill-in-the-blank, drop-down, and interactive questions—to introduce each concept, build learning, and test understanding.

Figure 7. Mindspark's approach to mathematics instruction



Through the Mindspark app, students take quarterly tests during the academic year to capture their learning progress. These tests help ensure that students receive content that challenges and motivates them to learn.

Findings from Project Nanhi Kali

Findings from the study's quantitative interviews in India provide insights into how Nanhi Kali has used Mindspark technology to provide improved math instruction to girls at scale.

The following subsections discuss the findings from Project Nanhi Kali in relation to the Numeracy at Scale research questions.

Research Question 1

What classroom ingredients (such as teaching practices and classroom environment) lead to learning in programs that are effective at scale?

To understand what instructional practices may be leading to improvements in learning outcomes, the study team analyzed the Mindspark software application, classroom observation data, and interview data from students and community associates.

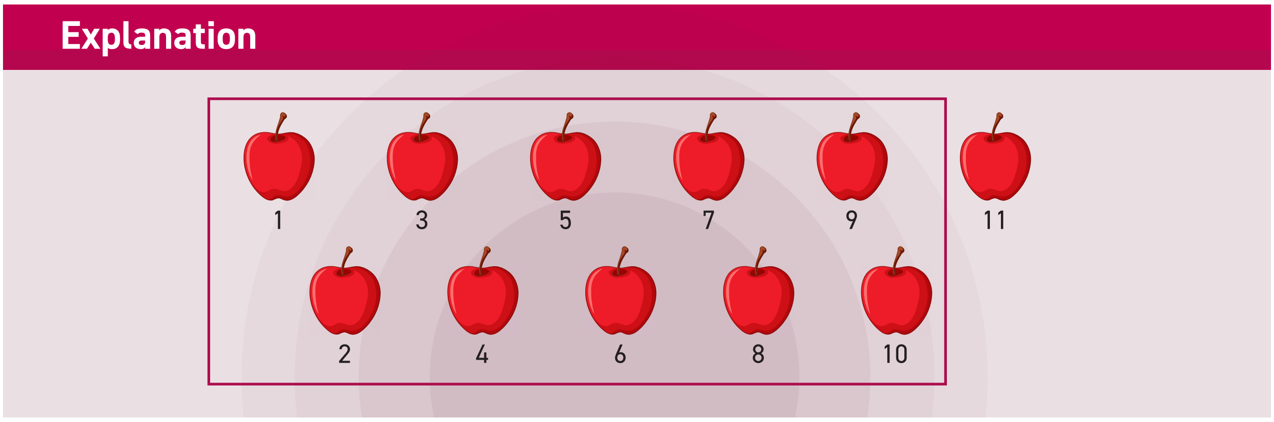
THEME 1 Students learn at their own pace through an instructional approach that prioritizes questioning and practice.

As previously noted, with regard to Nanhi Kali, Numeracy at Scale focused primarily on the program's utilization of the Mindspark app. User data from more than 5,600 sessions across grades 1 to 3 in selected centers revealed that students averaged just under 30 minutes per tablet-based lesson. During that time, grade 1 students attempted an average of 41 problems, while grade 2 and 3 students attempted 33 and 31 problems, respectively. This means that students were averaging more than one problem per minute on the tablets. Perhaps even more important is the way that the Mindspark app handles correct and incorrect solutions to problems.

Central to the success of this app is its targeted and differentiated instructional model. Mindspark allows students to master key skills before they move on to more difficult ones. For example, in a unit on counting and numbers up to 20, the app starts with smaller numbers and then moves to larger numbers. When there are incorrect responses to larger numbers provided, the app starts by giving problems with lower numbers again and slowly works back up to larger numbers.

For some topics, the software also provides clear representations of the mathematical content. For example, in the same unit noted above, the app presents pictures of objects and asks students to count them. After the child answers, the app provides the correct answer, as seen in Figure 8. In this instance, the app shows the student how to count 11 apples, while also highlighting a strategy that students can use to put the objects in groups of 10.

