Sattva Knowledge Institute SKI perspective

HARNESSING DIGITAL PUBLIC GOODS FOR FOUNDATIONAL LEARNING: USE CASES FOR SUNBIRD SARAL

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Acknowledgements

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Acronyms

ASER	:	Annual Status of Education Report
DPG	:	Digital Public Good
FLN	:	Foundational Literacy and Numeracy
LSA	:	Large Scale Assessment
MSDF	:	Michael and Susan Dell Foundation
NAS	:	National Achievement Survey
NDEAR	:	National Digital Education Architecture
OCR	:	Optical Character Recognition
OMR	:	Optimal Mark Recognition

Executive Summary

Foundational Literacy and Numeracy (FLN) in India is still in crisis despite significant improvements in student enrollment and retention in elementary schools. Only about 20% of rural students in class 3 can read texts intended for grade 2, according to the Annual Status of Education Report (ASER) 2022. Similarly, less than one-third of class 3 children demonstrate knowledge of subtraction or division and are yet to master math skills taught in lower grades.

Large-scale assessments (LSAs) such as ASER help to diagnose the learning deficiencies of students. Regular, timely, and effective LSAs can significantly contribute to resolving the ongoing learning crisis by guiding policy through data-driven decision-making. LSAs are crucial policy instruments that deepen pedagogy practice and improve governance. However, the sheer size of the Indian primary education system, with 75 million students enrolled in elementary grades 1 through 3, prevents high-frequency, high-quality, large-scale assessments from taking place due to time and cost considerations.

A big challenge in conducting large-scale assessments is digitising the massive volume of data. Many assessments are still done on paper, and student records and answers need to be digitised for analysis. For many LSAs, data entry workers manually input the assessment results into a spreadsheet format. The reliance on a labour-intensive, error-prone manual data capture process, or rekeying, poses a risk to the conduct of regular and high-quality assessments, as valuable time is lost in this massive exercise.

The Sunbird Saral reference application, developed per the openness and interoperability principles of the National Digital Education Architecture (NDEAR), addresses the concern of inefficient data collection. Data in physical formats can be instantly converted to digital form using Saral, a digital public good (DPG). It's capable of recognising handwritten numbers using advanced optical character recognition (OCR) technology. In 2022, nearly 6 lakh instructors in Uttar Pradesh adopted the Saral mobile app, which was created using Sunbird Saral, to instantly digitise the handwritten formative assessment data for more than 1.4 crore students. Similar digital solutions built on top of Saral, were deployed in Gujarat, Assam, Odisha and Jharkhand. Using Saral's streamlined procedure, data collection in these states was finished within one day instead of 3 to 4 months with manual data capture.

Through exploring the use cases of Sunbird Saral and examining how it can be used in conjunction with complementary DPGs, we hypothesise how it can improve foundational learning outcomes in students. In addition to speed and accuracy, Saral's automated data collection can provide further advantages. Interoperability between Saral and other NDEAR building blocks unlocks additional functionalities such as analytics, dissemination of insights, and targeted remedial instruction. This can empower teachers, parents, school administrators and educational policymakers to access and use assessment data to improve foundational learning.

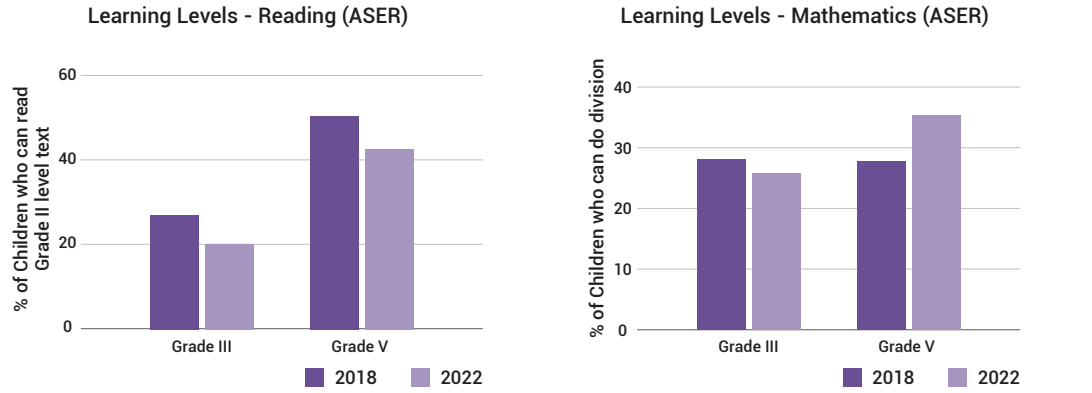
Saral, being a DPG, is at a relatively early stage of development and adoption. Philanthropy can significantly contribute in removing operational hurdles and lowering the cost of implementing DPGs like Saral. We identify three key areas where philanthropic organisations can focus their efforts to support the wider and faster deployment of these digital commons. We elaborate on how donor capital can foster dialogue around innovation in DPGs, forge strategic partnerships to integrate DPGs like Saral within educational interventions and provide support for capacity building to accelerate the reach of Saral and other NDEAR compliant ed-tech tools.

