EdTech Hub

Clear evidence, better decisions, more learning.

unicef for every child

Shaping the future of digital education

A global conversation on how to move beyond digital as usual

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About EdTech Hub

EdTech Hub is a global research partnership. Our goal is to empower people by giving them the evidence they need to make decisions about technology in education. Our evidence library is a repository of our latest research, findings and wider literature on EdTech. As a global partnership, we seek to make our evidence available and accessible to those who are looking for EdTech solutions worldwide. EdTech Hub is supported by UK International Development, World Bank and UNICEF. The views in this document do not necessarily reflect the views of these organizations. To find out more about us, go to edtechhub.org. Our evidence library can be found at docs.edtechhub.org/lib.

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Foreword

By Pia Rebello Britto and Verna Lalbeharie

Both the opportunities and threats from digital technologies in education are larger than ever before. But our starting point cannot be what technology can do. It must be what children need in order to learn, and what education systems need in order to deliver that learning equitably and at scale.

The technologies are changing fast, the applications for education are changing fast, and the education sector's understanding of how they should be used for learning is also changing fast. The current moment has raised the stakes: digital technologies are becoming more deeply embedded in children's lives, and artificial intelligence (AI) is becoming more deeply embedded in all technologies used in education.

But while technological change rushes ahead, progress towards global learning equity remains slow. As investments in AI globally are projected to surpass US$2 trillion in 2026,[1] global financing to education is shrinking.[2] Progress has stalled on ensuring access to education: 273 million children still are not in school.[3] For millions more, learning is delayed or disrupted, from disability-related exclusion to conflict- and climate-related school closures or persistent financing gaps. This is especially important for girls, who continue to face unequal access to devices, connectivity, digital skills and safe participation in technology-enabled learning.

Against this backdrop, it is clear that the use of digital and AI-enabled technologies in education can lead to harm or good. On one side, greater potential for faster breakthroughs: for children falling behind, for multilingual support, for classroom inclusion and, critically, for teachers. Teachers are the essential infrastructure of education systems, and the promise of digital and AI-enabled technologies should be measured in part by whether they strengthen teachers' ability to teach, respond to different learning needs and spend more time on the human dimensions of teaching that technology cannot replace. On the other, greater potential for harm to learning, learners and education systems: cognitive atrophy, reduced human connection, exacerbation of educational and social inequities, data privacy threats and complex relationships with for-profit technology providers. With the recent proliferation of both AI hype and EdTech backlash, it can seem as if every child, parent, teacher or policymaker feels differently – and strongly – about which way the pendulum should swing and the degree to which the public and governments can sway its course.

Across the global education community, plenty of voices are explaining how AI will transform education, and likewise plenty are also explaining that AI in education is primarily a distraction or worse. What you hear most depends on what part of the community you are closest to, and that is worth reflecting on. The rapid evolution of AI will continue to generate contrasting narratives, conflicting strategies and substantial noise regarding the future of how digital technologies are used in education. But education cannot simply be a recipient of technological change. Teachers, learners, communities and governments must have a hand in shaping technologies themselves.

Of course, whether the use of digital and AI-enabled technologies leads to harm or good in education depends on a wide range of complex factors and how they are applied within specific contexts.

Because of this, amid the challenges, possibilities and noise, we must keep a clear focus on **ensuring that use of digital and AI-enabled technologies in education produces cost-effective, long-term improvements in children's learning and human flourishing; enables teachers to thrive; and strengthens education systems.** This also means moving beyond pilots to financing models that governments can afford, sustain and take to scale.

Shaping technologies to ensure education quality and equity requires intentional and careful work. For organizations committed to protecting children, improving education for those most marginalized and preserving relationship-centred teaching and learning, a simplistic 'pro-AI' or 'anti-AI' dichotomy is not sensible. We also need to ensure that the benefits of these technologies are treated as a global public good for education, designed and governed to serve all learners and education systems equitably, rather than being shaped primarily by commercial opportunity or the ability to pay. To manage the threats and maximize opportunities, public international education organizations, including UNICEF, are assertively engaging in the global conversation, working with AI industry leaders to critically evaluate and inform how these technologies influence education.

Informed by analysis of evidence and practices, this report explores how the sector can approach this work collectively and responsibly. Developed collaboratively by UNICEF, EdTech Hub and a wide range of leading experts, it engages with diverse issues and perspectives to map the landscape of change in digital education, shed light on cross-cutting themes that require foregrounding to make progress, and outline routes forward.

Now is the time to raise the bar for how we use technology in education, including AI. Business as usual in education is not enough. Business as usual in digital education is not enough. That is why UNICEF, with support from EdTech Hub, launched its Digital Education Strategy for 2025–2030, titled 'Beyond Digital as Usual'. This report recalls this title for a reason: we cannot continue as we have in the past, nor simply digitize education systems that are already failing too many children. Together, we need to drive a paradigm shift away from the status quo to a new way of working that positions digital and AI technologies to deliver on the promises of quality education for all and the broader 2030 Agenda for Sustainable Development. Let this report mark a step towards the shared understanding needed to govern this shift towards digital and AI-enabled tools that are transparent, safe, educationally sound, contextually appropriate and accessible – for every child.

Pia Rebello Britto

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About this report

Developed in collaboration between UNICEF and EdTech Hub, this report explores the relationships between digital and AI-enabled technologies and learning, teaching, safety, inclusion, equity, system sustainability and political economy. The report comprises a series of evidence reviews, think pieces and country case studies authored by researchers, policymakers, practitioners and technical experts working across the digital education ecosystem.