Figure 8. Example of Mindspark teaching strategy



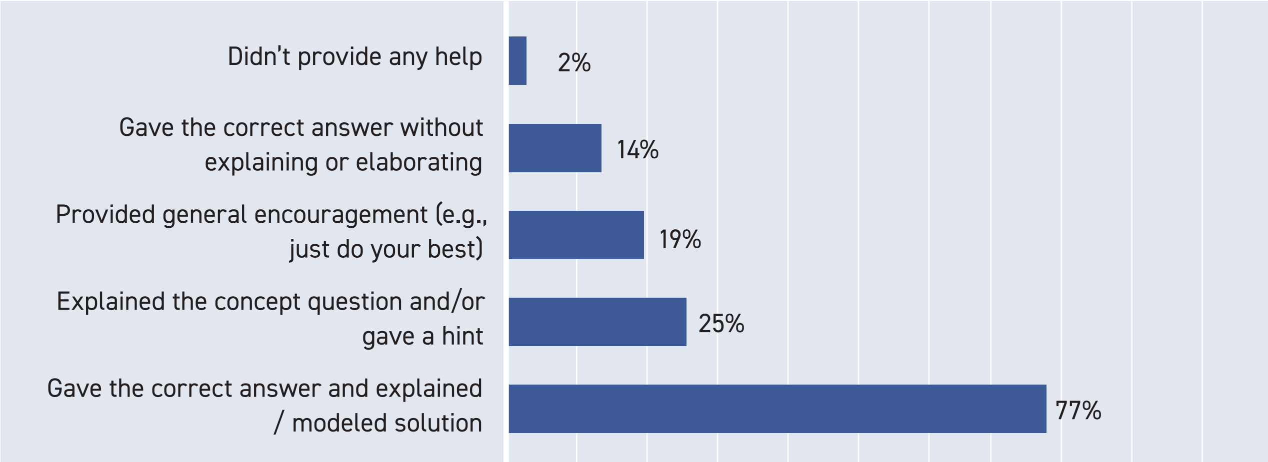
Revealingly, 81% of interviewed students reported that their math skills have improved as a result of the program, and 84% of students claimed that they like math more than before they started the program. Moreover, the majority of students (79%) reported that their improved skills and enjoyment of math are the result of their ability to practice problems using Mindspark.

THEME 2 Community associates provide essential instructional support to students learning on tablets.

By design, community associates are meant to support students with their work in ASCs. Despite not being trained teachers, they are relied on for instructional support in mathematics, as well as for classroom management and technological support (which was found to be necessary in nearly all observed classes).

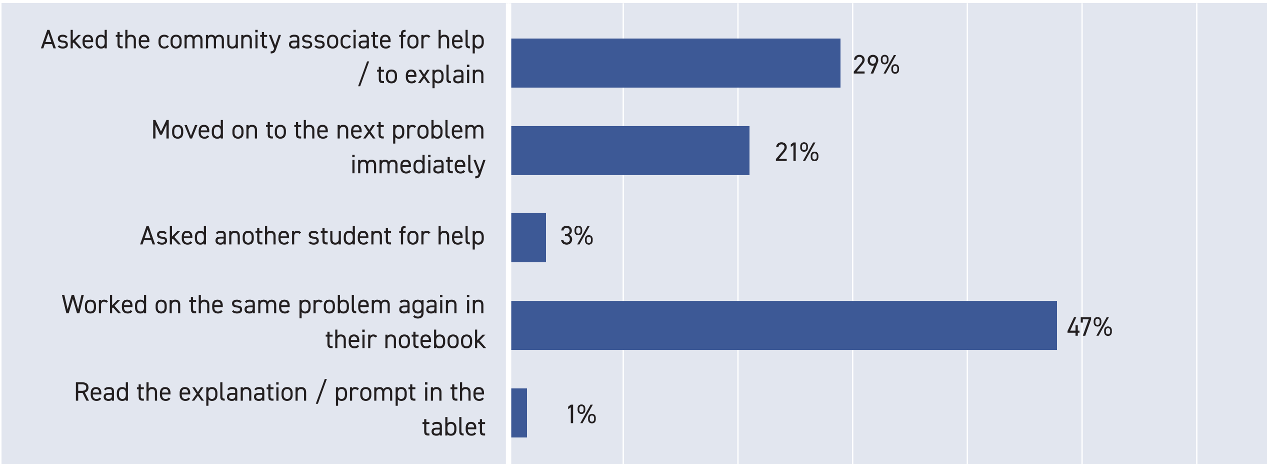
For example, while 69% of observed students asked community associates for technological assistance while working on the tablet, 67% of students also asked them for support on Mindspark math content. As shown in Figure 9, when students asked questions about math content on the tablets, community associates provided the correct answer while also explaining or modeling the solution more than three-quarters of the time (77%). Additionally, community associates explained the concept or gave a hint approximately one-quarter of the time, while they simply provided the correct answer without explanation or elaboration only 14% of the time. Furthermore, over half (54%) of community associates used manipulatives when explaining or modeling math content, questions, or problems from Mindspark.