Foundational Learning Needs Urgent Attention

Despite massive strides in student enrolment and retention in primary schools, Foundational Literacy and Numeracy (FLN) continues to be in crisis in India. The ASER, which provides estimates of children's enrolment and basic learning levels for nearly 600 rural districts of India, captures this crisis well. According to ASER 2018, only 27.3% of all government and private students of Class 3 can read text meant for grade 2. The percentage of children in Class 3 in government and private schools who can read at the Class 2 level further dropped to 20.5% in 2022 (ASER 2022). The findings are similarly disappointing for math (numeracy) outcomes as well, with less than one-third of Class 3 students being able to perform division.

Similar learning levels are reported by the National Achievement Survey (NAS), which is a large-scale survey of student learning undertaken by the Ministry of Education. Overall national performance results of NAS 2017 show that only 36.7% of Class 3 students were proficient in mathematics. A more recent round of NAS, 2021 reports a worrying decline in the learning levels of students. Moreover, UNICEF (2022) reported that in rural Karnataka, the share of Class 3 students in government schools able to perform simple subtraction fell from 24% in 2018 to only 16% in 2020, presumably owing to the pandemic-induced school closures.

Figure 1: Less than 30% of rural students in grade 3 are proficient in foundational skills



Source: ASER, 2018 and 2022

Regular and timely large-scale assessments of learning can help to diagnose the FLN crisis

LSAs that are regular, timely and effective can play a significant role in remedying the FLN crisis by informing policy through data-driven decision-making. LSAs are essential policy tools to improve governance and accountability in addition to strengthening pedagogy practice and customising intervention design (CSSL et al. 2021; Tobin et al. 2015). While district and state administrators can use LSAs to identify high priority geographies or groups, schools and teachers can gain sharp granular insights into the learning competencies and deficiencies of students at the subject and learning outcome level.

To drive LSAs and address the learning crisis in India is a mammoth task and requires the mobilisation of various stakeholders, including NGOs and philanthropic organisations. The interest of philanthropists in aiding the conduct of large-scale assessments stems from the fact that LSAs provide the donor community with quality data and information to support their decision to invest in improving the learning outcomes of children (UNESCO 2022). On the other hand, donors stimulate policy dialogue and action while providing scale to interventions.

Philanthropic organisations like the Michael and Susan Dell Foundation (MSDF) have successfully implemented LSAs in India by partnering with assessment organisations such as Educational Initiatives and ConveGenius Insights. LSAs supported by the MSDF in Haryana, Rajasthan, Himachal Pradesh, and Andhra Pradesh have demonstrated how large-scale testing can improve learning outcomes. These results were reported to have been used by stakeholders for changes in policies at the systemic and school level. For instance, in Haryana, the evidence for improvement in learning outcomes encouraged the establishment of a dedicated budget for high-quality LSAs.

Figure 2: Philanthropists can choose from a range of digital tools for tech-enabled assessments*

*Indicative list

Digitising and Managing Large Amounts of Data from Regular LSAs is a Challenge

While the NAS and ASER reports highlight the learning crisis effectively, these surveys do not happen at a regular frequency (CSSL et al. 2021). ASER is conducted every alternate year, and NAS every three years (ASER 2022; *Indian Express* 2021). Given the scale of the primary education system, time and cost considerations prevent high-frequency large-scale assessments from taking place. more frequently.

Further, these initiatives assess a representative sample of students, rather than the entire student population. For example, there are 18 crore enrolled school students in rural India (U-DISE 2022) but ASER conducts the assessment for only about 6 lakh students. While the sampling strategy ensures that the findings can be generalised for the entire population, it is challenging for the state education departments to make sharper policy decisions such as customised interventions at the school, classroom or student level, using this data.

