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Digital integration: Catalysing public school transformation

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Foreword by KPMG in India

Over the last two years, all of us have experienced the role of technology in our lives and have witnessed how it has saved millions of children from 'unlearning' education. India responded aggressively to the challenges posed during the pandemic by reimagining education delivery through innovations ranging from content delivery through social media platforms and mobile apps, chatbots for conducting assessments, webinars for training of staff and so on. The disruption that was witnessed only reaffirmed that technology is here to stay in education delivery. The government also provided an impetus to this digital transformation in school education through various policy interventions and initiatives such as the National Education Policy (NEP) 2020, NDEAR, Learning Enhancement Guidelines, among others. We see World Bank and ADB funded programmes such as STARS and ASPIRE add further impetus to this by laying out certain clear digital priorities to help achieve programme results.

While we have seen tremendous advancements on one hand, the last two years also threw up a multitude of challenges for all stakeholders related to technology adoption. These challenges were across the levers of access, equity and quality of learning and impacted a range of stakeholders including teachers, students, parents, school leaders, education administrators and the government. To scale up innovations and institutionalise good practices for lasting impact, there is a pressing need to take a planned approach to digital integration in public schools in India.

In this direction, this paper outlines the key recommendations for systemic adoption of technology practices in public school education, across the four broad pillars of (i) access to devices, (ii) digital capacity building for in-service teachers and educational administrators, (iii) digital content ecosystem, and (iv) assessment and analytics. It brings perspective on how some of the current challenges can be mitigated through investments made in technology reforms by central and state governments, through phased implementation based on the state's needs and priorities.

We, at KPMG in India, thank everyone who has helped us in bringing out this paper. We hope this triggers a dialogue among policy makers, ecosystem players and decision makers at the centre and states to bring systemic, tech-led transformation in the domain of education.

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Table of contents

List of figures

List of tables

List of boxes

List of abbreviations

ADB	Asian Development Bank
AI	Artificial Intelligence
ANOVA	Analysis of Variance
AR	Augmented Reality
ASPIRE	Accelerating State Education Program to Improve Results
AWP&B	Annual Work Planning & Budgeting
CAL	Computer Adaptive Learning
CBSE	Central Board of Secondary Education
CPD	Continuous Professional Development
CWSN	Children with Special Needs
DIKSHA	Digital Infrastructure for School Education
DEO	District Educational Officer
DTH	Direct to Home
ECCE	Early Childhood Care and Education
E-MIS	Education Management Information System
HPC	Holistic Report Card
HRMS	Human Resource Management System
ICT	Information and Communication Technology
IT	Information Technology
LMS	Learning Management System
MEiTY	Ministry of Electronics and Information Technology
MEXT	Ministry of Education, Culture, Sports, Science and Technology
MIS	Management Information System
ML	Machine Learning
MoE	Ministry of Education
MOOC	Massive Open Online Course
MoP	Ministry of Power
MSDF	Michael & Susan Dell Foundation
NAS	National Achievement Survey
NCERT	National Council of Educational Research and Training
NCTE	National Council for Teacher Education
NDEAR	National Digital Education Architecture
NDLI	National Digital Library of India
NEP	National Education Policy
NIC	National Informatics Centre
NIEPA	National Institute of Educational Planning and Administration
NIPUN	National Initiative for Proficiency in Reading with Understanding and Numeracy
NISHTHA	National Initiative for School Heads' and Teachers' Holistic Advancement
NLP	Natural Language Processing
NPST	National Professional Standards for Teachers
NROER	National Repository of Open Educational Resources
OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturers
OLPC	One Laptop per Child
PARAKH	Performance Assessment, Review, and Analysis of Knowledge for Holistic Development
PDF	Portable Document Format
PISA	Programme for International Student Assessment
PLC	Professional Learning Communities
PLI	Production Linked Incentive
PMU	Project Management Unit
PRABANDH	Project Appraisal, Budgeting, Achievements and Data Handling System
PRAGYATA	Plan, Review, Arrange, Guide, Yak(talk), Assign, Track, and Appreciate
QCBS	Quality cum Cost-Based Selection
QR	Quick Response
RACI	Responsibility, Accountability, Consulted, Informed
RFP	Request for Proposal
RIDE	Readiness Index for Digital Education
SAFAL	Structured Assessment For Analysing Learning
SAS	State Achievement Survey
SCERT	State Council of Educational Research and Training
SEDG	Socio-Economically Disadvantaged Groups
SS	Samagra Shiksha
STARS	Strengthening Teaching Learning and Results for States
SWAYAM	Study Webs of Active-Learning for Young Aspiring Minds
TAG	Teacher Activity Group
UDISE	Unified District Information System for Education
UI	User Interface
ULOF	Unified Learning Outcome Framework
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UX	User Experience
VR	Virtual Reality

01 Executive summary

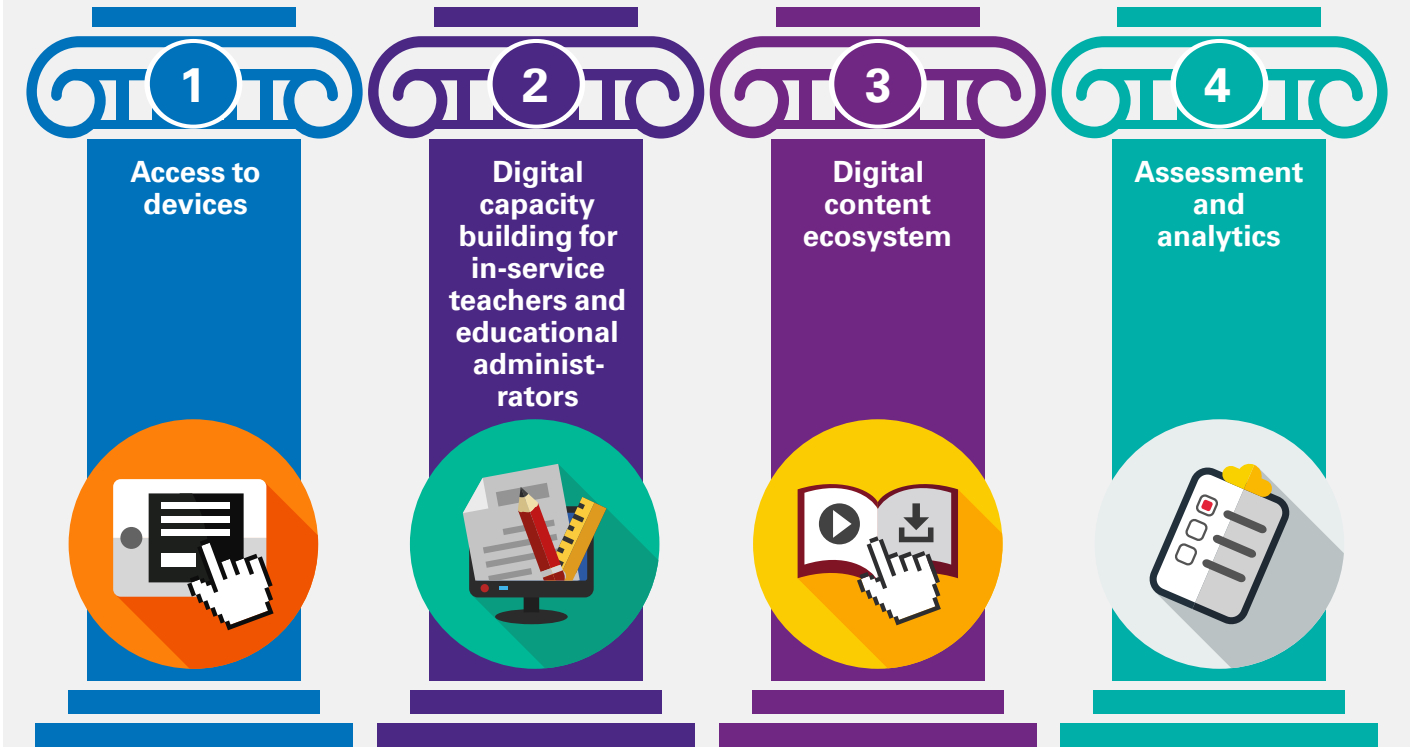
Introduction

School education system in India is one of the largest in the world with 15.09 lakh schools, 96.96 lakh teachers and 2,644.5 lakh students (from pre-primary to grade 12) of which 68.39 per cent schools, 50.81 per cent teachers and 51.01 per cent students belonging to the public school ecosystem.[1] Technology integration in school education is a key priority for the government as can be seen through various policies, schemes and interventions introduced over the years by both Central as well as several state governments. The pace of adoption of technology in education was accelerated during the COVID-19 pandemic when emergency remote learning was implemented through online platforms. However, several of them were stop-gap measures implemented in a fragmented manner, not uniformly resulting in scalable solutions in public school system. Online learning during COVID-19 threw up a multitude of challenges for all stakeholders including teachers, students, parents, school leaders, education administrators and the government.

With globalisation and technological breakthroughs disrupting civic spaces and the world of work, school education plays a key role moulding the citizens of tomorrow and future workforces. This requires a shift in content as well as learning experiences. Technology plays a key role in this transformation of education by helping scale up education delivery, improving classroom instruction, providing access to quality content, supporting teacher professional development, and streamlining education administration, planning and management. However, considering the scale at which the public school system in India operates, technology integration is a massive undertaking requiring significant resources – budgets, manpower, infrastructure and so on. Other factors such as ensuring teacher readiness and alignment to curriculum will also be key to ensuring a smooth deployment of technology. Hence, there is a need to undertake a phased transformation to integrate digital in public schools in India, and this is also well-recognised by key stakeholders in the government and the larger school education ecosystem.

With an objective to consolidate learnings and experiences of edtech implementations in India and globally, this report is aimed at assisting policy makers at centre and states in creating a forward-looking digital policy in public school education. It outlines the current challenges and proposes recommendations centred around four key pillars of digital integration outlined below:

Figure 1: Four pillars of digital integration



1. Unified District Information System for Education (UDISE) Plus for the academic year 2020–21, KPMG in India analysis

The insights of this paper are based on secondary research of evidence of impact of edtech in the global context, as well as extensive primary consultations with government stakeholders at centre and in states, academicians working in the space of public ed-tech, practitioners from leading donor organisations and private sector service providers. The paper also draws out a phased roadmap indicating how stakeholders can come together to integrate digital technology fully and most efficiently in public schools within the evolving policy architecture.

Challenges and recommendations

1 Access to devices

This theme focuses on recommendations towards providing access to devices to children in public schools, especially in the context of in-school digital interventions. Governments are currently facing challenges in providing access to digital devices to all students, and given the scale of the system, the challenge manifolds. Based on our understanding of current Information and Communication Technology (ICT) models implemented by states, it has been observed that access is limited due to multiple challenges across the value chain from design, procurement, deployment, adoption, maintenance to sustenance. For instance, the budget allocation for procurement of ICT infrastructure is not proportionate to the size of the student population[2], due to which deployment of devices is either limited to a few schools or cost per device is low which impacts quality (durability, functionality) of devices. These devices are often deployed as standalone units limiting students' experience and course work within their own schools only. The procurement is also not need based and purpose-driven, which often leads to the wrong type of devices being procured, and schools not being prepared to optimally use the infrastructure for the right age group or type of intervention (remediation versus concept clarity). To solve some of these challenges, recommendations proposed are:

1.1. Shift towards a 1:1 student device ratio in three phases to improve device penetration in schools

- Short term- 1:10–1:15 device to student ratio (~20 devices per school)
- Medium term- 1:6–1:8 device to student ratio (~40 devices per school)
- Long term- one device each for every child to access at school and home in the secondary grades; 1:6 device to student ratio in the primary and middle grades.