Rather than presenting one single institutional stance, it offers a curated collection of evidence-informed perspectives designed to stimulate debate, reflection and practical action among governments, donors, multilateral agencies, researchers and education leaders. The views expressed are those of individual authors and contributors, and do not necessarily represent the official positions of UNICEF, EdTech Hub or affiliated partners.

Structurally, the report opens with an introduction to UNICEF's EdTech for Good Framework 2.0[4] and current trends in EdTech markets, before moving into five thematic parts organized around the Framework's five pillars: contextual readiness, educational impact, inclusive access, safety and well-being first, and designed for learning and teaching. Each part contains a synthesis of the global evidence base, think pieces offering implementation and policy reflections, and country case studies exploring how digital education policies and investments play out in national contexts.

How to engage with this report

The current context of how digital technologies should inform education is complex and fast-moving, which is why the report intentionally features a wide range of contrasting expert viewpoints. No reader is expected to agree with all that is written in the report; indeed it is unlikely that anyone who contributed to it agrees with the entirety of all the other contributions. Space is needed to explore diverse, complex and contested topics from a foundation of practical expertise. The report provides evidence-based insights to help readers inform their own thinking and practice. Readers can read it from beginning to end or consult it chapter by chapter.

We anticipate that the education work of most readers is focused on low- and middle-income contexts, where lack of finance, infrastructure and capacity each influence what is viable and appropriate regarding digital technologies and specifically AI in education. Most of the content and the examples focus on this. If you are working solely in high-income, well-resourced contexts, then the content is likely to be less relevant to you.

A note on terminology

This report uses the term 'EdTech' to mean digital and AI-enabled tools built for education. They include tools built for learning and teaching, tools used to administer education systems and, in some cases, general-purpose technology not designed for education but widely used within it. 'Digital education' is used to describe the systems – comprising policies, financing, governance, infrastructure, culture and human capacity – into which EdTech is integrated.

The report does not impose a single definition on its contributors. Authors from multilateral organizations, universities and research institutes, development partners and governments use the terms current in their own fields, and their usage is preserved. Readers will therefore encounter 'EdTech', 'education technology', 'digital education', 'EdTech and AI', and 'AI in education' across the report. Where a term carries a specific meaning for a particular author, it is defined in that section.

A note on methodology

Methodologically, the country case studies are based on a combination of desk research and key informant interviews with relevant government stakeholders and development partners. Background papers were developed through a structured, human-led and AI-assisted process designed to extend coverage and accelerate evidence synthesis, while also testing how generative AI can be used responsibly in research. The process began with a human-led mapping of key themes aligned with the EdTech for Good Framework 2.0, followed by targeted searches of relevant academic and institutional sources. Selected materials were then reviewed and synthesized with the support of selected AI tools to assist with evidence extraction, organization and drafting. Outputs were quality-assured and refined through expert human review at each stage. Further detail on the approach, and the lessons learned through its application, is provided in the annexes.

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These evidence reviews are a synthesis of work that others have carried out. Gratitude is therefore extended to the wide community of researchers, evaluators and practitioners whose studies and field experience are collated across these chapters – much of the work conducted over many years, in demanding contexts and often without the visibility it deserves. The value of this report rests on the strength of that underlying evidence base.

The report brings together think pieces from contributors across the digital education ecosystem, each of whom is credited in the chapter they authored. Thanks go to Noam Angrist, Ekua Bentil, Pia Britto, Marta Carnelli, Cristobal Cobo, Melissa De La Cruz, William Doyle, Carlos Ferrari, Catherine Flagothier, Brenda Haiplik, Isabelle C. Hau, Beth Havinga, Ursula Hinostroza Castillo, Michelle Kaffenberger, Afrooz Kaviani Johnson, Heather Kayton, Niko Lindholm, Anna Lindroos Čermáková, Susanna Loeb, Joel Mitchell, Eszter Nagy, Juliette Norrmén-Smith, Daniel Plaut, Pasi Sahlberg, Julian Sefton-Green, Maria Spies, Luke Stannard, Auken Tungatarova, Dan Wagner, Xinyu Zhao and Chris Zomer for their time and their willingness to write candidly and constructively on contested questions. EdTech Hub is also grateful for the support of UK International Development. We hope their contributions prompt debate well beyond this report.

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Executive summary

This report is written during a global hype cycle around AI and education. As with any hype cycle, the conversation is future-focused, centred on how education systems should respond to accelerated change to ensure that the technology's strengths can be harnessed and risks managed. Amid the discourse of future perils and potential, it is useful to look back and reflect on what we have learned about digital and AI-powered technology in education systems over the past 25 years.

After over a quarter century of promising claims about technology's transformative potential, the global learning crisis remains acute. Some 273 million children are out of school and a large proportion of those in school are unable to read. Financing for education has shrunk. Meanwhile, global investment in AI is projected to surpass US$2 trillion in 2026. Total global venture capital investment into EdTech grew to US$2.6 billion in 2025, concentrated in AI-enabled platforms and tools.

These figures point to a fundamental risk: time and money may be wasted if AI in education is used to repeat mistakes made during earlier waves of digital education investment. Seeking quick wins by deploying the latest technologies to the greatest number of students is one such mistake. It overlooks learning outcomes and neglects the sustained, systemic factors that form the backbone of any successful digital education strategy or programme.

Digital and AI-enabled technologies can accelerate progress for children falling behind, sustain education during crises, support multilingual learning, strengthen school inclusion and help teachers tailor instruction to learner levels and needs. But these technologies can also weaken human connection, corrode or impede cognitive development, widen inequities and expose children to harm.