Figure 9. Community associates' responses to student questions about Mindspark content



During targeted observations of individual students, observers noted that 47% of students incorrectly answered at least one question on the tablet. This is similar to the average rate of incorrect responses from Mindspark user data (43%). When students were faced with an incorrect answer, their most common response was to work on the same problem again in their notebook (47%) before moving on to the next problem on the tablet. However, nearly one-third of the time (29%), students asked a community associate for assistance in solving the problem. Interestingly, students did not tend to read the explanation or prompt provided by the tablet (only 1% did so).

Figure 10. Student action after incorrectly answering a question



In 49% of the ASCs, observers indicated that students were paired or arranged in small groups according to ability. In multigrade classrooms, purposeful seating arrangements were helpful to students since they often relied on their peers for support during tab time. More specifically, 59% of students talked to another student while working on the tablet. These conversations almost universally revolved around the tablet or math content, thus providing an additional layer of support to students without negatively impacting their time on task.

Research Question 2

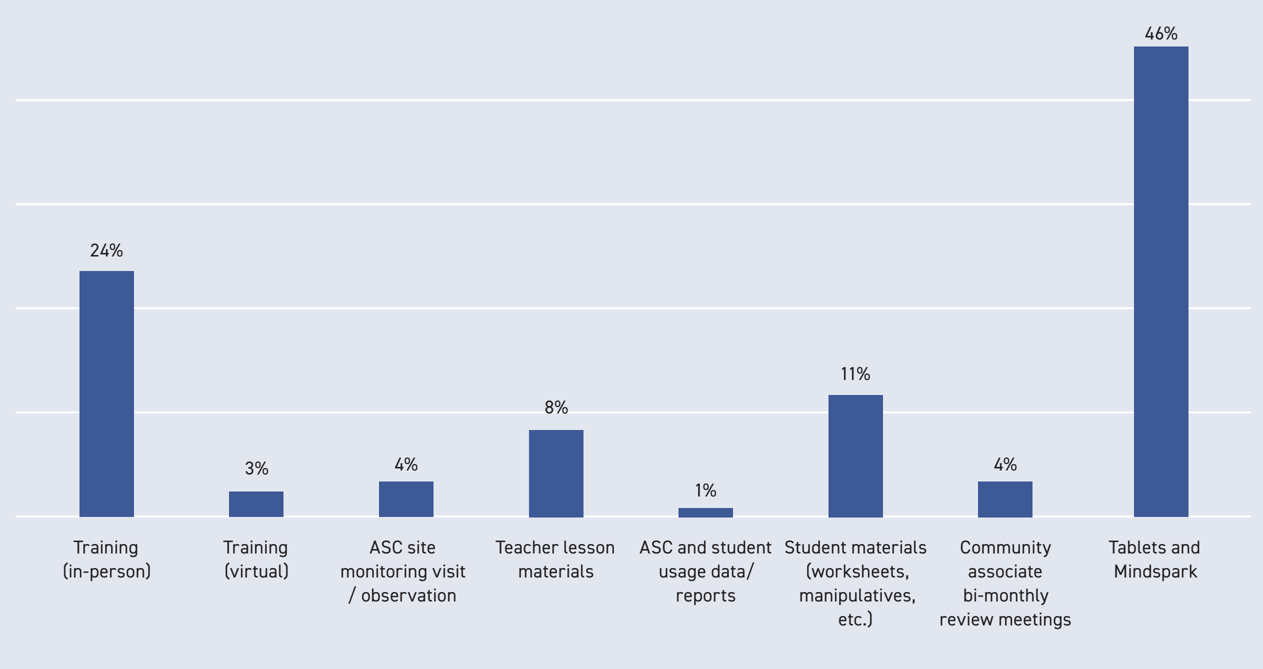
What methods of training and support lead to teachers adopting effective classroom practices?