1.2. Procure devices that meet the following guidelines:

- Connected (internet/cloud based)
- Enabled with a platform that comes with collaboration and shareability features
- Adherence to accessibility standards
- A managed device ecosystem that enables maintenance, monitoring of outcomes and security.

1.3 Ensure teachers across all grades are provided access to devices, particularly laptops, to aid teaching-learning initiatives as well as undergo Continuous Professional Development (CPD)

1.4. Ensure that budget allocation for device procurement in schools is purpose-driven and need-based, instead of standardised funding per school

1.5. Adopt a bundled/integrated procurement model shifting away from "hardware only" procurement, to include the following:

- Hardware/digital devices
- Learning software preloaded with LMS capabilities and educational content including assessments
- Management software for remote device management
- Infrastructure such as furniture, storage cabinets, etc.
- Services such as capacity building, maintenance support, grievance redressal system, etc.

2. KPMG in India analysis of Samagra Shiksha budget

2 Digital capacity building for in-service teachers and educational administrators

This theme provides three broad areas of recommendations - quality of digital training for public school teachers, systems to ensure its adequacy as per teachers' needs, and systems through which teachers can sustain the continuum of professional development by networking and sharing best practices.

The National Education Policy (NEP) 2020 lays emphasis on the need for upskilling teachers in digital literacy. This need emerged during the pandemic when all teachers were required to conduct classes online, create digital content, conduct assessments, and use tools to engage with students at different learning levels.

Another challenge that emerged from stakeholder consultations is the need for building a connected learning system for teachers such that trainings, instead of remaining as a one-time activity, become a continuous process of professional development. This could also solve the challenge of teachers being isolated in classrooms and not getting benefited from their peers and larger teaching community. The recommendations, therefore, under this pillar are:

2.1. Develop robust and high-quality digital-training programmes for teachers of all grades aligned with National Professional Standards for Teachers (NPST) as well as educational administrators (cohort of 'digital experts'); prioritise important digital competencies required across levels (for delivering curriculum, conducting assessments, pedagogy and enabling collaborative learning in classrooms through technology), impart training (both synchronous and asynchronous) in those areas and provide credentials based on performance in assessments

2.2. Build a unified, interconnected ecosystem for teachers' continuous professional development, with curated content and assessments and with enhanced search and discovery capabilities for teachers to identify relevant and need based training content

2.3. Set up a Learning Management System (LMS) that facilitates networking and collaboration among teachers to clarify on and internalise trainings, access best practices, network with other teachers and help teacher educators (mapped) close feedback loops.

3 Digital content ecosystem

In the current digital content ecosystem in India for public K-12 schools, there is no dearth of availability of digital content, and the government and non-government organisations have been developing bulk of content for all age groups and domains of knowledge. However, availability of quality content in different formats and management of digital content such that students and teachers can locate the most relevant and high-quality content has been a challenge. Stakeholder consultations also informed that states often have no means to benefit from content developed by each other due to limitations such as formats, accessibility, language etc, which can be solved by leveraging appropriate technologies. A connected content ecosystem with advanced capabilities can lead to better usage and collaboration across multiple delivery systems. The recommendations, therefore, under this pillar are:

3.1. Cultivate a digital content ecosystem that allows interoperability and ensure that content is modular, packaged and organised according to recognized learning and technical standards in order to promote better usage and collaboration across multiple delivery systems, devices, and contexts

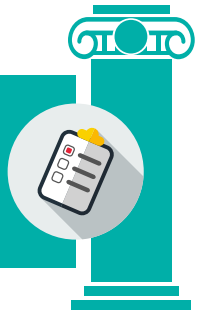
3.2. Enhance search and discovery of content by upgrading existing content platforms (like Digital Infrastructure for School Education (DIKSHA), Study Webs of Active–Learning for Young Aspiring Minds (SWAYAM), etc.) with metadata tagging, rating and comparison mechanisms, to facilitate finding of relevant content, better experience, and adoption by users

3.3. Investments to be made in creation and curation of good quality learning content of different formats with linkages to standards through crowdsourcing and partnerships with content providers and third parties

3.4. Leverage technology to provide personalised learning experience through content that is level appropriate and aligned with students' interests

3.5. Develop content for digital competencies of students with themes around information and data literacy, communication and collaboration, content creation, safety and ethics, problem solving and technology operations across grade levels.

4 Assessment and analytics



This pillar brings focus firstly on challenges in areas of assessments design and administration, and secondly on student learning data management and its use-case for decision making at all levels of centre, state, districts, blocks, and schools.

Currently at school level, teachers' time and efforts are being consumed in periodic test design that are not necessarily learning outcome linked, and further on administration - a process felt to be burdensome owing to infrequency with which it is conducted. Even data generated from these assessments often stay inside the classrooms and are not sufficiently used to make decisions at a system-level. Also, student level data collection and consolidation as a process currently is infrequent, not holistic, inadequate, non-uniform and inefficient in most states, and technology can play a big role in solving the same. The recommendations suggested under this pillar are:

4.1. Adopt systems that can fetch competency linked questions from test banks across portals, linking back to content portals and energised textbooks (that are in turn learning-outcome linked) and helping standardise test design and evaluation

4.2. Adopt low-cost technology solutions for frequently administering assessments via online modes so that quick analysis of results can help teachers and learners understand next steps in learning

4.3. Gather and track holistic data digitally on a multitude of dimensions across various stakeholder levels (student, teacher, school, block, district, and state) from all relevant sources over schooling years, pertaining to input as well as outcome parameters such as academics, user behaviour (of technology tools), attendance, drop-outs, behavioural, health etc. such that insights from holistic student level data can inform fund channelisation, dropout predictions etc.

4.4. Enable stakeholders to generate easy, actionable insights, empower in decision-making at their level (classroom instructions or policies) and enhance efficiency through data analytics through easy to use/understand dashboards, enabling predictive analysis to guide decisions at various levels.

The above recommendations are further detailed in the paper along with the rationale on why they are right for the current context, backed up with case studies of successful implementations. The paper also outlines an implementation roadmap capturing activities, key departments at centre and states that should own activities along with a time plan. We hope that the education administrators can customise these recommendations for implementing digital education in schools within their jurisdiction.

02 Introduction

India has one of the largest school education systems in the world

School education system in India is one of the largest in the world with 15.09 lakh schools, 96.96 lakh teachers and 2,644.5 lakh students across pre-primary, primary, middle, secondary, and higher-secondary grades. Of these, 68.39 percent schools, 50.81 per cent teachers and 51.01 per cent students belong to the public-school ecosystem, indicating the scale at which it operates.[3]

Technology has the potential to transform school education delivery and management

With globalisation and technological breakthroughs disrupting civic spaces and the world of work, school education plays a key role in moulding the citizens of tomorrow and future workforces. This requires a shift in content as well as learning experiences. Technology plays a key role in this transformation of education. Technology has the potential to transform school education by scaling up education delivery, improving classroom instruction, providing access to quality content, supporting teacher professional development, and streamlining education administration, planning and management. Technology can help education in taking a learner centric approach by facilitating differentiated instruction and increasing student engagement through applications such as computer adaptive learning and gamification. Emerging technologies such as Artificial Intelligence (AI), Machine Learning (ML) and blockchain have shown promising applications across the education value chain and have been adopted by many countries.

India has taken several initiatives to integrate technology in school education

Technology integration in school education is a key priority for the government as can be seen through various policies, schemes and interventions introduced over the years by both Central as well as several state governments. The ICT in Schools scheme was introduced in 2004 (currently subsumed under Samagra Shiksha (SS)) which acted as a catalyst for introducing computer infrastructure in public schools and providing opportunities for building ICT skills among secondary grade students. The NEP 2020 advocates the usage of technology across all aspects of education including teaching, learning, professional development, planning and administration. The policy lays special emphasis on bridging the digital divide by increasing access to technology in regions with large populations of educationally disadvantaged Socio-Economically Disadvantaged Groups (SEDG) and Special Education Zones. In order to implement this vision laid down by NEP 2020, the government came out with a blueprint for National Digital Education Architecture (NDEAR) aimed at unifying the national digital architecture in the education ecosystem.

In addition to the government of India, several donor agencies have also prioritised digital integration in public schools. For example, the World Bank funded programme Strengthening Teaching Learning and Results for States (STARS) and Asian Development Bank's (ADB) Accelerating State Education Program to Improve Results (ASPIRE) lay clear digital priorities as a means to achieving programme results. There is emphasis on leveraging technology across several areas such as teacher training, assessments, and digital education.

COVID-19 accelerated digital integration in public schools

The COVID-19 pandemic-induced school closures forced schools across the world to shift to emergency remote education through online platforms. The Indian government also undertook several initiatives, both at the Central and state levels, to ensure education continuity using technology. The PM e-VIDYA initiative, introduced during the pandemic period, focused on providing multimodal access to education through DIKSHA platform, Swayam Prabha TV channels, SWAYAM portal and radio broadcast. The DIKSHA platform played a significant role in scaling up learning content delivery by connecting the online platform to offline textbooks through QR coded energised textbooks. The same platform was also used for teacher professional development through the National Initiative for School Heads' and Teachers' Holistic Advancement (NISHTHA) undertaken by the National Council of Educational Research and Training (NCERT). Several initiatives were also undertaken by state governments to ensure education continuity including providing access to devices, conducting online classes through social media platforms, web platforms or mobile apps, enabling online content creation and capacity building of teachers. Some states leveraged partnerships with edtech players and civil society organisations to implement these initiatives.

But there continue to be gaps in digital integration which need to be attended through policy priorities

COVID-19 exposed the digital divide particularly for students and teachers from public schools. These were in the areas of device access, and digital competency skills to impart and undertake online remote learning effectively. Gaps were also witnessed in areas of digital content and inadequacy of technology driven data systems for effective decision-making.

In summary, India is well placed to attain new heights leveraging technology in the education sector. However, given the current gaps and challenges, there is a need for the government as well as the larger ecosystem to adopt a systemic approach towards digital integration in public school education.

3. UDISE+ for the academic year 2020–21, KPMG in India analysis

Purpose and methodology of this report

Stemming from a thorough understanding of the current gaps and challenges, this report seeks to lay out recommendations and an implementation roadmap for policy makers for creating a forward-looking digital strategy in public school education. Specifically, the report is centred around four key pillars pertaining to digital integration viz (i) access to devices, (ii) digital capacity building for in-service teachers and educational administrators, (iii) digital content ecosystem, and (iv) assessment and analytics.

The paper lays down the following:

- Recommendations for improving digital education ecosystem across the four pillars
- A phased roadmap indicating how stakeholders can come together to integrate digital technology fully and most efficiently in public schools within the evolving policy architecture, and
- An index to assess digital readiness of districts and schools viz. Readiness Index for Digital Education (RIDE index) to assist in decision-making.

A three staged approach was adopted to arrive at key recommendations across each of the four pillars:

Stage 1: Secondary research

A desk review was undertaken covering the following for each pillar: (i) policy objectives and funding, (ii) existing value chain, covering the roles of stakeholders, needs and gaps, (iii) initiatives undertaken by public and private players, (iv) trends and preferences of key stakeholders, and (v) current state of penetration in Indian market.

Stage 2: Formulation of hypothesis and study of best practices

Insights from policy priorities, challenges, user preferences and trends were triangulated to formulate key hypotheses in the form of recommendations. Global best practices were also identified across the four pillars.