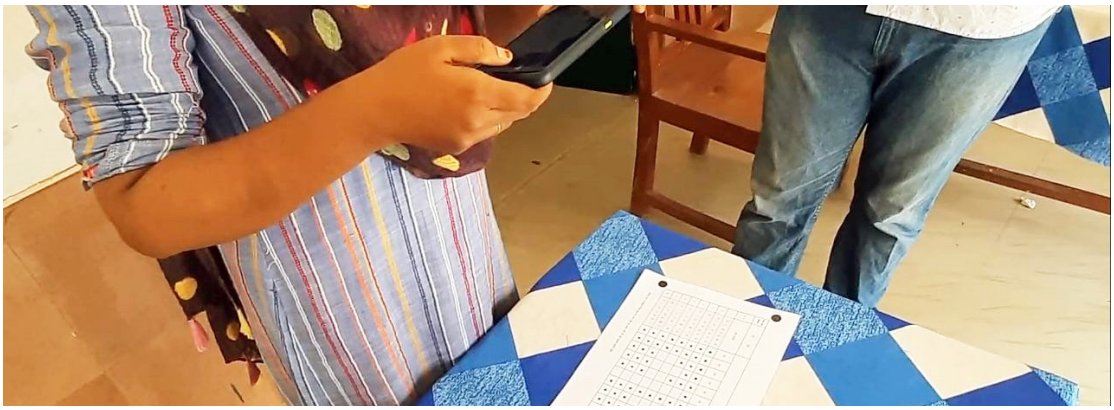
The value of LSAs such as ASER and NAS can be enhanced severalfold by collecting data on every student. Nearly 75 million students are enrolled in grades 1 through 3 in India (U-DISE 2022). While regular assessments at the population scale can unarguably allow educators, administrators, and policymakers to support timely learning improvements, conducting such assessments and managing the data is a mammoth task. Digitising the large amount of data generated from frequent large-scale assessments is a key challenge. Given the diversity of schools in India, many assessments continue to be conducted in pen-and-paper mode, and student records and answers need to be digitised for further analytics.

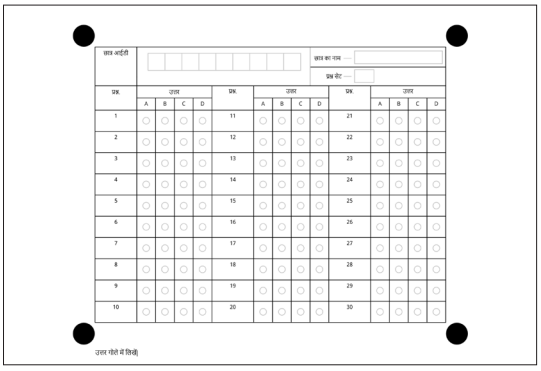
Digitised assessment records and computerised report cards are increasingly being embraced by education administrators and policymakers in India, but some problems remain. One of the critical challenges is the dependence on manual data capturing, or rekeying, which is time-consuming and prone to errors. In this laborious process, data entry operators manually feed the results of physical assessments into a spreadsheet format. Given the large number of students in the Indian schooling system, this process can take months, or even years in a few cases, to complete. For example, assessment data collected in a physical format for nearly 6 lakh rural students by the ASER survey takes almost two months to enter and analyse (ASER 2018). Due to the effort-intensive nature of this task, conducting regular assessments for timely intervention becomes difficult, posing a massive risk to efficient governance and administration.

Saral Eases the Process of Digitising Assessment Records, Unlocking many Cross-functionalities

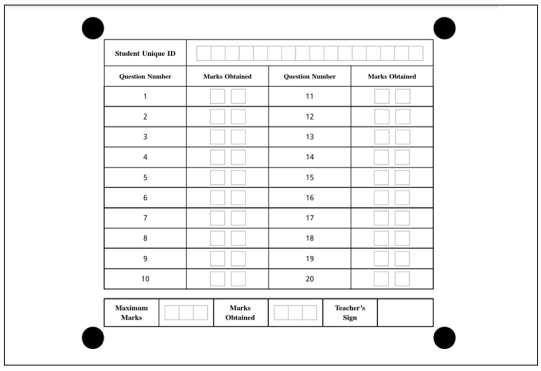
The challenge of inefficient data capturing is addressed by the Saral reference application, built on the National Digital Education Architecture's (NDEAR) principles of interoperability and openness. Sunbird Saral is a DPG that instantly digitises physical format data. It is an Optical Character Recognition (OCR) application that also recognises handwritten numerical data. In addition to exam or assessment data, Saral's flexible configuration can be used to digitise quantitative information traditionally captured in a physical (pen-and-paper) format, including attendance records, school visit observations and nutritional indicators (height and weight measurements). Saral eases the process of data collection by transforming data in physical records into structured, digitised data. The Saral app developed using Sunbird Saral was adopted by 6 lakh teachers to instantly digitise handwritten formative assessment data for 1.4 crore students in Uttar Pradesh in 2022 (Department of Basic Education, Uttar Pradesh Government, 2022). Almost 80% of the primary and middle school population was covered in this exercise, allowing visibility on the students' learning performance at a large scale. Other solutions built on top of the Saral building block have been piloted in Assam, Jharkhand, and Odisha. In these states, data capturing was completed within 1-2 days with Saral's simplified process compared to the drudgery of 4 to 6 months with manual data capture.