The direction of this impact is not inevitable. By critically interrogating our past and present, we – governments, educators, development partners and AI industry leaders – can collectively steer towards improving learning and bridging barriers to equitable education. But this is not the default direction of change. **Without strong and proactive governance, business as usual in digital education does not deliver safe, quality learning opportunities for every child.**

Developed in collaboration between UNICEF and EdTech Hub, the report examines the relationships between digital and AI-enabled technologies and learning, teaching, equity, safety and system sustainability. The report is structured using UNICEF's EdTech for Good Framework 2.0, launched in July 2026. Its five pillars organize the chapters of the report: Contextual Readiness, Educational Impact, Inclusive Access, Safety and Well-being First, and Designed for Learning and Teaching.

Each thematic chapter combines a synthesis of global evidence, think pieces offering implementation and policy reflections, and country case studies showing how digital education policies and investments play out in practice. Most content addresses low- and middle-income contexts, where constraints around finance, infrastructure and capacity significantly shape what is viable in digital education.

The report focuses on the equity, sustainability and safety considerations that should inform all decision-making around the use of digital and AI-enabled technologies in education systems. The five chapters explore the best of the current evidence on these issues, examining the points of tension, welcoming expert reflections and ultimately presenting a series of recommendations for a more equitable future that goes 'beyond digital as usual', recalling the title of UNICEF's Digital Education Strategy. The content below summarizes the main insights from each chapter, highlighting the current evidence (what we know) and what productive action can be taken in light of this (what we can do).

Part 1 addresses contextual readiness. It focuses on the central question: What evidence do we have about how digital and AI-powered tools can be implemented and scaled responsibly within real education systems and environments?

What we know	What we can do
Public governance. Without government ownership, digital education interventions will not scale or sustain impact in the long term. In the absence of curriculum alignment, ministries have no structural reason to integrate a platform, teachers have limited confidence in or opportunity to use it, and children have no assurance that their learning will translate into formal schooling.	When partnering with private providers, ensure that each choice increases the government's capacity to own or lead the deployment of the platform independently. Private providers can play an important role, but within systems governed around public education goals rather than commercial incentives, safeguarding pedagogical sovereignty, data governance and long-term fiscal sustainability.
Co-creation and iteration. In the AI era, the most scalable and impactful digital learning tools are those that support educators, are validated by public authorities and continuously improved through feedback loops that connect research, practice and innovation.	Build educator and government participation into the design and continuous improvement of digital education tools and programmes to ensure curriculum alignment, content ownership, and data governance and evidence uptake.
Relevance and representation. Digital and AI-enabled technologies can widen rather than close inequities when local languages, curricula and cultural norms are not reflected in content, design choices or underlying data sets. A significant performance gap between African languages and English persists in AI models used in education.	Co-design and adapt digital education tools to local languages, curricula and cultural contexts, and invest in representative data and evidence to close critical gaps, particularly for underrepresented languages and vulnerable populations.
Interoperability, infrastructure and crisis-readiness. System fragmentation and poor interoperability remain among the most persistent institutional barriers to impactful use of digital and AI-powered tools in education. Reliable electricity, connectivity and affordable devices are absent or constrained across many national education systems. When infrastructure, data systems and teacher capacity are built and maintained consistently over time, they can be crisis-response assets.	Integrate digital education tools into existing workflows and public sector digital ecosystems where relevant. Take the financial, technical and environmental demands of digital and AI seriously by governing and financing across public sector bodies. Explore whether low-tech, offline-first platforms and AI and shared or teacher-led use can simultaneously support crisis readiness, reduce resource demands, extend access and support better models of learning at a low cost, particularly in low- and middle-income countries (LMICs).

What we know	What we can do
Financing and procurement. Recurring and long-term operating costs need a home in domestic budgets before donor project financing ends. This includes budgeting for long-term teacher support and costing system readiness over the device life cycles. Investments focused narrowly on devices, connectivity or software licensing fees consistently underperform without reliable and maintained support to teachers. Procurement planning and distribution coordination are critical factors for enabling positive and equitable impact.	Be realistic about long-term operating costs and human capacity development. Align digital education plans with a government's technical capacity to manage large-scale deployment. Expand and sustain investment in pre-service and in-service teacher professional development to strengthen digital pedagogy and maintain the impact of digital education interventions, financed through core education budgets. Make deliberate design choices related to geographic reach, scheduling, supervision, software calibration and targeting, and consider rolling replacement cycles for 20–25 per cent of devices annually by region or grade level.

Part 2 addresses educational impact. It focuses on the central question: What evidence do we have about how digital and AI-enabled technologies can have a meaningful impact on student learning and broader educational outcomes?

What we know	What we can do
Multidimensional impact. Impact evaluations can focus narrowly on learning outcomes, which overlooks the impact of digital education interventions on teaching, equity, safety, well-being, the learning environment and the broader system.	Expand and nuance the concept of impact beyond learning outcomes alone, including by using frameworks such as EdTech for Good 2.0 that have broader scoring criteria across different domains of educational value. Include metrics in evaluations to explore effects on well-being, relationships, social-emotional learning, engagement, safety and the wider learning environment.
Implementation conditions. A digital tool's educational impact depends not only on its quality, but on how it is adapted, adopted and used in a specific context. Hardware-heavy approaches can carry high costs without corresponding learning gains when implementation capacity, teacher training, technical support, infrastructure or adaptation to local needs are insufficient.	Assess implementation requirements and the readiness of learning environments before investing in a digital or AI-enabled intervention and ensure programming includes consistent pedagogical, technical and operational support for sustained and effective use.
Teacher-led differentiation. Teachers, not automated tools, are the central enablers of learning. Evidence shows that digital tools are most effective when they help someone assess each child and teach to that child's learning level.	Prioritize educational technologies that help teachers identify children's learning levels, align instruction accordingly, monitor progress and provide targeted support.
Measurement and evidence pathways. Programme-level measures such as quiz scores, module completion and progress against tool-specific content can reward what is easiest to measure and limit comparability by showing what happens inside an EdTech tool rather than against established benchmarks or learning that happens outside the platform. Traditional research timelines are often too slow to inform live implementation decisions, and rapid iterative models are not yet routine.	Use psychometrically validated assessments and established benchmarks. Embed evaluation into implementation and explore iterative methods that generate evidence on programme delivery, teacher engagement and outcomes disaggregated by key factors including gender, performance level and disability where appropriate. Where possible, invest in longitudinal research to understand whether early gains hold at scale and how outcomes differ over time.