Stage 3: Stakeholder consultations and finalisation of recommendations

The key challenges and hypotheses identified in the previous stage were consolidated. These challenges and recommendations were validated through primary stakeholder consultations with government officials, donor organisations, subject matter experts and practitioners in the public education ecosystem. The recommendations were finalised based on the following criteria: (i) impact on learning, (ii) scalability and sustainability of the opportunity, and (iii) potential to address using policy design.

03 Recommendations for digital integration

Four pillars of digital integration

1

Access to devices

Current state of digital infrastructure at public schools in India

As of 2020–21, penetration of computers across state government schools and primary schools is low, with only 32 per cent overall state government schools and 20 per cent state government primary schools having access to computers.[4] With respect to supplemental infrastructure, only 13 per cent[5] state government schools have access to the internet. About 50 to 60 per cent teachers have access to a personal device such as a laptop or computer and about 76 per cent government schoolteachers have access to the internet on their phone.[6]

The government has been investing in digital initiatives to improve the learning environment in India. 86 per cent[7] of the government funds for ICT and digital initiatives at government schools is contributed by the Samagra Shiksha scheme. These funds are used for recurring and non-recurring expenses such as setting up smart classrooms, providing devices and offering supplementary infrastructure to schools. Approximately INR641 crores have been approved in the year 2021–22 for these initiatives and this allocation has been increasing at 16 percent annually.[8]

Policy priorities and initiatives by the government

Recognising the need for extensive use of technology in improving the teaching-learning process, the government has undertaken a few policy measures and initiatives to improve access to digital devices in schools. Some of the key policies and interventions under the Ministry of Education (MoE) include NEP 2020, NDEAR, Samagra Shiksha and Operation digital board. In addition to MoE, policies or programmes by other ministries also have an impact in this area such as Make in India, National Policy on Electronics (2019), Production Linked Incentive (PLI) Scheme, Phased Manufacturing Programme for indigenous manufacturing of mobile phones and smart city mission.

These policies cover aspects related to the following:

- **Smart classrooms and digital infrastructure- NEP 2020, Samagra Shiksha, ASPIRE, Smart Cities Mission, Operation Digital Board:** States are encouraged to deploy differential funding based on technology and student enrolments. They are also incentivized to improve the RIDE index for districts and schools. Schools are further motivated to develop smart classrooms and methods of deployment could be on a pro-rata basis
- **Access to supplementary infrastructure- NEP 2020, Smart Cities Mission:** The policies lay emphasis on providing shared digital infrastructure to citizens. Adequate supplementary infrastructure is expected to be be built across all schools
- **Inclusive, equitable infrastructure access- NEP 2020, Samagra Shiksha:** Providing assistive devices for Children with Special Needs (CWSN), improving ICT facilities in aspirational districts, improving device access for students and teachers belonging to SEDGs are some focus areas for the policies
- **Interoperable ecosystem - NDEAR:** The building blocks of NDEAR lay emphasis on hardware that is connected with the NDEAR ecosystem to share content and facilitate learning interactions with schools, labs, classrooms
- **Digital device manufacturing and distribution – electronic manufacturing policies[9]:** The focus is on local manufacturing of devices where production linked incentives are offered for manufacturing mobile phones and other electronic components.

4. UDISE+ for the academic year 2020–21, KPMG in India analysis
5. UDISE+ for the academic year 2020–21, KPMG in India analysis
6. United Nations Educational, Scientific and Cultural Organisation (UNESCO) state of education for India report, 2021
7. KPMG in India analysis of Samagra Shiksha Project Approval Board minutes documents
8. KPMG in India analysis of Samagra Shiksha Project Approval Board minutes documents
9. such as Make in India, National Policy on Electronics (2019), Production Linked Incentive (PLI) scheme

Recommendations to improve access to digital devices[10]

I. Devices and digital ecosystem

Indian public schools have a large device to student ratio

The present computer to student ratio is 1:25 to 1:30 per state government school and 1:12 to 1:17 per central government school.[11] Countries such as Singapore, Hong Kong, Chile have a 4 to 6[12] students per device ratio, with some of them moving towards a 1:1 model in select higher level grades. The inequity is even more with certain schools having a device-student ratio even greater than 1:30.

Recommendation 1.1

Shift towards a 1:1 student device ratio in three phases to improve device penetration in schools

Many studies have showcased the impact of 1:1 student device ratio on learning.

A study on One-Laptop-per-child in rural India suggests that children's usage of One Laptop per Child (OLPC) laptops in a contextualised implementation design in rural Indian primary schools did indeed lead to positive learning outcomes, both in technological and functional literacies (details of the study are captured in Appendix 3).[13] This indicates the need for countries to move towards a 1:1 laptop implementation. However, considering the fact that this is a massive undertaking, this needs to be done in a phased manner by adopting a shared cart model of device deployment as seen in countries such as Singapore, Chile, and Hong Kong.

We propose that this is undertaken in three phases. These phases have been elaborated below:[14]

Table 1: Phasing out access to devices

Phase	Current state	Short term (2022–25)	Medium term (2026–30)	Long term (2031 and beyond)
Device: Student ratio per school	1:25 to 1:30	1:10 to 1:15	1:6 to 1:8	1:1 for secondary grades 1:6 for primary grades
Absolute number of devices per school	10	20	40	100+
Weekly usage per child	1 hour	1 hour	4 hours	Unlimited for secondary grades 4 hours for primary grades

10. Digital device in the context of this paper refers to laptop, desktop, or tablets
11. UDISE+ dashboard, KPMG in India analysis
12. Scaling access and impact - realising the power of Edtech, Omidyar Network report, Digital skills and education: Singapore's ICT master planning for the school sector
13. Contextualised-OLPC education project in rural India: measuring learning impact and mediation of computer self-efficacy, Educational Technology Research and Development, Ale, K., Loh, Y. A.-C., & Chib, A. (2017)
14. The ratios and absolute number of devices is provided for an enrolment of 250 students in government school. These ratios and number of devices will vary depending on the enrolment per school

In order to help states prioritise districts and schools for device roll-out and ramp-up, we propose a RIDE index (refer Appendix 1) which can help meet the following objectives:

i. Help key stakeholders understand the current state of digital infrastructure and access in a district and school

ii. Help analyse district strengths and gaps in providing an effective technology enhanced learning environment

iii. Help state authorities guide their decision making with regard to improving the access and quality of digital education in the state, and in prioritisation of districts and schools for digital enhancement.

This initiative can be funded through ADB's ASPIRE scheme which aims to establish 1800 exemplar schools across five states. These exemplar schools will be equipped with state-of-the-art digital infrastructure (smart classrooms, ICT labs and devices for students).

Challenge

Devices in schools currently operate in a standalone, non-connected manner

Devices currently provided have limited capabilities in terms of collaboration, communication, and monitoring. They are also limited in their shareability, an aspect that is critical in a shared device scenario prevalent in most schools in India. Further, activities undertaken by students using the devices and individual progress of students are not sufficiently tracked.

Recommendation 1.2

Procure devices that meet the guidelines of being connected (internet/cloud based) interoperable, secure, shareable and adopt a managed device ecosystem that enables learning, collaboration, and monitoring of outcomes.

States to focus on procuring interoperable devices with connected architecture which support the following five key aspects: connection to the internet, collaboration, shareability, flexibility, maintenance, monitoring, and security of devices.

Figure 3: Features of device ecosystem

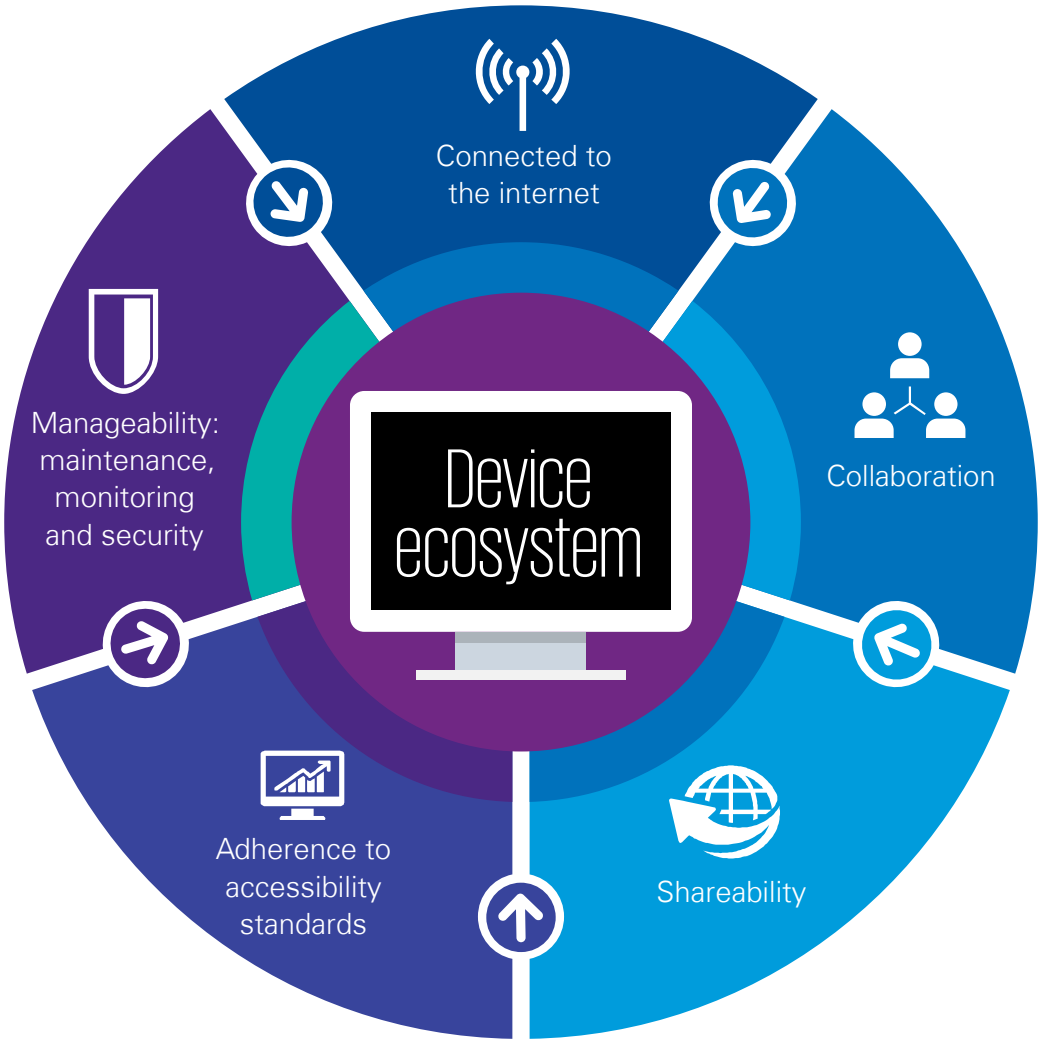


Table 2: Features of device ecosystem and their rationale

Feature	Why is this needed?	Details
Connected to the internet	• Connected devices enable access to a wealth of learning materials and resources for students and teachers- both asynchronous content as well as synchronous lectures from the best teachers across the world • Connected devices also enable teachers to pursue professional development opportunities and learn from best practices across the globe • They also improve system efficiency by providing real time data to education administrators and policy makers for agile decision making.[15]	Devices should be able to have access to the internet for students to work on a cloud platform. This will ensure students can have anywhere access to their files, records, progress, device settings and other personalised details through any device at home or in school.
Collaboration	Education policies including NEP 2020 stress the need for education to be made more collaborative and exploratory to enable experiential learning for students.	Students should be able to work on projects, day to day schoolwork in a collective manner where they are able to easily share information with each other and edit documents together. The device should be enabled with a platform which comes with such collaboration features.
Shareability	India currently does not have the resources to implement one to one computers for all 2,644.5 lakh students across all public schools.[16] Hence, devices need to be shared among students. However, it is equally important to personalise the student's learning journey by tracking their progress and saving their work. A shareable device accommodates multiple student accounts, each mapped to an individual student.	The same device should be shareable by multiple students at different points in time with the student work and progress saved in the individual student's account. The device should be enabled with a platform which comes with this shareability feature.
Adherence to accessibility standards	India has around 22.8 lakh CWSN enrolments.[17] These children need to be provided with devices catering to their specific needs to ensure inclusive and barrier education for all.	The devices and the learning platform should conform to accessibility standards. The devices should also come with features such as screen reader, speech recognition software, alternative input devices such as pointing devices, etc.