Figure 3: Printed sheets in OMR format are scanned instantly with Saral mobile app





उत्तर गोले में लिखें



Student Unique ID			
Question Number	Marks Obtained	Question Number	Marks Obtained
1		11	
2		12	
3		13	
4		14	
5		15	
6		16	
7		17	
8		18	
9		19	
10		20	
Maximum Marks		Marks Obtained	Teacher's Sign

Source: Department of Basic Education, Uttar Pradesh Government, 2022

USE CASE FOR NON-PROFITS
Simplifying Large-Scale Assessments with Saral

Non-profit organisations such as the Central Square Foundation and the Centre for Science of Student Learning have been working with state and district administration to transform school education in India (Sharma and Sachdeva 2022, Centre for Science of Student Learning et al., 2021). These organisations can integrate Saral within existing assessment programs to efficiently diagnose learning deficiencies and use the diagnosis as input to drive learning improvement interventions.

The first step in implementing a learning intervention is to conduct an assessment to diagnose the existing learning levels. This diagnosis can be used to design appropriate learning programmes for remediation. Given the large number of schools and students, carrying out an assessment is a massive exercise. For example, Central Square Foundation collaborated with the Punjab government to conduct a baseline assessment for students sampled from 13,000 schools. The assessment captured 400 data points per student, including student scores on three subjects. Many other organisations and state governments are working on similar assessments.

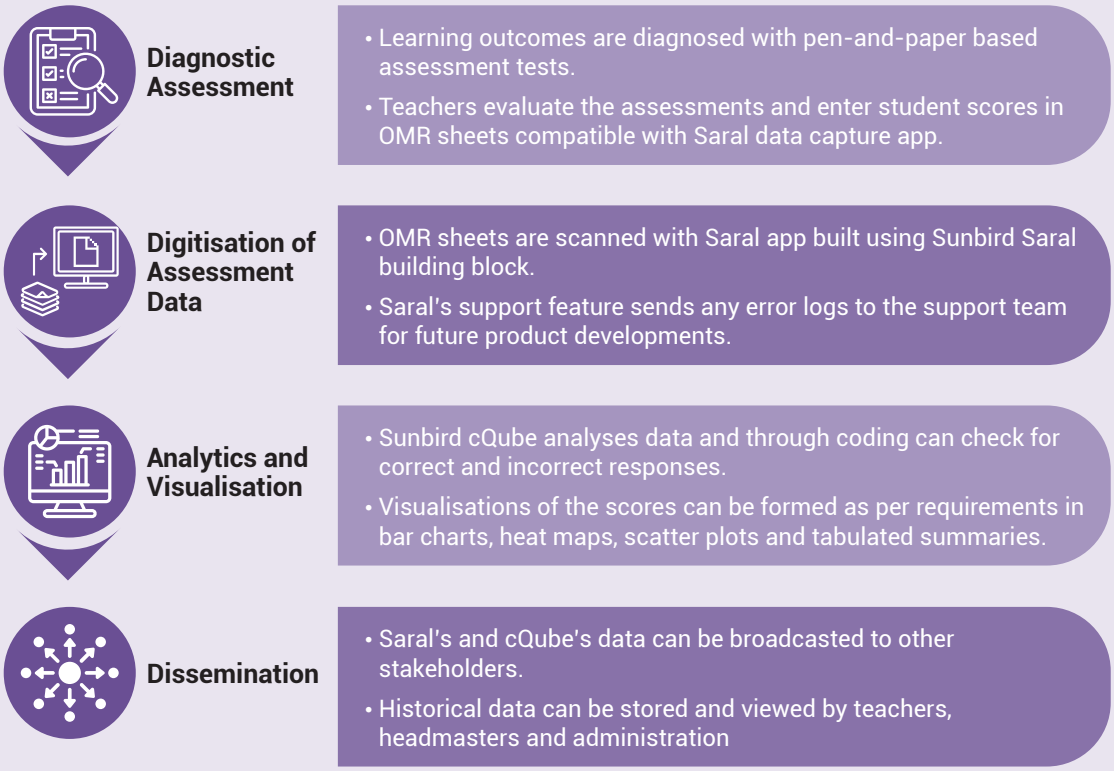
Using Saral for the above exercise can simplify large-scale operations' data-capturing, analysis and dissemination processes to empower ecosystem partners for taking evidence-based decisions:

- **Instant data capture:** Saral can read handwritten numbers and student answers (or scores) recorded in a printed format similar to a traditional Optical Mark Recognition (OMR) sheet. The layout of the printed sheets can be configured in different formats according to the requirement. The printed OMR sheets can be scanned with a mobile-phone-based application created using the Saral building block. The data captured by Saral can be saved locally in offline mode, which is useful in remote areas with erratic internet connectivity. Further, the support feature of Saral allows troubleshooting by quickly sharing failure logs with a support team.

- **Simplified analytics:** The data captured by Saral is emitted to the backend for analytics and visualisation with Sunbird cQube, a complementary DPG. This analytics engine processes assessment data to generate actionable metrics and visualisations of these metrics. Several pre-defined visualisation options are available in cQube, such as maps, bar charts, scatter plots, tabular reports, heat maps and trend charts. This can enable school administrators to access the learning histories of students in an easy-to-understand format. State-level Vidya Samiksha Kendras (Command and Control Centres) are also using the metrics generated from cQube to feed into real-time data dashboards to enhance the overal governance of the education sytem. Additionally, student performance can be analysed at a granular level, to understand the deficiencies and competencies in exact concepts or learning objectives.

- **Frictionless dissemination:** In addition to speed and accuracy, Saral's automated data capturing yields other benefits by making large-scale assessments more effective. Interoperability across the building blocks enables seamless integration with other building blocks of NDEAR to unlock key functionalities. For example, by leveraging solutions such as cQube and student registries, it is possible to prepare digital report cards using the data collected by the Saral app. Digital report cards provide an overview of the obtained results. These summaries can be shared with multiple stakeholders, including teachers, students and their parents.

Figure 4: Simplifying assessments with digital public goods



Source: Sattva 2023

USE CASE FOR NON-PROFITS

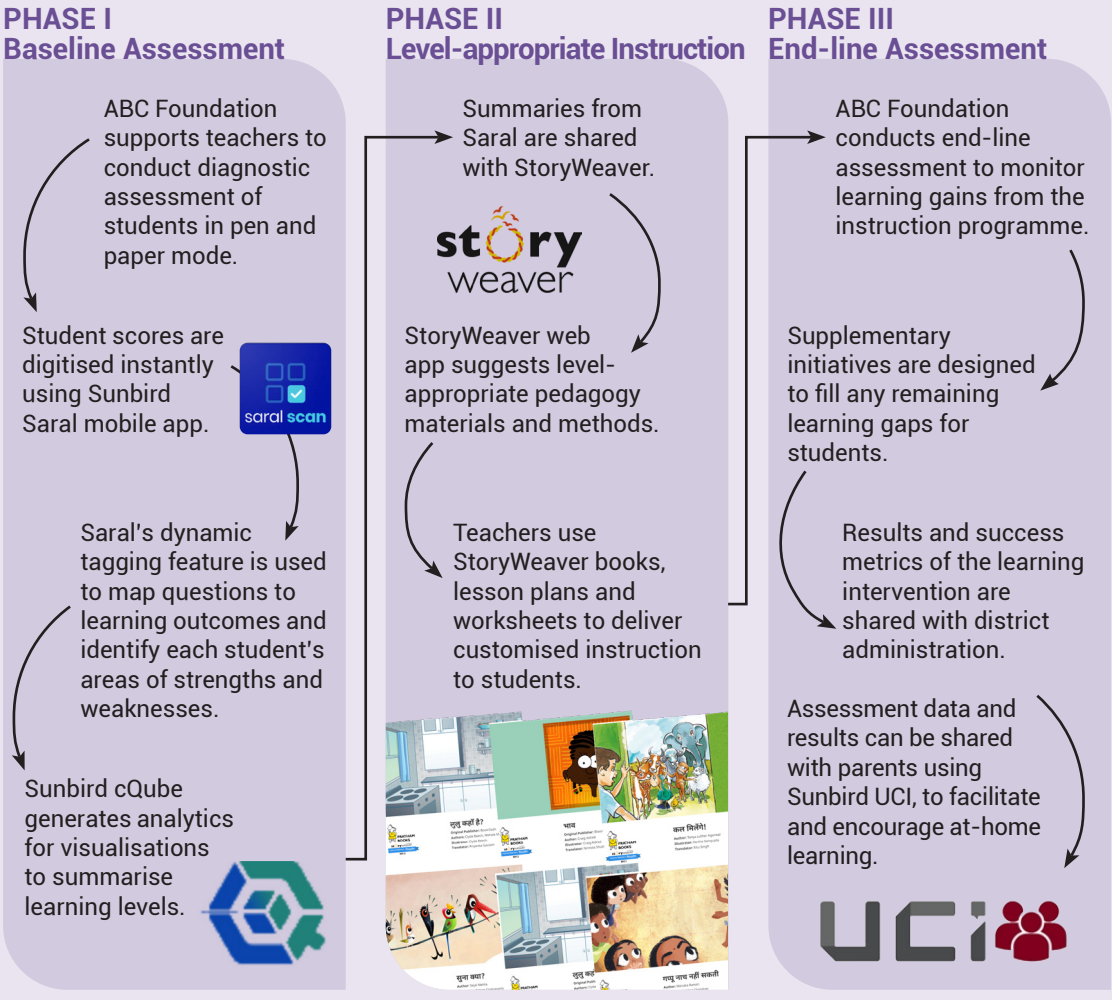
Designing Interventions to Improve Foundational Learning by Leveraging NDEAR-compliant Solutions