What we know	What we can do
Cost-effectiveness. Evaluating the links between costs and outcomes is under-researched and not standardized across digital education interventions.	Capture all data relevant to implementation costs, including foundational infrastructure, and hold EdTech suppliers accountable to meeting targets for both provision and outcomes for a given cost. Develop a benchmark of minimum standards for what stakeholders can reasonably expect in terms of learning outcomes, at what cost per child, for different forms of digital and AI-enabled technologies, calculated over time.

Part 3 addresses inclusive access. It focuses on the central question: What evidence do we have about how digital and AI-enabled tools and services can be used to support equitable access to and participation in education for diverse learners?

What we know	What we can do
Equity, exclusion and digital education. Out-of-school children, girls, learners with disabilities and those in crisis-affected contexts face overlapping barriers to safe and meaningful participation in digital learning, including prohibitive connectivity costs, gendered household dynamics, exclusionary design and systemic biases. Technology can help sustain learning under difficult circumstances when the enabling conditions are in place, such as affordable connectivity, accessible digital content and platforms, assistive technology, teacher capacity, inclusive procurement and accountability mechanisms.	Develop a whole-of-system approach that accounts for constrained environments and addresses multiple dimensions of exclusion simultaneously, ensuring that teacher training is at the core. Design interventions for and with learners who face the greatest barriers, including learners with disabilities, girls, least-connected learners and children in low-resource or crisis-affected contexts. Invest in combinations of offline applications, low-bandwidth platforms, content with accessibility features, local-language instruction, gender-responsive design and strong community engagement to reach the most marginalized.

> Our starting point cannot be what technology can do. It must be what children need in order to learn, and what education systems need to deliver that learning equitably and at scale."

Pia Rebello Britto
Global Director, Education
UNICEF

Verna Lalbeharie
Executive Director
EdTech Hub

What we know	What we can do
Inclusive and flexible design. Accessible digital content is most effective when supported by wider enabling conditions, such as accessibility standards and inclusive procurement, access to assistive technology and reasonable accommodation, teacher and school capacity, and meaningful participation of persons with disabilities in design and implementation.	Develop accessibility guidelines and require them to be built into the design of digital and AI-enabled technologies and programmes by ensuring assistive compatibility and usability, flexible use to accommodate different learning needs and contextual requirements, and language and cultural adaptation to support diverse needs and abilities. Ensure these features are meaningfully and safely tested with users and improved.
Language and local adaptation. Language support remains one of the most persistent and least recognized barriers to learning, with millions of children speaking a different language at school than at home. AI increasingly enables educational resources to be translated, adapted and generated in historically underserved languages, but major gaps remain in quality and comprehensiveness.	Establish processes to expand language coverage, strengthen localization, improve translation quality and assess cultural appropriateness to strengthen both learning and cultural inclusion, particularly for historically underserved populations.
Limited evidence base. There is limited child-centred, gender-disaggregated evidence on how children use digital and AI-powered technologies; the impacts on their cognitive, social and emotional development; the risks they encounter; and the experiences of children in LMICs. Data systems frequently exclude those who are disconnected or disabled, creating a persistent invisibility that undermines inclusive planning. The evidence base on disability-inclusive education interventions in LMICs remains limited.	Disaggregate data before scaling digital education programmes, assess who benefits and who remains excluded, the conditions under which EdTech interventions have impact or not, and how outcomes differ across groups and contexts, using disaggregated evidence to track whether digital investments reduce or widen gaps. Invest in evidence generation in LMICs that reflects real implementation conditions, including government-run systems, low-resource and crisis-affected settings and diverse learner groups.
The potential of AI. While AI is not a substitute for accessibility, pedagogical, linguistic or technical expertise, it can help reduce production timelines of accessible, translated or adapted education materials at scale and support accessibility workflows when they are combined with strong human oversight, validation processes, accessibility expertise and clear governance.	Explore how AI can accelerate inclusive design processes, keeping educators, accessibility specialists, language experts, ministries of education and human-in-the-loop validation processes at the centre of review of AI-enabled accessible digital education materials.

Part 4 addresses safety and well-being. It focuses on the central question: What evidence do we have about how digital technologies can be designed and governed in ways that uphold children's rights, protect them from harm and support their well-being?

What we know	What we can do
Data rights and public accountability. The education sector is particularly susceptible to cyberattacks and the tacit neglect of children's data rights. EdTech can pose multifaceted risks to children's rights when their data are shared without meaningful consent or legal basis for gathering, processing or sharing personal data. Data security measures and regulatory frameworks are struggling to meet the moment.	Establish and implement laws, policies and normative standards that treat digital and AI-enabled harm as part of violence prevention in, around and through schools. Any digital or AI-powered platform that gathers children's educational data must be governed, financed and controlled by public authorities with data sovereignty in national hands.
Safety-by-design. The scale and cross-national consistency of online harms confronting children is substantial. Frameworks such as safety-by-design, child rights impact assessments, and privacy-enhancing technologies are well developed in theory, but there are significant barriers to implementing them in real learning environments.	Translate regulatory and standards-setting instruments into prevention and response systems that place responsibility on technology developers to identify and mitigate potential harms at the product design stage, not reactively after launch. Require companies contracted by governments to implement rights-respecting standards across their products and wider business practices.
Digital and AI literacies. Teachers, learners and caregivers need opportunities to expand their digital and AI critical literacies. Without these, even well-designed tools can be used in ways that undermine privacy, well-being and development.	Invest in the capacity of schools and educators to make informed decisions about how technologies are used. Ensure that teachers and learners are well equipped with digital and AI literacies that enable them to make day-to-day decisions about leveraging digital and AI-enabled technologies in ways that prioritize their privacy, well-being and development.