15. Connecting learners: Narrowing the educational divide, The Economist Intelligence Unit, 2021
16. UDISE+ for the academic year 2020–21, KPMG in India analysis
17. UDISE+ for the academic year 2020–21, KPMG in India analysis

Feature	Why is this needed?	Details
Manageability: Maintenance, monitoring and security	• In interest of time as well as cost efficiency, there is a need for technology enabled solutions to maintain hardware and devices remotely. There is also a need for strong central monitoring of device usage to help ensure that devices are used sufficiently and in the right manner. This will also enable course correction and facilitate decision-making with regard to future procurement, aspects that are currently lacking in the system today • Education devices carry a significant amount of data regarding the learners. Also, since the devices are in the hands of children, additional data security measures are needed to protect them from any privacy violations or cyber-attacks.	• Central management of devices- which shall enable addition of additional devices, users, printers, and internet connection from a central command centre in real time. The central command centre shall also facilitate setting of policies and commands for a large number of devices at once (for example, blocking a particular website across all devices) • Remote maintenance of devices- make use of administrative portals which facilitate remote maintenance of devices • Security updates- Through the console, automatic security updates against ransomware and virus attacks, even for large deployed systems, should be provided in a short span of time • Device monitoring- Devices should also be monitored through these administrative consoles to understand their usage which will help in learning about the student's progress.

Challenge

Teachers do not have sufficient access to devices

Only 50 to 60 per cent of teachers in India are estimated to have access to a laptop or a computer. Moreover, only 76 per cent government schoolteachers in India have access to the internet on their phones.[18] Due to the insufficient access of devices among teachers, teaching-learning activities as well as opportunities to pursue CPD become limited.

Recommendation 1.3

Ensure teachers across all grades are provided access to devices, particularly laptops, to aid teaching-learning initiatives as well as undergo CPD

There is an urgent need for Indian states to prioritise device access for teachers. This is required to facilitate better lesson planning, content creation and curation, lesson delivery, conducting assessments, collecting and analysing student data and professional development activities at both, home and at school. The benefits of device provision among teachers have been established through experiments in other countries. For example, an evaluation of the Laptop for Teachers Scheme in New Zealand suggested evidence towards increasing confidence and ICT expertise among teachers, increased use of laptops for classroom practice and student learning, increased use of laptops for communication and collaboration, and efficiencies in lesson planning, preparation, administration, and reporting.[19]

Stakeholders consulted for the study believe laptops to be the right device for teachers, with tablets being the second preference due to its limitations with respect to smaller screen size and limited content creation. Also, providing devices alone might not be enough, and should be coupled with frequent training support and government led initiatives that require teachers to use these devices such as online surveys, polls, webinars, data collection apps etc.

Correspondingly, the time is ripe for Indian states to prioritise device access, particularly provision of laptops to teachers. A shared devices model can be explored in the near term. For example, a device rotation policy can be implemented by which devices can be rotated between teachers with each teacher gaining access to the device for a specific amount of time. A digital hub with ICT infrastructure can also be established at the district level where the teachers can come together to pursue online training or create online content. In the long term, a 1:1 device model for teachers can be explored.

18. No teacher, no class: State of the Education Report for India 2021, UNESCO, 2021

19. Laptops for Teachers: An evaluation of the TELA scheme in schools (Years 1 to 3), Ministry of Education, New Zealand, Bronwen Cowie, Alister Jones and Ann Harlow with Mike Forret, 2010

II. Funding

Funding for ICT infrastructure is standardised per school, rather than being enrolment or need based

The funding for ICT infrastructure in public schools is standardised per school at INR6.4 lakhs for non-recurring expenditure and INR2.7 lakhs for recurring expenditure for five years[20]. This amount does not take into account the number of students in a school or the device type as per the need or use case of the device.

Recommendation 1.4

Ensure that budget allocation for device procurement in schools is purpose-driven and need-based, instead of being standardised per school.

As per most ICT schemes in India, there is a blanket budget allocation for all schools which may lead to insufficient number of devices in high enrolment schools and vice-versa, resulting in an inequitable distribution of digital learning. The benefit of digital intervention in a lab model in a school can be realised only when students are given sufficient digital learning hours in the timetable of all classes, which can be attained only if number of devices is proportionate to student enrolment numbers.

Further, stakeholder consultations suggested that the procurement of devices should be done based on the purpose and the use-case at state level in case of state-wide deployment. This could also mean that different regions within a state may get different kinds of digital interventions. For example, if the predominant need or use case with the devices being procured is personalised learning, the devices procured per school should be sufficient to deliver 1:1 intervention. Likewise, if the priority is to promote group work or any form of common instruction and peer learning, the state can look at a shared device model (one device being shared by two or more students) in schools. Similarly, if the state's priority is classroom teaching and reinforcement of concepts where there are less or no teachers, the state can go for 1:many models through TV or smart classrooms. The state budgets allocated for procurement in such cases can be adjusted accordingly.

This need and use case and the classes for which they are envisaged to be used should also determine the type of device (laptop vs tablet vs others) that is to be procured, which in turn will have implications on budget. Experts suggested that devices in school should meet the content creation requirements by the students, especially the higher-grade students who work on projects, presentations, documents etc. which is better on a bigger screen. Therefore, factors such as screen size, User Interface (UI)/User Experience (UX), ease of handling, durability, battery life, longevity, etc. are important to consider while selecting the devices for schools.

States need to undertake a need mapping exercise to determine the following:

I. Number of devices- The number of devices in a school should be determined based on enrolments. An example of mapping basis number of devices is given below:

Table 3: Enrolment based funding for devices

	Scenario A	Scenario B
No. of students (enrolment)	250 students	400 students
Weekly usage per child	2 hours	3 hours
Number of devices	20	48
Funding required (non-recurring expenditure)[21] per school	INR5.6 lakhs	INR9.9 lakhs

20. MoE website

21. Funding required is basis assumptions on cost per device, other cost such as internet connect, software and content, internet router, power backup, no. of hours device is used per student

This scenario analysis illustrates the need to move away from a standardised funding per school model to one that is based on need.

II. Type of devices - The type of devices (desktop v/s laptop v/s tablet) need to be determined based on the end need for which the device is envisaged to be put to use. Some examples are given below:

- The type of device can differ based on whether it is used for content consumption, taking assessments, project based or collaborative learning and attending remote lectures
- The devices can be customised as per the local needs such as providing vernacular keyboards
- The type of devices can also be determined by the grades. Research shows that laptops are more suitable for higher grade children, while tablets are suitable for students in elementary grades.[22]

III. Procurement

Siloed procurement decisions with excessive weightage given to hardware procurement lead to inefficiencies across the value chain

The focus on hardware only procurement has thrown some challenges such as:

- The digital architecture in terms of the hardware and software are not interconnected
- Limited usage of devices due to lack of knowledge of schools or teachers on the accompanying software and LMS
- Low maintenance and replacement of devices
- School teachers have inadequate training in ICT and hence have a lower preference in using ICT in the teaching-learning process
- Curriculum-aligned digital content that can be taught through devices is yet to be sourced.

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Adopt a bundled/integrated procurement model shifting away from "hardware only" procurement, to include devices, supplementary infrastructure, software, content, execution capacity (for delivery, monitoring etc.) as one bundled solution

It is recommended that for better quality of services and quick turnaround time on operational issues, states should go for bundled procurement of hardware and services so that the ownership of all the services lies with one vendor. Bundled procurement allows single system integrator (SI) onboarding for all components of digital infrastructure. The following could be the components for bundling:

- Hardware - digital devices (laptop/tablet/computer/ smartboard/screen), internet device (LAN/dongle), headphones, movable trolleys, cables etc.
- Learning software preloaded with LMS capabilities and educational content including assessments
- Management software for remote device management
- Infrastructure - furniture (tables/chairs), storage cabinets etc.
- Services such as
  - Hiring and handholding of field management staff
  - Trainings for students, teachers, and administrative staff periodically
  - Hardware maintenance support (both online and offline)
  - Grievance redressal system with centralised help desk.

22. A short case study of the impacts of the One Laptop Per Child (OLPC) project around the world, Sonika Coomar and Ilia Ryzhov, OLPC at Peru, The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis

To run an effective digital intervention in school, it is important that all these components are smoothly operational at a school level at all times through a single SI since there are interdependencies between components. The SI can do so by bringing together hardware manufacturers, software and content providers and the government for services such as electricity and internet availability in the area. The roles and responsibilities of each player in such a procurement model is explained through a Responsibility, Accountability, Consulted, Informed (RACI) matrix (please refer to Appendix 2).

Furthermore, Requests for Proposal (RFP) provided by central and state governments should mention the need for bundled infrastructure i.e., devices, content, manpower, supplementary infrastructure so that Original Equipment Manufacturers (OEM) and other players in the ecosystem set up infrastructure with education sector related requirements. The devices should also be aligned to relevant standards to ensure quality, relevance, and interoperability.

Box 1: Case in point- bundled procurement in Chhattisgarh

For procurement of ICT infrastructure which included hardware for ICT labs, smart classroom, content, assessments, and infrastructure for 4330 schools, Chhattisgarh School Education department rolled out bundled procurement in the year 2019 which led to selection of single service provider for infrastructure and services for both 1:1 and 1:many digital interventions. This resulted in easy deployment, management, training and grievance redressal services and ease in operationalising ICT intervention across rural and urban geographies of the state.