For-purpose organisations such as the MSDF, Piramal Foundation, Pratham Foundation, Teach for India and others have driven large-scale assessments and educational interventions in India. Integrating NDEAR-compliant DPGs into the diagnosis and learning improvement programmes can help these organisations achieve last-mile impact at scale. For example, Saral's diagnostic capabilities can be used in conjunction with complementary digital commons, such as StoryWeaver (by Pratham Books), to deliver effective level-appropriate instruction to students.

Similar to Saral, StoryWeaver is a DPG, built using the 'open' philosophy with open-source content and code at its core. StoryWeaver's Foundational Literacy Programme comprises 180 freely accessible digital books across six reading levels for Grades 1 through 3. In addition to the books, the programme provides supporting teaching-learning resources such as lesson plans, discussion questions, instructional routines and demo videos.

Consider the ABC Foundation, a non-profit organisation which supports primary school teachers in government schools to improve foundational reading fluency among students. The intervention consists of three key steps: a **baseline assessment** to diagnose initial learning levels, an **instruction** programme teaching the level-appropriate curriculum, and an end-line **assessment** to measure the learning gains of the programme. Conducting assessments and capturing data manually is time-consuming, hence the Foundation, with its limited personnel capacity, works with 10 schools in an academic year. By combining the capabilities of Saral and StoryWeaver, ABC Foundation can streamline and accelerate the intervention to scale up its efforts and reach more schools.

Figure 5: Achieving foundational literacy with Saral and StoryWeaver



Source: Sattva 2023, with inputs from StoryWeaver

Key Risks Need to be Addressed to Tap into the Full Potential of Saral

There are several attractive features of Saral, such as an offline mode and integration with an analytics engine. These advantages can drive up the use and application of this powerful digital common across various sectors in high-value use cases. However, the large-scale adoption of Saral may be hindered by certain risks that have been observed in the implementation and other stages. Mitigating these risks will be crucial for wider use and application of this digital building block.

Training requirements

Certain guidelines need to be followed while using the Saral app for the successful scanning of an OMR sheet. For example, the mobile device needs to be handheld in landscape mode, the sheet should be kept on a table, and one needs to wait for specific indicators on the sheet to be detected by the app before initiating a successful scan. The personnel involved with the scanning process requires extensive training and hands-on experience to understand and adhere to these protocols.

Quality of digital solution

While Sunbird Saral provides the reference application, States have built their own digital solutions using the reference. It was observed that the quality of these solutions varied across states, owing to differences in the technical expertise of app developers. Since the backend capacity, user interface design and troubleshooting quality, together influence the adoption and convenience of use, the technology partner needs to ensure a robust design of the solution configured using the reference app.