“The government should require companies to comply with a set of requirements for digital products used by children.”

Child, Spain, 10–13 age group[5]

What we know	What we can do
Well-being and screen-free time. Education benefits of digital tools should be weighed against emotional, developmental and other negative impacts, which evidence suggests can be substantial. Harmful social and gender norms extend into digital spaces and can be amplified there.	Teach learners how to live safely, responsibly and wisely with and without digital and AI-powered technologies, including by guaranteeing regular screen-free play and by confronting social and gender norms shaping how technologies are used. Support parents and caregivers to help children understand advertising, online risks and problematic usage patterns.
Evidence on risks and harms. The evidence on online risks, psychosocial harms and data governance failures in LMIC educational settings is disproportionately thin and largely derived from secondary adaptations of research conducted in high-income contexts. Children's own views on privacy, data governance and AI ethics are conspicuously absent from governance initiatives.	Generate and use evidence about the realities of technology-facilitated and AI-related risks and harms, with a focus on LMICs and crisis-affected contexts. Children's own voices should be included in this research, especially from vulnerable and underrepresented populations.

Part 5 addresses design for learning and teaching. It focuses on the central question: what evidence do we have about how digital and AI-enabled technologies can be designed and used in ways that support effective teaching and learning processes for greater educational equity?

What we know	What we can do
Pedagogy over product. Commercial EdTech products often prioritize technologically novel features over meaningful learning opportunities, driving adoption based on shallow engagement metrics rather than pedagogically grounded learning progression. Education systems need to actively shape how AI is used, rather than simply absorb what commercial markets produce and promote.	Invest in development and testing conditions, not evaluation alone. Decisions about digital tools are more likely to produce lasting educational benefits when they begin with clearly identified learning challenges and test whether technology can help address them before tools are integrated into education systems.

What we know	What we can do
Collaborative digital learning. In resource-constrained settings, shared-device models that combine digital technology with collaborative, playful and peer-to-peer learning can challenge the assumption that effective EdTech requires one device per learner.	Use technology to strengthen the human relationships and collective capabilities at the heart of education, and where appropriate, use shared-device, collaborative and teacher-led models to avoid a future in which better personalization leads to greater individualization and isolation.
Teacher agency. Learner-facing EdTech can sideline teachers into support roles while platforms deliver core instruction, undermining teachers' relational, creative, empathetic and ethical qualities within the pedagogical process. AI can free up time for routine tasks, but also introduce hidden labour and risks of de-skilling and automation bias.	Reaffirm the irreplaceable, relational role of teachers with their students and protect teacher agency by mandating that AI augments rather than substitutes for teachers, embedding AI competencies in teacher education (pre- and in-service), and funding and supporting teacher-led communities of practice.
Co-design with teachers and learners. Teachers are not passive recipients of digital and AI-powered tools; many are already adopting them on their own and making judgements about where they help. Participatory, iterative approaches to designing EdTech tools with educators and students that consider the interconnection between humans and technology are more effective in the long term.	Keep teachers at the centre and co-design with and for teachers from the problems they actually face. Where appropriate, co-design with learners with disabilities, girls and other underrepresented groups to shape tools, content and implementation strategies that reflect their lived experiences and consider learner variability from the outset.
Human–AI collaboration. Emerging concepts such as 'hybrid intelligence' describe AI and humans working collaboratively to extend each other's cognition, producing outcomes greater than either alone. These approaches can support holistic, pedagogically purposeful and context-responsive learning in the age of AI while safeguarding human connection.	Prioritize models of human–AI collaboration that enhance teacher judgement and learner agency rather than displacing them. Test and refine these approaches through structured sandboxes and testbeds before wider roll-out, ensuring that AI supports rather than undermines teachers' professional roles and identities.

Across these five chapters, it is clear that what counts as 'what works' in digital education is always conditional: on governance, infrastructure, pedagogy and local capacity and context. Translating evidence into good decision-making requires deliberate structures that help different stakeholders, including policymakers, educators, development partners and providers align on expectations and commit to connecting evidence to practice.

Call to Action

As a top priority for the whole education sector, there needs to be a concerted effort to establish the norms and standards that will guide effective practice for how digital and AI technologies inform education. The public sector must govern technologies in education by setting strong and transparent rules that put the public good ahead of short-term market incentives and prevent long-term vendor dependence. In turn, technology partners must respect public authority by working together within clear accountability frameworks and standards for equity, safety, pedagogy, sustainability and evidence.

This report provides five recommendations:

1 Equity

Make learning equity the defining driver of investment in digital and AI in education. Digital education interventions should be designed for equity from the outset. Investments should be assessed on who is reached, who continues to be excluded and whether outcomes are improving for the groups furthest behind. This means co-creating needs-based interventions with communities through the meaningful participation of children, teachers and caregivers; investing in mother-tongue-based multilingual learning, and culturally relevant and accessible digital content; and offering continuous and integrated teacher development, in particular for those serving children at the greatest disadvantage.