Implementation roadmap

Table 4: Implementation roadmap- access to devices

#Rec	Implementation activities	Responsibility	Timeline
1.1	Higher allocation of funds under the 'ICT and digital enablement' sub-component of Samagra Shiksha budget such that optimum student device ratio in every school is achieved (1:10 >> 1:5 >> 1:1)	MoE and states (SS)	Ongoing
1.1, 1.4	Roll-out of RIDE index to measure district and school readiness for digital enablement	MoE and states (SS)	Short term
1.1	Develop a state-level district, school, and grade prioritisation plan for phased deployment of devices	State (SS, District Educational Officers (DEO) of chosen districts)	Short term
1.1	Increase in school grant (hire field staff, device upgradation) for device security and maintenance in every school	State (SS)	Medium term
1.1	Provision of electricity, internet, device safety, maintenance services and other necessary resources in all schools	MoE, Ministry of Electronics and Information Technology (MEiTY), Ministry of Power (MoP)	Ongoing
1.2	RFPs for device procurement to be in a manner that new devices are connected (internet/cloud based) interoperable, secure, and in alignment with NDEAR principles	State (SS, National Informatics Centre (NIC)/ Information Technology (IT) cell of state education department)	Short term
1.2	Conduct as-is assessment of existing devices in schools, and upgrade to allow cloud based and interconnected ecosystem	State (SS)	Medium term
1.3	Earmark funds for device access to teachers in Annual Work Planning & Budgeting (AWP&B)	State (SS)	Short term
1.3	Launch scheme for one laptop for every teacher for delivering educational services	MoE, State (SS)	Medium term
1.3	Design and implement initiatives to improve access to devices for teachers such as: • Establish device banks and draft a device rotation policy • Devise interest free loan schemes for laptop purchase for teachers	MoE, State (SS)	Medium term
1.4	Conduct a stakeholder need-assessment survey to help inform the state's device strategy (type of device, grades, purpose for which device is envisaged to be used etc.)	States (SS)	Medium term
1.4	Cap funds for device deployment based on actual enrolment per school (greater than INR6.4 lakhs fixed cost in schools with enrolment greater than 350, and vice versa)	MoE and states (SS)	Short term

#Rec	Implementation activities	Responsibility	Timeline
1.4	Allocate funds for periodic review of deployed digital infrastructure, and necessary upgradations required	State (SS)	Short to long term
1.5	Draft RFPs for procurement of bundled solution to select one system integrator for hardware, content, maintenance, and management services	State (SS)	Short term
1.5	Adopt Quality cum Cost-Based Selection (QCBS), instead of L1, as a method of selection for system integrator such that 'quality' of solution can be ensured	State (SS)	Short to medium term
1.5	Select SIs for solutions with future ready technology of hardware and software, and aligned to defined standards	State (SS)	Short to medium term
1.5	Form a 'Standards committee' for interoperability standards for compliance with procurement	State (SS)	Short term

2

Digital capacity building for in-service teachers and educational administrators

Current state of teacher training in the country

Of the total 49 lakh government schoolteachers in India, only 41 per cent have received in-service training. Around 21 per cent of state government schoolteachers (10 lakh teachers) do not have a graduate degree. Only 22 per cent of state government schoolteachers have been trained in using computers and teaching through computers.[24] The NISHTHA initiative was started by NCERT to impart professional development for public school teachers across the country. The initiative has so far achieved 43 per cent of its target among teachers and 49 per cent among school heads.[25]

Policy priorities and initiatives by the government

The NEP 2020 lays significant emphasis on continuous professional development of teachers. The Central government also introduced a country wide professional development programme for teachers and school heads called NISHTHA which is funded through the Samagra Shiksha scheme. Improving teacher performance is also one of the results areas for STARS. It has identified digital priorities through means of providing ICT resources for teachers, adopting ICT-enabled approaches to teacher training and assessing digital competencies of teachers.

The following are the government's focus areas with respect to teacher training:

- **Early Childhood Care and Education (ECCE) educators**-The NEP 2020 states that depending upon their qualification, anganwadi workers and teachers shall undergo a six-month certificate or a one-year diploma programme covering early literacy, numeracy, and other relevant aspects of ECCE and these programmes will be available in digital and distance modes.
- **CPD for in-service teachers**- The NEP 2020 has stated a minimum of fifty hours per annum for CPD. Blended models would be used to train teachers from pre-primary to grade 12 while school leaders shall be trained through National Institute of Educational Planning and Administration (NIEPA) or state leadership academies.
- **Knowledge sharing platforms among teachers**- NEP 2020, NDEAR and National Initiative for Proficiency in Reading with Understanding and Numeracy (NIPUN) Bharat mention the need for Professional Learning Communities (PLC) and platforms, including online, wherein teachers, mentors, peers, and experts can interact and collaborate with each other.
- **Teacher professional standards and teacher registries**- To ensure high motivation, qualification, and professional readiness of a teacher throughout her teaching career, National Council for Teacher Education (NCTE) has come up with NPST that covers expectations of a teacher's role across different levels of experience and at different stages of career. NDEAR has mentioned the need to create and maintain federated teacher registries at the central and state level.
- Strengthening digital literacy skills for teachers as well as administrators which is also given emphasis in STARS and ASPIRE.

24. UDISE+ for the academic year 2020–21, KPMG in India analysis
25. NISHTHA website

Recommendations to improve in-service teacher training

In this paper, we study the area of digital capacity building of in-service teachers in two parts (1) Training teachers on digital technologies to enable them to use technology to improve classroom practice and (2) Technology's role in improving speed, scale, and efficiency of delivering teacher training programmes.

A deep-dive analysis of teacher training in public-schools presents us with three main challenges. The challenges and the recommendations are elaborated below:

ICT training for teachers is inadequate

Only 22 percent of teachers in state government schools are trained in the use of computers and teaching through computers.[26] Around half to two-thirds of teachers report having some exposure to computers and usage of content on smartphones. However, most of them do not have the skills to create content using a computer or using interactive software.[27] In the current training model, the number of hours spent training teachers on digital skills as well as the quality of training imparted is inadequate. As a result, teachers are not sufficiently confident in using technology for teaching. This was especially exposed during the COVID-19 pandemic.

Recommendation 2.1

Develop robust and high-quality digital-training programme for teachers of all grades aligned with NPST; prioritise important digital competencies required (for delivering curriculum, conducting assessments, pedagogy and enabling collaborative learning in classrooms through technology) and impart training in those areas

Research suggests that when teachers are provided with appropriate professional development and resources to integrate ICT into subject teaching, they develop greater agency and self-confidence to promote active learning.[28] The government needs to develop high-quality digital-training programmes with optimal time duration and content, linked with certifications and aligned to NPST, for public school teachers. The NEP 2020 has suggested 50 hours per year for CPD out of which dedicated hours for digital literacy have not been carved out. Global best practices encourage 30 to 80 hours dedicated solely to digital training.

As a first step, similar to the UNESCO ICT Competency Framework for Teachers, standards for digital training for teachers should enable building teachers' digital capabilities in delivering curriculum, conducting assessments, pedagogy and facilitating a collaborative learning environment in classrooms. Next, training programmes need to be developed with optimal content and duration, depending on the level of the teacher. These programmes should be made personalised and demand-driven to cater to the individual needs of teachers. The right level of content should be offered to the teacher based on their performance in baseline assessments, and credentials should be provided as they progress through the levels. The government can explore partnerships with industry players to design and deliver these programmes. The STARS programme provides technical assistance for assessing the digital competencies of teachers and teacher educators, as well as development of operational guidelines to improve the same.

Educational leaders and administrators also need to be equipped with the right set of digital skills so that they can handhold teachers as well as facilitate digital transformation of schools. Digital training programmes should also target this set of people in order to create a cohort of 'digital experts' in the education sector.

In addition to imparting training, the government should also focus on implementing 'master trainer' programmes who will help the teachers in translating their learnings to classroom practices and promoting the adoption of ICT among teachers.

26. UDISE+ for the academic year 2020–21, KPMG in India analysis
27. No teacher, no class: State of the Education Report for India, UNESCO, 2021
28. No teacher, no class: State of the Education Report for India, UNESCO, 2021

Challenge

Current trainings are more supply driven rather than being demand driven, and discovery of relevant training programmes is a challenge for teachers. Speed and efficiency of teacher training programmes is also affected by the fragmented nature of training

Multiple avenues of training make it challenging for teachers to navigate and find relevant, context-appropriate content. Even if they do, it has been observed that there's a poor completion rate of these online training courses due to lack of initial support for habit formation or incentive. Furthermore, limited reuse and leveraging of existing content across states also affects the speed and efficiency of in-service teacher training.

Recommendation 2.2

Build a unified, interconnected ecosystem for teacher's CPD, with curated content and assessments and with enhanced search and discovery capabilities for teachers to identify relevant and need based training content

Studies suggest that a blended learning approach (combining both online and offline components) to teacher training offers flexibility to teachers to accommodate training within their busy schedules. Online training delivery also provides cost efficiencies related to reducing face to face meetings as well as reusability of same online components with multiple cohorts.[29]

Having a unified, interconnected online platform, dedicated to teacher training, with enhanced search and discovery capabilities and curated content and assessments would be helpful for both teachers and government. With a single sign-on, teachers can access training content across multiple platforms. Recommender systems can be used to display courses or modules based on teacher profile, interest, and capabilities. Not just that, to increase completion rate and incentivise teachers to sustain the practice of online professional development, the size of content units should be easy to consume and comprehend, followed by teachers' follow up support mechanisms to push teachers to adopt this new behaviour of online learning. The government can leverage existing open-source content from NCERT, other states and private players and customise the training according to the local requirement. Moreover, all teacher training credentials and certificates can be stored in centralised teacher registries and all decisions pertaining to teacher promotions, awards and incentives can be connected to these registries.

This initiative can be funded through the STARS scheme which will support states to develop ICT enabled approaches to enhance teachers' access to trainings.

29. Blended Learning in Teacher Education & Training: Findings from Research & Practice, European Schoolnet, 2021

There are limited peer learning and networking opportunities for teachers to reflect upon their classroom experience, share knowledge and learn from best practices

Teachers often find themselves isolated in classrooms to deal with a diverse group of students. Even during peer interactions or group meetings and teacher training gatherings, they are hardly given opportunities to reflect on their experiences in the classroom and the struggles they might be facing. There are limited and if any, only localised collaborative platforms where teachers, teacher educators and school leaders can discuss learnings, share best practices, or ask for support from each other. Such platforms have now become ever so important given teachers operating in silos and the increasing prominence of blended teaching-learning models due to the pandemic.

Recommendation 2.3

Set up an LMS that among others, facilitates networking and collaboration among teachers to clarify on and internalise trainings, access best practices, network with other teachers and help teacher educators (mapped) close feedback loops

Studies have shown that online professional learning communities allow educators to connect with their peers over greater geographic distances as well as network with specific individuals based on area of interest.[30]

Box 2: Case in point- digital communities of practice in Maharashtra

Project Tejas was a joint initiative between the government of Maharashtra, Tata Trust and British Council aimed at improving the quality of English language teaching and learning across primary schools in the state. Under this project, digital communities of practice were established on various social media platforms for Teacher Activity Group (TAG) coordinators. These digital communities allow TAG coordinators to access resources as well as provide ongoing support, communication, and professional development. An evaluation of this project showed that 84 per cent of teachers found their TAG social media useful.[31]

The government should focus on building an LMS that facilitates interaction and collaboration among teachers, which will also lead to better impact of training programmes that are delivered offline. Expert consultations suggested that by providing shared spaces to teachers for post training reflection, the teachers are more equipped with techniques to adopt the knowledge provided in the training programmes. Such avenues can also be leveraged to promote collaboration between teachers and the trainers. On such platforms, teachers can also discuss classroom-specific context, struggles in dealing with specific issues of subjects or student behaviour, reflect on best practices to guide other teachers, clarify on and internalise specific areas of training they have undergone. This platform shall also enable teacher educators, mapped to the teachers for last-mile impact, to close feedback loops. A networking portal within the LMS will provide avenues for teachers to access teacher networks and become aware of best practices that have worked in similar contexts.