THEME 1 Initial training and continuous development via twice-monthly review meetings may be particularly important for community associates with limited education and training.

Naandi Foundation and Educational Initiatives staff provide orientation training for new community associates. Training includes sessions on general program operations, as well as hands-on activities using tablets and other technologies, the Mindspark application and content, and data and dashboards. In addition, new community associates spend time shadowing another ASC or community associate during orientation.

When asked what they found to be the most useful support provided by Nanhi Kali, community associates most often said the in-person training, second only to the Mindspark app itself (Figure 11).

Figure 11. Most useful support, as reported by community associates



Community associates said that during the training, they found opportunities for discussion (46%) and small-group practice (41%) to be the most useful learning methods—more so than lecture, modeling, and large-group practice. In terms of the content presented, community associates found the guidance on using tablets and Mindspark most useful, followed by guidance on lesson plans and assessments (Table 1).

Table 1. Useful training content for facilitating student learning, according to community associates

Tablets and software / eLearning application	50%
Lesson plan development	30%
Conducting student assessments	11%
Using student assessment results	11%
Parental involvement	6%
Classroom management	4%

Following the initial training, community associates attend block-level twice-monthly review meetings led by project staff. Meetings are typically held at a central school or the project office and are designed to last approximately six hours. Agendas are prepared and shared in advance through WhatsApp. During these meetings, Nanhi Kali staff support community associates in reviewing student usage data from the Mindspark software to monitor progress.

During interviews, a subset of community associates were asked about these meetings (N=23). When asked if their lesson plan delivery or students' use of Mindspark changed due to the meetings they attended, 91% said they saw a large or very large improvement. (The remaining 9% said they saw a small improvement.) When asked about their level of participation during the meetings, 83% of community associates said they discuss their own experiences delivering lessons and facilitating Mindspark sometimes, most of the time, or always (Table 2).

Table 2. Community associate interviews: How often do you discuss your own lesson plan delivery and students' use of tablets/Mindspark during twice-monthly meetings?

Rarely	17%
Sometimes	52%
Most of the time	9%
Always	22%

When asked what they found useful from the meetings, community associates most often cited feedback on challenges, learning new information and approaches, and discussions with other community associates (Table 3).

Table 3. Community associate interviews: What do (or did) you find useful from twice-monthly meetings?

Feedback on how to improve or deal with challenges	65%
Learning new information and approaches	65%
Discussions with other community associates	57%
Time to practice teaching	43%
Refresher of skills, information, and approaches	43%
Having someone answer my questions	30%

THEME 2 Program staff use data to inform ongoing, positive monitoring and support.

Project office staff conduct site visits to monitor and support ASCs and community associates. Ideally, they visit each ASC two or three times per year. New ASCs and community associates—in addition to ASCs that are identified as "critical"—are prioritized and may be visited more frequently. During their visits, the project office staff use a digital monitoring form loaded on tablets to observe a community associate and collect data on other indicators such as average daily tablet time and student attendance. If a school has more than one ASC, the project office staff can observe more than one community associate during their visit. At the end of the visit, the project office staff provide feedback to the community associates.