2 Safety

Enforce safeguarding and privacy requirements before digital and AI-powered tools reach schools, and continue monitoring safety and well-being throughout use. This means requiring safety-by-design, child rights impact assessments, high-privacy defaults, minimized data collection, no targeted advertising, accessible redress mechanisms and clear accountability for learner-facing tools. It also means requiring that the companies which governments contract demonstrate that child rights impact assessments have been conducted and produce regular evidence that tracks how technologies are impacting the safety and well-being of children and school communities over time.

3 Pedagogy

Engage teachers as decision makers and co-designers of digital and AI-enabled tools and programmes to ensure that technology serves pedagogy. AI is not pedagogically beneficial by default: purpose-built, vetted and locally adapted EdTech can integrate AI around specific learning goals, curricula and contexts through deliberate pedagogical design to support teaching and learning. Teachers should be supported as co-designers and decision makers in choosing and using digital and AI tools, rather than being displaced or reduced to technical support roles. This means prioritizing inclusive, culturally appropriate solutions and expanding and sustaining investment in digital and AI technologies for pre-service and in-service teacher professional development, financed through core education budgets, tailored to local contexts and aligned with evidence-informed approaches, such as structured pedagogy and Teaching at the Right Level.

4 Sustainability

Ensure that contextual fit, interoperability and cost-effectiveness are prerequisites for scaling education technologies and are reflected in deliberate design choices for procurement, distribution and implementation models. Sustainable digital education systems should be grounded in public-interest principles, interoperable standards and reusable public goods, with collective action and collaboration helping to build, align and improve them over time. Programmes must account realistically for long-term operating costs, and one cannot assume one device per child nor reliable connectivity. To scale and sustain effective practice, especially in complex contexts, deliberate and evidence-informed decisions must be made around geographic scope, age-appropriateness, accountability clauses in vendor agreements, device ratios and heterogeneity, rolling and replacement cycles, management, security and accessibility.

5 Evidence

Invest in human and institutional capacity to use robust evidence to guide the effective use of digital and AI technologies in education systems, and to continuously adapt and improve how these technologies are implemented.
The education sector, and those working within it on the role of digital and AI technologies, now has access to clearer evidence regarding 'what works' and what does not, and, more significantly, how they can be adapted and applied effectively in different contexts. Evidence that a tool works in selected schools is not evidence that it can be delivered nationally with the same quality, so scaling should be staged by evidence-informed decisions to adapt, expand or stop the implementation. Efforts to build evidence should focus on learning outcomes, align with government priorities, be cognizant of political economy and consider cost across the full life of an intervention. Capacity to build and use evidence is strongest when it is structured into government systems for education delivery.

The bigger picture

Enacting these five recommendations and establishing sector-wide standards, with UNICEF's EdTech for Good Framework 2.0 as a reference point, will help governments, technology providers, multilaterals, teachers, young people, researchers and civil society align around responsible and purposeful use of digital and AI technologies for learning. UNICEF is committed to helping governments take more ownership over all phases of digital and AI transformation in education: from strategy development and the development of clear evaluation criteria to informed and transparent decision-making on procurement and partnerships.

The evidence base on digital and AI-enabled education has been strengthened considerably in recent years through the work of EdTech Hub, UNICEF and others. But there are still significant challenges ensuring that evidence is contextualized, fully grounded in the realities of many lower-resourced education systems and used to inform decisions. One finding is consistent across all contexts where evidence exists: on their own, technologies cannot resolve the systemic challenges faced in education and, if poorly designed or implemented, they will cause damage and deepen existing inequalities. And yet digital technologies can and do contribute to positive change in education when their usage is determined by what will have a cost-effective impact on learning outcomes at scale.

At a time when many children risk falling further behind, the evidence-based use of digital and AI technologies offers a measure of hope. This comes with a clear responsibility for the education community: to ensure that technologies are used in a way that serves education and the common good, widening the possibilities for every child to learn, participate and thrive.

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Introduction

Looking back to move forward with purpose

Frank van Cappelle and David Hollow

Frank van Cappelle is UNICEF's Global Lead for Digital Education and Head of the UNICEF Global Learning Innovation Hub in Finland. David Hollow is Research Director at EdTech Hub. Their introduction explores what we can learn from past EdTech mistakes, how to navigate the current AI hype cycle and empower public-sector governance to shape technology around real education system needs. They explain what it means to go 'beyond digital as usual' by using digital and AI-enabled technologies only where they demonstrate evidence of improving learning, equity and system resilience, while recognizing where non-digital approaches may be more appropriate to strengthen the human relationships and collective capabilities at the heart of education.

Acknowledging the present context

This report is written in the midst of significant global discussion around artificial intelligence (AI) and education. As with any hype cycle, much of the current discourse is inevitably future-focused, centred on what the technology might enable and how education systems may need to respond. There is growing recognition that AI is not just accelerating change in education, but that the direction of this change will depend on the extent to which its strengths can be harnessed and risks managed. Used well, AI could significantly improve aspects of learning, used poorly, it could undermine learning, encourage excessive cognitive offloading and deepen existing inequalities.

There is a compelling narrative around what AI could make possible in education: enabling us to do more for less, improve learning, empower teachers and make education systems more efficient. All of this has the potential to be true in specific instances, and there are examples of it in practice throughout this report.

But the other side of the narrative is equally important – at what cost, for whose benefit and with what long-term implications for the nature of public education provision? In recent months, there have been increasingly candid conversations regarding the extent of the challenges ahead, and many of the sweeping initial claims about the transformative impact of AI are now being scaled back.