30. Engagement and Discourse of Educators through Online Professional Learning Communities, Michigan Virtual University, Kwon, J. B., Dirkin, K., & Bruno, J., 2018

31. Engage, Lear, Act: Tejas, British Council, Government of Maharashtra, Tata Trusts, accessed April 2022

Implementation roadmap

Table 5: Implementation roadmap- digital capacity building of in-service teachers and educational administrators

#Rec	Implementation activities	Responsibility	Timeline[32]
2.1	Conduct nationwide assessment for all teachers on NPST to assess teachers' digital competencies	MoE and States (State Council of Educational Research and Training (SCERT))	Short term
2.1	Design digital literacy training programmes between 30-80 hours duration (depending on the level of the teacher) mapped to NPST standards to ensure that all teachers are equipped with digital skills	MoE and States (SCERT)	Medium term
2.1	Onboard third parties for relevant training programmes for both provision of content and delivery	States (SCERT)	Short term
2.2	Upgrade DIKSHA as national portal for teacher training with AI/ML capabilities such that it can be leveraged to identify teacher needs, competency gaps and suggest relevant courses	MoE	Short to medium term
2.2	Establish a Human Resource Management System (HRMS) with teacher registries and with capabilities to identify each teacher's unique learning journey and performance to make decisions on awards, incentives, transfers, and promotions	States (Dept of School Education)	Medium term
2.2	Invest in building a unified, interconnected ecosystem for teachers with LMS capabilities that allows access to training content, analytics on teacher needs, pre-post training assessments etc.	MoE and States (SCERT)	Short term
2.2	Shift to fully online teacher trainings (interactive as well as Massive Open Online Courses (MOOC), courses) delivered through national / state training portals	MoE and States (SCERT)	Long term
2.3	Set up a state level LMS for conducting teacher trainings	States (SCERT)	Short term
2.3	Integrate networking and collaboration capabilities in state LMS for online professional learning communities	States (SCERT)	Short term
2.3	Incentivize cluster resource coordinators and teacher mentors to use digital tools for classroom observations and feedback	States (SCERT)	Medium term

3

Digital content ecosystem

Current state of digital learning content ecosystem in the country

There are multiple online platforms through which digital content is pushed to public schools in India. These include DIKSHA, e-Pathshala, National Repository of Open Educational Resources (NROER), National Digital Library of India (NDLI) and SWAYAM. In addition to these, individual state governments developed their own e-content repositories (mobile apps and/or web portals), sometimes in partnership with third party edtech players or civil society organisations. The central and various state governments have particularly strengthened their digital content repositories during the pandemic, albeit there are challenges and gaps to be addressed in this regard.

Policy priorities and initiatives by the government

During the COVID-19 period, the government adopted a 'push strategy' to increase access to content for public school students. Policies and initiatives such as NEP 2020, NIPUN Bharat and NDEAR also focus on improving access to quality content. The Central government also came out with Plan, Review, Arrange, Guide, Yak(talk), Assign, Track, and Appreciate (PRAGYATA) guidelines and learning enhancement guidelines aimed at improving the quality of digital education.

The following aspects are covered across these policies and initiatives:

- **Use of DIKSHA for scaling up content delivery**- Curated e-content will be uploaded on DIKSHA, which shall be linked to energised textbooks using Quick Response (QR) codes.
- **Type and language of content**- Samagra Shiksha and the learning enhancement guidelines state that content will be developed in a variety of formats such as virtual and augmented reality resources, video, audio, multimedia digital charts, etc. and pushed through multiple channels including web portals, mobile apps and Direct to Home (DTH) channels. NEP 2020 and Samagra Shiksha also lay emphasis on creating content in vernacular languages.
- **Role of technology in content ecosystem**- The content building block in the NDEAR framework consists of contribution and curation, taxonomy and tagging, language and translation, discovery and personalization services which can be leveraged for creating and hosting quality e-content.

The ADB ASPIRE programme also aims to mainstream digital education by developing a digital content library in the respective beneficiary state's medium of instruction. The STARS programme also focuses on using technology portals to deliver content for classroom use, classroom preparation, curriculum and learning level aligned supplementary worksheets for students and formative assessment item banks.

Recommendations to improve learning content ecosystem

In this section, we analyse the public digital content from two lenses i) quality, user-centricity, and availability of digital content across all subjects ii) content specific to digital literacy of students. Using this approach, we encounter two major challenges.

I. Quality, user-centric content

There is limited reusability of existing content across states

While DIKSHA as a national platform achieves the objective of digital content consolidation and is adopted by most state governments, it has limited capabilities in terms of features, use-cases, and adaptability, as informed by experts during consultations. Teachers in the states are developing bulk of localised content for their state which may not be available for other state governments or platforms. Thus, there is limited reusability of learning content which limits the usage of content across geographies, languages, and context, leading to system inefficiencies.

Recommendation 3.1

Cultivate a digital content ecosystem that allows interoperability and ensure that content is modular, packaged and organised according to recognized learning and technical standards in order to promote better usage and collaboration across multiple delivery systems, devices, and contexts

The public digital learning content should be packaged and organised according to recognized standards (both content related as well as technical standards), so that it is interoperable across multiple delivery systems, devices, and contexts. Experts suggested that for states to gain maximum benefit out of digital interventions, the content units need to be flexible, modular, and unbundled and should be made accessible in an open or non-proprietary data format that can be plugged and played wherever required, increasing access to all learners as mentioned in NDEAR.

This digital content ecosystem shall have the following features:

- flexible units of content in various types and formats
- mapped to national standards
- organised for easy adoption by multiple state governments
- access through single sign-on so that the user can use the same credentials across multiple platforms
- authorization and authentication capabilities to provide access to resources to relevant learners only
- version control tools to ensure that the learning resources are updated regularly
- language and translation services
- adherence to accessibility standards for CWSN
- strong analytics capabilities to monitor content usage and its impact on learning outcomes.

The government can implement this kind of content interoperability by mandating standard compliances for new content providers, negotiating content integration with existing vendors and setting up a 'Digital Interoperability Standards Committee' to oversee and guide the ecosystem. The content should also be mapped to the curriculum and the right learning outcomes. In the future, technologies such as Natural Language Processing (NLP) and AI can facilitate this mapping.

33. KPMG in India analysis of DIKSHA usage metrics

Teachers and students find it difficult to identify good quality, relevant content

COVID-19 accelerated the creation and delivery of e-content within the public-school ecosystem in a big way. Apart from the state governments, edtech players, civil society organisations and individual contributors also contributed content, thereby leading to massive amounts of content being created. However, this content is spread across multiple platforms and not tagged to the right taxonomies. This makes it difficult for teachers and students to identify good quality, relevant content. Teachers have also reported that they spent more time curating the right content for students.

Recommendation 3.2

Enhance search and discovery of content by upgrading existing content platforms (like DIKSHA, SWAYAM, etc.) with metadata tagging, rating and comparison mechanisms, to facilitate finding of relevant content, better experience, and adoption by users

There is a need for the government to come out with a common taxonomy for education content (created by both public and private players) which when used for tagging shall improve the search experience for users. Content curators can ensure that metadata is created, and content tagged to the right taxonomies to ensure easy and appropriate discoverability for users. The government may also come up with a lighthouse of best practices on the right way to interact with this content. Discussion forums, rating or feedback systems should be made available so that teachers can compare content across different platforms and choose the content most suitable for them or modify the available content for effective implementation. Appropriate authorities (such as NCERT) may also badge quality content so that it is easier for users to discover credible content.

Box 3: Case in point- content organization in online learning platform

During the COVID-19 pandemic the Ministry of Education, Culture, Sports, Science and Technology (MEXT) in Japan launched an online learning platform (Children's Learning Support website) to provide access to online learning content. The portal contains learning material in various formats across all grades from preschool to high school. The content was sourced both from public as well as private sources. This content is organised by subject, grade, and topics.[34]

34. Japan Case Study: Situation Analysis on the Effects of and Responses to COVID-19 on the Education Sector in Asia, UNESCO and UNICEF, 2021

Currently available content is mostly in the form of non-interactive videos and Portable Document Format (PDF), with limited interactivity

The digital learning content available in the current ecosystem is mostly in the form of videos and PDFs. These formats allow for limited interactivity and practical learning for students, leading to low user engagement.

Investments to be made in creation and curation of good quality learning content of different formats with linkages to standards through crowdsourcing and partnerships with content providers and third parties

Content must be provided in a variety of forms to overcome the current problem of public digital content being majorly in the video and text format. Technology can facilitate the creation of engaging experiences for students through content in a variety of formats. For example, evidence suggests that gamification improves student engagement and thereby motivation.[35] Technologies such as three dimensional imaging software, Augmented Reality (AR) and Virtual Reality (VR) have shown potential to create immersive learning experiences for students by enhancing the classroom experience.[36] In addition, technology also can make content accessible to all kinds of learners through tools such as text-to-speech, speech-to-text, dictionaries, etc. check for understanding assessments of different formats such as multiple choice, true or false, fill in the blanks, graphical response, performance tasks, etc. shall also be embedded with the learning content ecosystem. The government can achieve this through various measures such as partnering with content providers, crowdsourcing or third-party integration.

Students are taught at their grade level, and not based on their needs; within a given grade, there is limited availability of content suited to different learning levels

The digital content available is currently uniform across a board for a particular grade. It doesn't account for the individual student's background, needs and capabilities. When students are not taught at the right level, it leads to lower learning outcomes.

Leverage technology to provide personalised learning experience through content that is level appropriate and aligned with students' interests

Technology should be leveraged to deliver personalised learning to students. Evaluation of several personalised adaptive learning initiatives have shown improvements in test scores for students undergoing them.[37]

35. Realizing the promise: How can Education Technology Improve Learning for All?, Brookings, Alejandro J. Ganimian, Emiliana Vegas, and Frederick M. Hess, 2020
36. The Promise of Immersive Learning: Augmented and Virtual Reality's Potential in Education, Information Technology & Innovation Foundation, Ellysse Dick, 2021
37. Realizing the promise: How can Education Technology Improve Learning for All?, Brookings, Alejandro J. Ganimian, Emiliana Vegas, and Frederick M. Hess, 2020

Box 4: Case in point- impact evaluation of computer adaptive learning

An evaluation of the Computer Adaptive Learning (CAL) software in Rajasthan showed positive results for students in the treatment group. 1528 students in grades 6-8 across 15 model public schools were randomly assigned to treatment and control groups. Students in the treatment group were assigned problems based on their individual preparation level measured through a diagnostic test. In the control group, students could only access exercises based on their enrolled grade level. The evaluation showed that students in the treatment group with a low initial score outperformed their counterparts in the control group by 0.22 standard deviations.[38]

This can be done through a technology-enabled system consisting of a) AI/ML enabled platform for predictive analysis b) taxonomy with skill and competency standards mapped to learning outcomes and c) content of different type and format mapped to the taxonomy. Personalised learning will cater to different learning styles, meet students at their learning levels and help them progress through levels, solve for the exact conceptual gap and be specific in its purpose of teaching, revising, or reteaching.

Personalisation aligning to the child's interest may result in better engagement and learning through the content. Keeping a realistic view of the scale and challenges in the public school system, the government should aim to deliver personalised learning in a phased manner ensuring every school that gets covered is provided with a sufficient number of devices to enable 1:1 intervention for every child.

38. Which Students Benefit from Personalized Learning? Experimental Evidence from a Math Software in Public Schools in India, Andreas de Barros and Alejandro J. Ganimian, 2021

II. Content for digital literacy

Digital literacy is not integrated in the curriculum across all grades, and the quality of digital literacy training currently imparted has room for improvement

There is limited content that aims to build and develop digital skills in students. Digital literacy is not sufficiently integrated into the NCERT curriculum framework and there is little attention to 21st century digital learning skills and emerging technologies.

Recommendation 3.5

Develop content for digital competencies of students with themes around information and data literacy, communication and collaboration, content creation, safety and ethics, problem solving and technology operations across grade levels

Content for digital competencies for students across all grade levels should be developed. Developing digital skills in childhood is extremely important due to multiple reasons. The number of children with access to the internet and devices are increasing every year. Organisation for Economic Co-operation and Development (OECD) data also suggests that the age of first use of digital technology is dropping, and younger children are increasingly using digital technologies. While this trend presents many opportunities, it is also accompanied by many risks such as exposure to harmful content, cyber bullying, misuse of personal data, engaging in illegal activities, etc.[39] Developing digital skills among young children is essential to ensure that children are engaging with digital technologies in a safe and effective manner.[40] Enhancing digital skills in secondary schools (grades 9–12) is also one of the result indicators under ADB ASPIRE.