State capacity and buy-in

Lack of resources at the State level to engage a technology partner, procure equipment, or conduct training can introduce friction in adopting Saral app for LSAs. Further, behavioural reasons such as inertia and unwillingness to try out a new solution may prevent state governments from participating in stakeholder discussions. For example, representatives from the Tamil Nadu government did not participate in the National Education Ministers Conference which facilitated deliberations on digital education initiatives such as NDEAR and Vidya Samiksha Kendra. Since India has a federal structure, and education is a concurrent subject in the Constitution, state-level acceptance and adoption of digital public goods is a key success metric to measure the reach of such solutions.

Philanthropy Can Accelerate the Reach of DPGs such as Saral

The reach of Saral and similar DPGs will accelerate further if the frictions are lowered. Philanthropy can play a prominent role in smoothing out operational friction and reducing the cost of adopting DPGs. Collaboration between social sector partners can facilitate wider and faster deployment of DPGs.

Figure 6: Philanthropy can orchestrate wider reach of DPGs by collaborating with ecosystem partners

Action	Collaborators	Intended Outcomes
Establishing collectives to drive innovation	• Industry experts • Technology leaders	• Strong networks for peer learning opportunities.
Enabling incubation support	• Ed-tech companies • Academia	• Participation by diverse actors.
Closing the imagination gap	• Technology leaders • Community networks	• Ideation of use cases.
Integrating Saral into learning intervention programmes	• State governments • District administration • Non-profit partners	• Enhanced monitoring and governance. • Wider adoption of Saral.
Capacity building at state-level and school-level	• Non-profit partners	• Enhanced processes to drive regular LSAs.
Training and troubleshooting	• Non-profit partners	• Reliable, timely data from LSAs with minimal errors.

Fostering dialogue and thought leadership around innovation in digital public infrastructure.

Philanthropists could support the thinking and vision around new-age solutions, such as Saral, by inviting thought leaders and experts to share their technical expertise and guidance.

Establishing dedicated collectives to drive innovation: Several contributors and volunteers have endowed organisations such as the Indian Software Product Industry Round Table (iSPIRT) and Foundation for Interoperability in Digital Economy with their talents and knowledge to collectively energise the vision of open digital technologies that can be used for social good. Funders, philanthropists and industry experts can lead similar non-profit technology collectives to drive innovations and pilots for NDEAR building blocks. These knowledge experts can support peer learning by contributing their ideas to develop NDEAR-compliant DPGs and aiding in designing lean user–facing platforms with robust backend and frontend architecture.

Enabling incubation support: Funders can crowd in participation from knowledge partners such as academicians and practitioners. For example, the Bill & Melinda Gates Foundation, Sir Ratan Tata Trust and Omidyar Network have funded the International Institute of Information Technology, Bangalore's (IIIT-B) initiative to anchor Modular Open Source Identity Platform (MoSIP) as a global DPG. Funders can also support ed-tech players to build or integrate Saral into their existing solutions to enrich the ecosystem and encourage the co-creation of solution capabilities. This could also incentivise private players to contribute to the ecosystem.

Co-creating shared value through strategic partnerships.

The positive network effects of DPGs will be realised with wide participation from multiple stakeholders. Philanthropists can forge partnerships with local governments and social sector players to enable widespread last-mile deployment of DPGs like Saral. The newly launched District Empowerment Initiative gives more choice and agency to District Institutes of Educational and Training to identify local needs and collaborate with appropriate ecosystem partners to remedy school education. There are more than 700 districts, which opens up huge potential for philanthropy to orchestrate customised learning interventions by engaging the non-profit sector and respective district administrators.

Closing the imagination gap: Technology leaders and key players in the impact ecosystem can collaborate to demonstrate the value of Saral or similar DPGs and spur imagination by developing diverse use cases which contextualise the technology. This can be done through field testing of digital solutions and supporting the creation of proofs of concepts, by involving last-mile actors and community partners. Organisations such as the Digital Public Goods Alliance and eGov foundation have initiated steps in this direction.

Integrating Saral into ed-tech initiatives: Ongoing and upcoming large-scale assessment programmes funded by philanthropic organisations can leverage Saral-based assessments as an efficient diagnostic solution. Funders can also collaborate with state governments and non-profit players to monitor the progress of educational interventions by integrating Saral into the governance mechanisms.

Resolving operational bottlenecks through training and capacity building.

Capacity bottlenecks and lack of training can slow down the adoption of DPGs such as Saral. Donor capital has a vital role to play in bridging these gaps.

Building capacity at a state and school level: Philanthropic capital can build administrative capacity to strengthen processes and deployment of state-wide learning assessments. Funders can also provide support to conduct post-assessment workshops to enable schools and teachers to use the analytics generated by Saral and cQube.