Global education is in a phase of high-stakes transition which is complex and needs to be navigated with wisdom. We have been through the first phase of the hype cycle of AI in education. We now need to be sober and focused to lift our ambition. The full story of how AI is used in education is not yet written, and the future is not inevitable in any particular direction. Amid all the future-looking discourse – its perils and potential, opportunities and risks – it is especially useful to look back and reflect on recent history. Too often the use of digital technology in education has been driven by solutions looking for problems to solve, and it has not achieved its desired positive impact. We can learn a lot from remembering how things have been tried before.[6]

Recalling past mistakes and learning from them

After more than 20 years of optimistic claims about the transformative potential of technology in education, why are 273 million children still out of school, while a large proportion of those who do attend school remain unable to read with meaning even after several years of schooling? It is worth considering whether this situation would have been different, better or worse without any EdTech investment.

Some readers will recall a peak in 'EdTech hype' around 20 years ago with well-known initiatives such as One Laptop per Child and the Hole in the Wall. These offered contrasting models of one device per child and outdoor computer kiosks shared by many children. But they shared a disconnect between the story and the substance, between the idea of simple technology-driven transformation and the reality of complex change. Anyone interested in but unfamiliar with these examples can read about them widely online.[7] Our assessment is that the mentality of these initiatives – and their associated mistakes – are at risk of being repeated today in relation to optimistic analysis regarding how AI might help address big challenges in education.

The current hype about AI in education in some ways reflects a familiar pattern of excitement about how technology might provide simple solutions to complex challenges. Many of the people advocating for technology in education 20 years ago were predisposed to look for quick solutions that overlooked the central role of teachers: drop laptops and tablets into schools in low-income countries, assume education is improved, and tell compelling yet misleading stories of the impact.

Perhaps anecdotes of such initiatives seem laughable now. But what is happening now with AI in education that people will look back and laugh at in the future? Some of the current big claims about how AI will transform education will not age well. This report seeks to help us avoid repeating the mistakes of the past and to grapple with what could be different today with the opportunities of AI in education and the ongoing effort to build a strong and safe future for children's learning.

Navigating the challenges ahead

The global education community has learned many things from the last two decades of implementing EdTech. There are some encouraging signs that an increasing proportion of digital education initiatives seek to align with the evidence. Hardware dumps still happen in the name of education, but less frequently than previously. Cost considerations are becoming more central and there is greater recognition and usage of quality standards to guide decision-making. There is increased recognition of the way market agendas shape the way digital tools are promoted in education. Funding is more likely to flow towards implementations that are aligned with sensible education practices and prioritize impact on learning outcomes.

And yet the challenges ahead are significant, and shaped by the power, cost and accessibility of the enabling technologies. Compared with 20 years ago, today much more of the world's population has access to personal hardware, and the associated enabling infrastructure is more widespread. Students and teachers often begin using new technologies to help them learn and teach well before education systems have agreed on formal, system-level responses. As AI becomes capable of taking on a wider range of cognitive and creative tasks, students will need to make deliberate choices about what to do themselves, what to do with AI and what to delegate. AI literacy needs a more assertive, human-centred orientation, with greater emphasis on the communication, creativity, judgement and collaborative problem-solving skills that underpin working effectively with both people and AI. Together with empathy and respect for diverse perspectives, these enduring skills support social cohesion and human flourishing in an increasingly AI-shaped world. They should be developed alongside an understanding of AI's workings, limitations, ethics and societal implications. The challenge is to use AI to amplify human capability without replacing the thinking and effort through which students develop their own.

Education systems will need to make deliberate choices about what technologies to adopt, what to outsource and what must remain under public oversight. The role of the private sector in the provision of digital education has grown significantly and it is important that national and local governments do not passively adopt market-driven technologies. Rather than largely or fully outsourcing the digital architecture of learning to proprietary platforms, governments must actively build coordinated digital public infrastructure for education, and platforms grounded in global standards and good practice. There is a real risk that the shift towards EdTech solutions embedding AI – particularly closed-source, proprietary models over open-weight or true open-source alternatives – means public education systems become increasingly beholden to the private sector. This risks surrendering their pedagogical sovereignty, data governance and long-term fiscal stability. When ministries buy into loss-leading commercial products that use subsidized tokens to capture market share, they lock themselves into severe vendor dependency before eventual price increases take effect. This long-term lack of sustainability is insufficiently recognized and planned for, and also risks widening inequalities between countries which can and cannot afford to invest significant resources in education.

As with any significant innovation, the current risk is that time and money are wasted by trying to do lots of things with AI in education that are not based on the best of what is already known about education. Experimentation is crucial, but it should be disciplined in approach: the use of technology in education should be built on the established evidence bases of learning science and implementation science,[8] and should focus on careful adaptation to the specific implementing context.[9] Alongside this is a need to establish a new culture of measuring what really matters within digital education, avoiding vanity metrics and instead focusing on cost-effective impact on learning outcomes at scale.

Shaping the future of learning that children deserve

For much of the past 20 years, digital education has too often meant taking traditional approaches to teaching and learning and reproducing them in digital formats: a textbook becomes a digital textbook, a classroom lesson becomes a video, and a worksheet becomes an online exercise. Going beyond digital as usual means moving beyond the digital replication of existing practice. Instead, it means using technology to address pervasive challenges that conventional approaches struggle to overcome, such as language and accessibility barriers, differences in learners' levels and needs, limitations of traditional forms of assessment, and the challenge teachers face in responding to wide variation in learning within a single classroom. It means aligning with learning science, implementation science and focusing on outcomes over outputs. It does not mean maximizing the use of technology but using it where it can make learning more effective, inclusive and responsive, while recognizing where human interaction and non-digital approaches may be more appropriate, a distinction reinforced by PISA 2025: poorly designed or distracting technology use can undermine learning, while purposeful, human-centred and evidence-based use can help overcome learning barriers and improve outcomes.[10]

Much of the current use of AI in education brings back the old tension from the One Laptop per Child approach in a new form, with tools often designed for one-to-one interaction rather than learning with others. Between the growing emphasis on AI-enabled personal learning experience and the typically individualized nature of screen time, classrooms should prioritize their role as places of social interaction and relationship-building where children learn to cooperate, negotiate and solve problems collaboratively. There is considerable scope to build AI-enhanced educational tools, and the classroom activities around them, for collaboration. We should avoid a future in which better personalization leads to greater individualization and isolation, and instead use technologies to strengthen the human relationships and collective capabilities at the heart of education.