An analysis of multiple digital literacy frameworks from across the world[41] show that the digital content for students should invariably cover education pertaining to information and data literacy, communication and collaboration, content creation, safety and ethics, problem solving, technology operations and career related competencies. Digital literacy should be integrated across all subjects instead of being looked at as a standalone subject. For primary-grade students, crucial aspects such as cyber wellness, basic coding and computational thinking can be taught through gamified, engaging experiences and for higher-grade students, advanced courses and certifications can be provided. This may be done in partnership with private players who are experts in this field.

39. Education 21st Century Children: Emotional Well-being in the Digital Age, OECD, 2019
40. 21st century children as digital citizens, OECD, accessed April 2021
41. Such as Digital competence framework for citizens by the European Commission, Digital kids Asia-Pacific competence framework by UNESCO, Digital intelligence framework by the DQ institute, etc.

Implementation roadmap

Table 6: Implementation roadmap- digital content ecosystem

#Rec	Implementation activities	Responsibility	Timeline
3.1	Aligning with National Curriculum Framework for School Education (NCFSE) and state board curriculum, define quality assurance processes for creation and curation of quality content for benchmarking	State (SCERT)	Short term
3.1	Improve adherence to learning and technical standards by all content creators through wider promotion of guidelines set by DIKSHA/NROER	State (SCERT)	Short term
3.1, 3.2	Upgrade DIKSHA as national content portal to integrate LMS capabilities	MoE (NCERT)	Medium term
3.2	Defining taxonomies to tag content across all grades and subjects, aligned to curriculum and learning outcomes	NCERT and State (SCERT)	Short term
3.2	Create a national as well as state level best practice repository of digital content across all format types, subjects, and grades for ready reference	NCERT and State (SCERT)	Short term
3.3	Set up a content hub in each state with advance capabilities to create content of different formats	MoE and States (SCERT)	Short term
3.3	Empanel content providers at common pricing for content development, training, and maintenance services	State (SS)	Short term
3.4	Onboard third-party service providers for services to deliver personalised learning • AI/ML enabled learning management system for predictive analytics • Different types and formats of content mapped to learning taxonomy	States (SCERT)	Short term
3.4	Capacity building of school leaders, teachers, administrators to be able to use personalised learning technology tools	State (SCERT)	Long term
3.4	Draft policy to incentivize teachers to adopt content to plan lessons based on content analytics (usage, preference, learning gaps) generated for each class	State (SCERT) and district administration	Long term
3.5	Assess digital literacy of students in national and state examinations by integrating assessment items that assess child's interest, attitude, and ability to adopt digital technology and communication tools	MoE and States (SCERT)	Short term
3.5	Create or curate high quality content for digital literacy and future skills (cyber wellness, coding, computational thinking, advanced courses on AI/ML) for students of all grades (9-12)	State (SCERT)	Short term
3.5	Revise curriculum and textbooks to integrate future skills and digital literacy within mainstream subjects	State (SCERT)	Medium term

4 Assessments and analytics

Current state of assessments in the country

The school-based, student-assessment ecosystem in India comprises individual-level and system-level assessments. Individual-level are mostly census-based formative and summative assessments. System-level assessments, usually sample-based, evaluate the direction of overall learning and progress at a regional, national, and international level, such as the large-scale National Achievement Survey (NAS) and State Achievement Surveys (SAS). Promoting students to higher grades or levels, measuring learning outcomes and providing recognition or certifications has traditionally been the use cases of assessments. However, in recent times, assessments in schools, especially formative, are being looked at as a way to track students' learning outcomes and intervene appropriately to bridge the learning gaps and increase student learning outcomes.

Policy priorities and initiatives by the government

- **Holistic Progress Card (HPC) and focus on formative assessments**-Schools to conduct regular formative assessments in multiple forms like project-based play, quizzes, group-work, or portfolios, and these can be self, peer or teacher-assessed. HPC is designed to keep track of students' progress across cognitive, affective, and psychomotor domains across schooling years.
- **Changes in the structure of assessments**- Grade 10th and 12th board exams will be held twice a year in a modular format to decrease the burden on students. Through Structured Assessment For Analysing Learning (SAFAL), competency-based assessments will be introduced for students from grades 3, 5, and 8 (in Central Board of Secondary Education (CBSE) schools on a pilot basis). The National Assessment Centre, Performance Assessment, Review, and Analysis of Knowledge for Holistic Development (PARAKH) will set up standards for all recognized school boards and govern the assessment activities.
- **System-level assessments**- While the focus continues to be on the NAS, all states have been encouraged to conduct SAS. This is one of the key priorities of STARS, in which the beneficiary states use the funds to strengthen state assessment cells that can design and manage SAS. India is also looking to partake in Programme for International Student Assessment (PISA) 2022.
- **Usage of technology in assessments, evaluation and analytics**- With initiatives like energised textbooks, DigiLocker and blockchain to store certificates, AI-based software to track students' growth, state-developed apps for class-wise question papers, Management Information System (MIS) dashboards, reusable analytics and visualisation services and Project Appraisal, Budgeting, Achievements and Data Handling System (PRABANDH) for decision making support, the government is promoting the role of technology in this space.

Recommendations to improve learning content ecosystem

I. Assessments

Assessments are not adequately mapped to learning competencies and there is limited reuse of existing test items

While the curriculum is in the process of being linked to national standards, assessments, in most parts, lack linkages to defined curriculum standards, resulting in disparity between what is taught vs. assessed.

Assessments are designed at the level of school for most grades, making it all the more important for test designers to have standardised frameworks for both teaching and conducting assessments. Also, framing assessment items as a process requires a lot of effort and knowledge of framing items that can test competencies and not memorising capacity of students. Teachers often spend time and redundant efforts in creating assessment items to test on the same topic, making it an inefficient and cumbersome procedure.

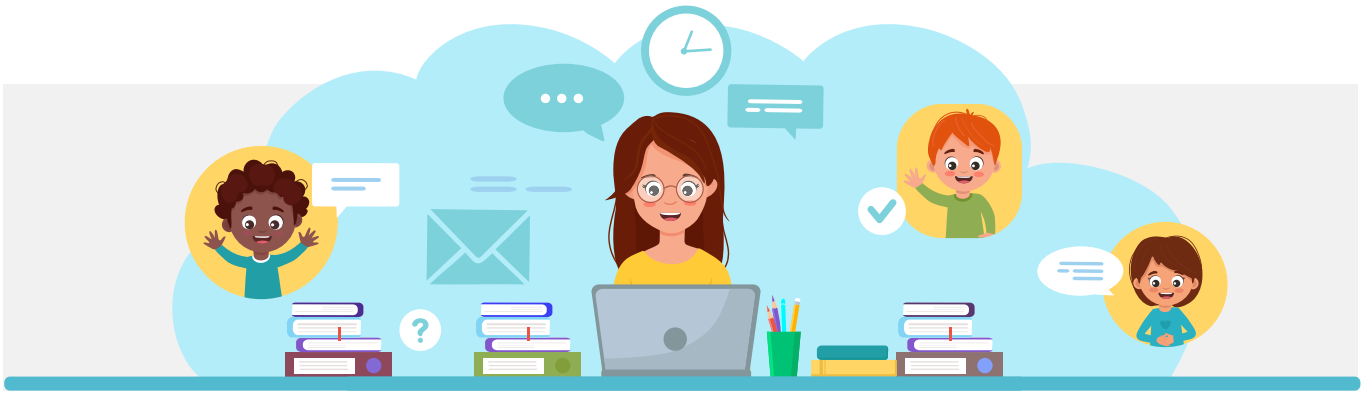
Recommendation 4.1

Adopt systems that can fetch competency linked questions from test banks across portals, linking back to content portals and energised textbooks and helping standardise evaluation

With the help of technology, states can develop competency-based question banks, in accordance with PARAKH and connected to content portals and energised textbooks, which the teachers can use to test students' mastery over learning objectives. This will help form linkages between what's been learnt vs. tested. On similar lines, the Government of Himachal Pradesh in 2020 launched Unified Learning Outcome Framework (ULOF) for all subjects in grades 1-8 which was used to create learning outcome-based teaching learning pedagogy as well as assessments.[42]

A technology enabled common framework for competency-based assessments will standardise the process of assessments and uniformly measure and track student performance at a system level. Further, having features like collaborative question authoring, question commenting, and question moderation will keep these portals engaging, alive and updated with the latest changes in syllabi. With this pool of competency linked assessment items, teachers can generate automated test papers reducing the effort, reducing dependency on test designer's skills, and making it an efficient process of testing. This will in turn also help standardise test evaluation through the use of rubrics created using technology tools.

This initiative can be funded through STARS in the beneficiary states which supports development of technology enabled assessment platform allowing teachers to create online assessments using online item bank.



42. KPMG in India analysis of Samagra Shiksha, Himachal Pradesh

Challenge

Test administration is largely pen and paper based, which leads to inefficiencies and infrequent assessments

The public-school education system in India heavily depends on pen and paper-based assessments, which require massive operational effort in terms of cost, time to administer, time to evaluate each paper and duplication of efforts in verification, to name a few. Also, assessments are not conducted frequently, partly because of the effort required. Owing to this, assessments are based on rote learning and students' subject understanding and learning progress are not assessed as frequently.

Recommendation 4.2

Adopt low-cost technology solutions for frequently administering assessments via online modes such that the quick analysis of results can help teachers and learners understand next steps in learning

Stakeholder consultations suggested that it is important to lift the burden of examinations as a process, which creates unnecessary pressure on students and teachers. The purpose of examinations and assessment of students should be identified (to check for understanding of a particular concept or to assess the competencies such as reasoning, critical thinking) and teachers and schools should be given the autonomy and flexibility to decide type and frequency of assessments best suited in the context of their classrooms. Technology can be a game changer in reduction of efforts for administering assessments, giving teachers autonomy.

To conduct digital assessments, one does not need massive hardware to be placed in every school. Simple digital tools like online forms and low-cost technology solutions like social media platform based assessments conducted through smartphones and shared student devices in schools are sufficient. The Saksham Haryana programme leveraged two-way communications, and social media platform based chatbots to conduct large scale competency-based assessments for over 3 lakh students from grades 3,5,7.[43] Another low-cost technology initiative 'One Mouse per Child' is integrating learning and assessments to individually engage all children through relative performance.[44]

Switching to low-cost solutions for conducting digital assessments will lead to a huge reduction in efforts, frequent testing, increased stakeholder-ability to track students' progress in real-time, more data generating meaningful insights for teachers to plan lessons. Technology will also enable consolidation of data from multiple assessments and classrooms, informing the state of learning to stakeholders at different levels.

43. Large-scale assessments in India, Michael & Susan Dell Foundation, Centre for Science of Student Learning, ConveGenius Insights, Central Square Foundation and Educational Initiatives, 2019

44. One Mouse per Child: Interpersonal Computer for Individual Arithmetic Practice. Journal of Computer Assisted Learning, 28(4), 295-309. Wiley, Alcoholado, C., Nussbaum, M., Tagle, A., Gomez, F., Denardin, F., Susaeta, H., Villalta, M. & Toyama, K., 2012

II. Analytics

The data collection process is infrequent, not holistic, inadequate, non-uniform and inefficient leading to limited use of data for decision-making

Despite having multiple portals to collect data at the state level, it is often seen that there's no/poor unified system that generates meaningful insights on the analytics coming from different data sources. Stakeholder consultations with practitioners from different state governments informed that often teachers and administrators are made to collect data on the same indicators for different portals, making it an inefficient and frustrating process. Even learning data that is gathered is rather infrequent and limited (to attendance, scholarships) and is not sufficiently outcome driven and holistic enough to generate 360-degree feedback. Besides that of students, limited data is collected at a teacher, school, and other levels of administration. Additionally, the format of data collection is not uniform and the entire process from data collection to data reporting, being non-digital, is inefficient, cumbersome, and subject to multiple loopholes. This opacity in data leads to decision-making happening in an ad-hoc manner.