Training and troubleshooting: The quality and accuracy of data collected through Saral heavily depend on adherence to guidelines and protocols. The training component of each round of large-scale assessments can cost up to ₹30 lakh (CSSL et al. 2021). Philanthropic capital can assist with conducting extensive personnel training focusing on experiential learning to prevent errors in data capturing. Additionally, donor capital can be earmarked to facilitate remote technical support and troubleshooting to take care of real-time concerns.

Conclusion

NDEAR's vision for education has immense potential to energise ed-tech initiatives in India, by enabling and encouraging synergies between diverse solutions. DPGs such as Saral and cQube aligned with NDEAR's guiding principles can be utilised to drive large-scale assessments which diagnose the extent and nature of India's foundational learning crisis. Assessment data and analytics can be critical inputs for data-driven decision-making, which can address the massive learning crisis, when used along with complementary remedial solutions such as StoryWeaver digital books.

Philanthropy has a large role in orchestrating faster adoption of DPGs by bringing together multiple stakeholders such as non-profit partners, government representatives and technology experts. These synergistic collaborations can drive the innovation and reach of DPGs in education. While industry leaders can encourage innovation and enable incubation support, funders can ensure that these innovative solutions are deployed on the ground, with the help of implementation partners. Further, donors and non-profit partners can contribute towards last-mile capacity building and advocacy for wider adoption and participation.

References

- About MOSIP 2019, *mosip.io*.
- Agarwal, P 2022, How tech adoption can help transform school assessments and empower teachers to provide a better learning environment, *Times of India Blog*, viewed 2 February 2023.
- ASER 2023, *Annual Status of Education Report (Rural) 2022*, ASER Centre.
- Bharathi, P et al. 2020, The Gujarat Model: Managing Learning Continuity During COVID-19, *World Bank Blogs*, viewed 2 February 2023.
- Blair, K & Schwartz, D 2012, How technology can change assessment, *UNESCO Institute for Information Technologies in Education*.
- Centre for Science of Student Learning et al. 2021, *Large-scale Assessments in India*.
- Clarke, M & Diego, L-B 2021, *Primer on Large-Scale Assessments of Educational Achievement*, National Assessments of Educational Achievement series. *World Bank*, Washington DC.
- Department of Basic Education, Uttar Pradesh Government 2022.
- DT Next Bureau 2022, TN govt boycott 2-day conference on National Edu Policy, *DT next*, viewed 2 February 2023.
- Ministry of Education, Government of India 2021, *National Digital Education Architecture*.
- Ministry of Education, Government of India 2021. *National Achievement Survey 2021 has been conducted successfully across the country, with enthusiastic participation of schools and students* [Press release].
- Mukherjee, A & Maruwada, S 2021, Fast-Tracking Development: A Building Blocks Approach for Digital Public Goods, *Center for Global Development*.
- Muralidharan, K & Sundararaman, V 2010, 'The Impact of Diagnostic Feedback to Teachers on Student Learning: Experimental Evidence from India', *The Economic Journal*, vol. 120, no. 546, pp. F187-F203.
- *Online Assessments Results (Capturing Student-Level Question wise Data in a short period)* 2017.
- Sharma, N & Sachdeva, S 2022, Using Technology for Large-Scale Assessments: Learnings from Punjab Baseline Study, *www.centralsquarefoundation.org*.
- Sunbird Saral Overview 2022, *Sunbird.org*.
- *The Economic Times* 2022, 'All stakeholders must come on board to resolve literacy crisis caused by Covid: Rajnath Singh', viewed 2 February 2023.
- Tobin, M et al. 2015, *Using Large-scale Assessments of Students' Learning to Inform Education policy: Insights from the Asia-Pacific Region*.
- Tobin, M, Nugroho, D, & Lietz, P 2016, 'Large-scale assessments of students' learning and education policy: synthesising evidence across world regions', *Research Papers in Education*, vol. 31, no. 5, pp. 578-594.
- UNESCO 2018, *The impact of large-scale learning assessments*.
- UNICEF 2022, *Where Are We on Education Recovery?*
- Von Maurice, J, Zinn, S, & Wolter, I 2017, 'Large-scale assessments: potentials and challenges in longitudinal designs', *Psychological Test and Assessment Modeling*, vol. 59, no. 1, pp. 35-54.
- Windlass, P & Dublish, S 2021, *How Large-Scale Assessments Improve Learning Outcomes in India?*