Staff also monitor ASCs and community associates via weekly dashboard reports. These weekly reports are aggregated by block and shared with community associates in each block's WhatsApp group. One of the main indicators used to monitor ASCs is students' average time spent per day on tablets/Mindspark. The project staff highlight the top ten performing ASCs each week. The dashboard also identifies "critical" ASCs, which are those that have an average tab time of less than one hour per week. Project staff hold Zoom calls with community associates working at critical ASCs.

Twenty-five percent of interviewed community associates reported that they receive site visits once per month or more often. Virtually all (96%) community associates, who received visits, said that their skills improved as a result of the site visits.

Community associates reported that the observation itself was the most helpful activity during these visits. Roughly one-half also said that the visit was helpful because it allowed them to ask questions, get positive feedback, or discuss progress from a prior observation, or because it allowed the program officer to assess learners (Table 4). These activities all require either the collection and use of data or a positive, supportive approach by staff to these visits.

Table 4. Community associate interviews: What are (or were) the most helpful activities in a typical ASC site monitoring visit?

Program officer observes my teaching	83%
I ask the program officer questions about my teaching and how to improve	57%
Program officer provides positive feedback on my teaching	52%
Program officer and I discuss progress from last observation	48%
Program officer assesses learners	48%
Program officer provides areas of improvement for my lessons	43%
Debrief with other community associates	43%
Program officer provides feedback on student performance	39%
Program officer and I agree on skills / practices to focus on moving forward	35%
Discussion of expectations at start of visit	30%

When asked how they would describe the main purpose of their support for community associates, four of the five program officers interviewed said "to improve teaching in ASCs." Only one officer cited monitoring or evaluating community associates.

All program officers said they received a tablet, loaded with an observation tool, for use during their visits. Three officers said they had received training on how to conduct site visits, and three said they received technology support. Two officers said they received guidance from other program staff.

Four of the five program officers noted that they regularly follow up on community associates' progress from previous visits. However, when asked how they know what topics to follow up on, program officers gave a variety of responses: that they remember previous discussions, that they use records of the observation form tablets, and that they refer to community associates' notes. Program officers also said that they use the information collected during site visits to inform debrief discussions, to feed into improvement plans, and to use during twice-monthly meetings.

Future Considerations

The analysis undertaken by the study team includes evidence that echoes the positive findings of the previous impact study on the Mindspark instructional approach and identifies some of the key elements that appear to be contributing to the success of Nanhi Kali. The analysis also highlights two areas that could be considered for future programming:

Will technology be the future of remediation?

One of the biggest questions surrounding after-school programs for early grade learners is who should be responsible for instruction. Some claim that it should be teachers, since they are trained in early grade instruction and are therefore acutely familiar with the content. However, teachers in many contexts are already overburdened and simply cannot take on additional responsibilities (regardless of whether doing so comes with additional incentives). Others feel that community volunteers are best suited for this work because they are intrinsically motivated and can reduce some of the burden on teachers. However, community volunteers are rarely pedagogical experts, nor do they typically receive comprehensive training on "how to teach." The Nanhi Kali approach of combining a tested instructional model (i.e., tablet-based instruction via Mindspark) with supplementary support from community volunteers may ultimately provide the best of both worlds.

The importance of focusing on coaching as both a signal and a support.

In recent years, coaching has become commonplace in most instruction-focused early grade education programs in low- and middle-income countries. However, one of the complicating factors has been ensuring that coaches can visit schools and teachers as often as needed. Therefore, it is difficult to either provide sufficient support or to provide a consistent signal about the priorities of a given program. The three-pronged approach to community associates' support in Nanhi Kali serves to address that concern. Direct coaching and support through ASC visits are essential but limited. They are thus supplemented with more frequent block-level review meetings, which include training and high-level support. Finally, by including weekly remote monitoring of ASCs through dashboard reports, Nanhi Kali provides a clear and consistent signal of program priorities, such as ensuring adequate opportunities for tab time. This model should be considered by other programs—particularly those with limited support staff.

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