Recommendation 4.3

Gather and track holistic data digitally on a multitude of dimensions across various stakeholder levels (student, teacher, school, block, district, and state) from all relevant sources over schooling years, pertaining to input as well as outcome parameters such as academics, user behaviour (of technology tools), attendance, drop-outs, behavioural, health, background, and profiling information from external portals

A robust and unifying Education Management Information System (E-MIS) at a state level can solve for the challenge stated above. Aligning with the NDEAR principles proposed by MoE, the E-MIS can be linked with multiple portals within the education department as well as other departments and can be utilised to streamline the process of data collection, management, and analytics across a multitude of dimensions for various stakeholder levels from all relevant and external sources when required. This child level holistic data can be used to generate insights that will be immensely useful in for example: a) channelising scholarship funds for children with more needs b) predicting drop-outs by looking at child's learning data over years, health and family income c) consolidated report card of child's past learning journey for teachers to be more equipped to support them in classroom d) guidance to district and block officials on specific areas of support required by the school, and so on.

When building the E-MIS, data pertaining to variables that are in immediate locus of control of the school education department (such as student data on academics, usage of technology tools by students and teachers, attendance etc.) can be prioritised in the near-term. In the medium term, data can be expanded to collect behaviour, health, and background information from external sources. By integrating simple tools for data analytics and visualisations, the E-MIS can generate dashboards with relevant metrics for various stakeholders at all levels, leading to data informed decision making for policy and practice.

This can be funded through ADB ASPIRE in the beneficiary states which focuses on improving the availability and quality of data in the MIS leveraging technology-based monitoring systems. The STARS programme is also focusing on strengthening national data systems to capture quality data on retention, transition and completion rates.

Challenge

Collected data is not used efficiently for drawing actionable insights

Due to inadequate capacity and systems being less user-friendly, even the available data is not being sufficiently leveraged for decision-making both on academic and administrative matters. Further, most stakeholders are not aligned on the purpose of the high quantum of data generation since clear actionable insights and next steps for them are not defined.

Recommendation 4.4

Enable stakeholders to generate easy, actionable insights, empower in decision-making at their level (classroom instructions or policies) and enhance efficiency through data analytics through easy to use/ understand dashboards, enabling predictive analysis to guide decisions at various levels

States should urgently invest in data analytics capabilities that help generate easy to articulate data reports and dashboards for stakeholders at all levels, enabling them to take decisions from classroom instruction to policy making. The immediate need is to present teachers and schools with easy-to-use customised dashboards providing practical insights that can be used to bridge the learning gaps of students in an academic year and plan other student related interventions. This will close the feedback loop for teachers and schools and enable district managers to focus on specific interventions in the schools of their blocks as per gaps identified.

States like Andhra Pradesh under VidyaVikassam project and Gujarat under Command-and-control centre projects have invested in technologies for robust data analytics and visualisations. Overtime, real-time aggregate level data can inform decision-makers and policies about priorities and resource mapping and enable budget planning.

43. Large-scale assessments in India, Michael & Susan Dell Foundation, Centre for Science of Student Learning, ConveGenius Insights, Central Square Foundation and Educational Initiatives, 2019

44. One Mouse per Child: Interpersonal Computer for Individual Arithmetic Practice. Journal of Computer Assisted Learning, 28(4), 295-309. Wiley, Alcoholado, C., Nussbaum, M., Tagle, A., Gomez, F., Denardin, F., Susaeta, H., Villalta, M. & Toyama, K., 2012

Implementation roadmap

Table 7: Implementation roadmap- assessments

#Rec	Implementation activities	Responsibility	Timeline[45]
4.1 – 4.5	Invest in an interconnected digital ecosystem (linking with 2.1, 2.2, 3.2) with unique student IDs to track assessment results from different types of exams, learning gaps, learning trajectory etc.	MoE and States (SCERT)	Short term
4.1 – 4.5	Launch scheme to set up assessment cells in each state for managing digital assessment activities (pre post examination processes, evaluations, and reporting)	MoE and States (SCERT)	Short term
4.1 – 4.5	Define assessment strategy for the state (participation in international exams, large scale assessments vs. sampled, online vs offline exams, processes etc.)	States (SCERT)	Short term
4.1	Develop itemised questions banks for all grades and subjects with each question mapped to learning outcomes	States (SCERT)	Short term
4.1	Link national (adopted under PARAKH) and state portals for automated test design for formative and summative assessments	States (SCERT)	Short term
4.1	Build capacity of teachers on online test item design, administration, and evaluation	States (SCERT)	Medium term
4.2	Empanel a set of blended learning platforms with assessment capabilities at state level which can be used by schools for formative assessments	States (SS)	Short term
4.2	Identify test-bed schools for adoption of tech-based formative assessments	States (school education department)	Short term
4.2, 4.3	Allocate funds (for hardware, capacity building, technology) to shift to online administration and evaluation of school examinations	States (SS)	Medium term
4.2	Expanding adoption of tech-based assessment administration for in-class/formative assessments across majority schools	State (school education department)	Long term

Implementation roadmap

Table 8: Implementation roadmap- analytics

#Rec	Implementation activities	Responsibility	Timeline[46]
4.3	Assess current processes of data management (collection, cleaning, transformation, aggregation, dashboarding) to find gaps	States (CSE)	Short term
4.3	Establish a state-level unified MIS either by connecting existing systems or by building a new system	States (CSE)	Short term
4.3	Set up of Project Management Unit (PMU) and vendor selection for streamlining data collection, monitoring completeness of data, and reviewing quality	States (CSE)	Short term
4.3, 4.4	Identify data managers at district and sub district levels and build capacity on digital data collection and data driven decision making	States (CSE)	Medium term
4.3, 4.4	Draw state plan for data collection and analytics with clearly defined parameters, cadence, reporting format, review mechanisms from near- and medium-term perspectives	States (CSE)	Short term
4.3, 4.4	Build systems and processes to integrate data sources from external portals to generate holistic report cards on student learning and behaviour	State (CSE)	Long term
4.4	Conduct periodic reviews and incentivize stakeholders for sustenance of efforts at all levels	State (CSE)	Long term
4.3, 4.4	Best practices on data collection and analytics to be documented and shared with all districts	State (CSE)	Medium term

46. Short term - 2022-23 (1-2 years) | Medium term - 2024-2027 (3-5 years) | Long term - Beyond 2027 (> 5 years)

Appendix 1- RIDE index

Overview

Readiness Index for Digital Education (RIDE) index is a composite index that will help monitor and measure progress of digital enablement and transformation in the public-school education ecosystem.

Objectives of the index

- To help key stakeholders understand the current state of digital infrastructure and access in a district with respect to school education
- To help state-level policy makers prioritize districts and facilitate planning and decision-making
- To analyze district strengths and gaps in providing an effective technology enhanced learning environment
- To helps district leaders create policies, procedures, and practices that empower school leaders to improve quality of digital education in their district

At a later stage, the index can also be used to monitor digital maturity at a school level and help meet the following objectives:

- Help school leaders' identify their needs and challenges in providing a technologically enhanced learning environment
- Help school leaders in decision making and adopting best practices to improve their schools' quality of education
- Help policy makers and key stakeholders in the government to identify/prioritize the right schools for digital enablement

Suggested framework

The RIDE Index further broken into four sub-indices helps capture digital maturity under the dimensions of i) infrastructure readiness ii) people readiness iii) availability of budget and resources and iv) vision. These sub-indices are further broken down into multiple parameters of measurement, which can be ascertained through a combination of data available with various government agencies and a sample-based survey approach.

Table 9: RIDE index framework

Framework	Metric	District level measure	School level measure
Infrastructure readiness	Mobile-cellular/broadband subscriptions per 100 inhabitants	Yes	
	Percentage of households with a computer or laptop	Yes	
	Percentage of households with Internet access	Yes	
	Percentage of households with electricity	Yes	
	Percentage of schools with a computer or laptop	Yes	Yes
	Percentage of schools with Internet access	Yes	Yes
	Percentage of schools with electricity	Yes	Yes
	District has an airport, railway or road network which is easily accessible	Yes	Yes

Framework	Metric	District level measure	School level measure
People readiness/ capacity	Parent literacy rate	Yes	Yes
	Students who report they can use computers for schoolwork	Yes	Yes
	ICT skills of teachers	Yes	Yes
Budget and resources	Funding identified for digital learning programmes in the district/ school's annual maintenance and operation budgets	Yes	Yes
	Non-recurring funding allocated for short-term initiatives or pilots	Yes	
	Average number of days taken by state govt./ union territory (UT) administration to release budgets for ICT related activities due to districts/schools	Yes	
	Average 3-year funding per student for improving ICT infrastructure of schools	Yes	Yes
	Availability of support, repairs, replacements in the district	Yes	Yes
	Average no. of days it takes for troubleshooting	Yes	Yes
Vision	District leaders' plans for digital learning	Yes	Yes
	School leaders' plans for digital learning		Yes

At subsequent stages, upon reaching a certain level of maturity, the framework can also be expanded to include parameters related to availability of digital content, its quality, adoption of technology based assessments, professional development activities and so on.

Appendix 2- Indicative RACI matrix for bundled procurement in a state

Table 10: RACI matrix for bundled procurement

Task	System Integrator		Learning Solution provider(s)	District level measure	School level measure
Project management for implementation of software and hardware	R	A			C/I
Deploy field management staff	R	A			C/I
Readiness of hardware and learning solution contextualised to state's needs	A		R	R	C/I
Deploy devices in schools	A			R	C/I
Capacity building of teachers	A		R	C	C/I
Internet, electricity, and furniture set-up					R
Monitoring support	R	A			C/I
Funding					R

*System Integrator will collaborate with service providers for learning solutions, hardware, equipment etc. and will be a single point of contact for the government.

	Responsible (R)		Accountable (A)		Consulted (C)		Informed (I)

Appendix 3- Study on contextualised OLPC project in India

A study on One Laptop per Child (OLPC) in rural India suggests that children's usage of OLPC laptops in a contextualised implementation design in rural Indian primary schools led to positive learning outcomes, both in technological and functional literacies.

The laptops were distributed across nine rural Indian primary schools. The contextualised design implemented strategies to address the following factors:

1. Unbiased gender access to devices- sensitization of teachers to ensure that both girl and boy students had equal access to devices
2. Local language use- translation of technical information to local language
3. Teacher training- technology training curriculum for teachers to build their capacities in using these laptops.

The study produced the following results:

- Analysis of Variance (ANOVA) test conducted among treatment and control groups to compare achievement in technological literacy showed significant results, $F(1203) = 54.75$, $p < 0.001$. Thus, the treatment group showed greater increase in technological knowledge in comparison with the control group.
- ANOVA test conducted to test for significant differences between the means of the treatment group and the control group while comparing functional literacies pre and post the intervention showed significant results, $F(1203)= 54.75$, $p < 0.001$. Thus, the treatment group showed greater increase in functional literacies compared to the control group.[47]

47. Contextualised-OLPC education project in rural India: measuring learning impact and mediation of computer self-efficacy, Educational Technology Research and Development, Ale, K., Loh, Y. A.-C., & Chib, A. (2017)

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