In light of this, education systems need to actively shape how AI is used, rather than simply absorb what commercial markets produce and promote. Otherwise, it is likely that a dangerous twin-track system will emerge: low-cost, unverified and addictive-by-design AI models for learners in low-income contexts, contrasted with premium, human-supported and mature pedagogical options for learners in high-income contexts. Without deliberate and sustained intervention, the proliferation of AI risks exacerbating existing educational inequalities and potentially impeding cognitive and social-emotional development. This means advocating for – and only purchasing – tools that are curriculum-aligned, age-appropriate, pedagogically sound, accessible, safe, local-language capable, transparent enough for oversight, designed with and for teachers, able to support both individual and collaborative learning, cost-effective for the long term and built to strengthen the systems within which they operate. This also means taking the environmental and resource demands of AI seriously, and exploring whether smaller models, offline and edge AI, and more shared or teacher-led use can simultaneously reduce resource demands, extend access and support better models of learning.

Global education is at a critical moment. Major changes are taking place, quickly, often without being well thought through and with significant vested interests. For all of us involved in how digital technologies are used in education it is time to lift our ambition, navigate with courage and make evidence-based decisions.

We need to get serious about the hype-fuelled wastage of the past and make a priority of applying rigour and building accountability for the future.

Our hope is that this report contributes to this priority.

> Going beyond digital as usual means moving beyond the digital replication of existing practice. Instead, it means using technology to address pervasive challenges that conventional approaches struggle to overcome."

EdTech for the common good

Juliette Norrmén-Smith and Carlos Ferrari, UNICEF Digital Education

In November 2024, UNICEF and its partners launched a global education campaign called *EdTech for Good*.

The pillars of the EdTech for Good campaign serve as the structural and theoretical framework for this report: contextual readiness, educational impact, inclusive access, safety and well-being first, and designed for learning and teaching.

Although EdTech for Good presents as a simple slogan, it also holds a series of assumptions – both semantic and conceptual – that require unpacking.

First, EdTech. There is no global consensus on what EdTech precisely is and what it is not. To some, the category comprises the technological infrastructure in learning spaces. To others, it includes digital platforms used in education but not designed exclusively for it. In this report, authors mainly use 'EdTech' to refer to the digital and AI-powered tools that learners, teachers, school leaders, caregivers, administrators and policymakers engage with directly in education systems. This report deliberately avoids giving a prescriptive definition of EdTech and rather welcomes a pluralistic understanding where each piece sets the scope that its argument requires.

Second, good. The use of 'good' carries an intentional double meaning. It sets an aspiration of EdTech to be associated with the many synonyms of 'good': positive, high-quality, favourable, valuable. The use of 'good' likewise beckons the binary of 'bad', insinuating that EdTech may be poor quality, harmful or undesirable, and that the EdTech for Good movement seeks to change this. 'Good' also conjures the concept of EdTech as a public good: non-exclusionary and accessible to all. This introduces a contrast with private goods that the report explores by examining the market forces that influence the production, use and spread of digital and AI-powered tools in education.

Third, EdTech for Good. Combined, this phrase positions the focus not solely on the digital technologies, but rather on the role EdTech can play in promoting the common good through human-centred benefit for all and, by doing so, contributing to upholding the values of public education systems.

Similarly, this implied binary indicates that there is an EdTech for Bad, or a reality in which EdTech impedes public value and corrodes equity, efficiency, cohesion or other common public values. This binary is likewise explored in this report.

Finally, EdTech for Good implies that EdTech is **present.** According to the UNICEF–ITU Giga Initiative,[11] this is not necessarily true for the nearly half of the world's 6 million schools that are offline – nor for the approximately two thirds of the world's school-age children without internet connection in their homes.

Connectivity, however, is only one dimension of the digital divide. Affordability, accessibility, digital literacy, language and access to relevant content also shape who can benefit from EdTech, and whether it narrows or deepens existing inequalities.

While closing the digital divide is a prerequisite to fully unlocking EdTech's potential to do good, EdTech for Good is not a call for aggressive digitalization of presently analogue practices in education. Rather, it is a push for the use cases of technology in education to be more critically minded, to be meaningfully evaluated and, ultimately, to be held accountable for doing good – for learning, teaching, education systems and the societies within which they exist.

UNICEF's EdTech for Good Framework 2.0,[12] launched in July 2026, is the translation of this call to action into a practical tool to build global alignment around the development goals and evidence EdTech tools should be required to publicly provide to be trusted, procured, scaled or rejected for use in education ecosystems. The Framework recognizes that determining whether an EdTech is 'good' requires a broad and contextualized view of value – one that considers not only what impact a tool achieves, but also how it is introduced, who is able to benefit, what risks it may create, and whether it can contribute responsibly and sustainably to the education system in which it is used.

The Framework is designed to support governments, development partners and investors in making more transparent, evidence-informed and child-centred decisions on EdTech. Ukraine, Singapore and the Council of Europe are among some of the early adopters, using it to inform national frameworks and regional approaches. The Framework also targets bottom-up change by providing EdTech organizations with a clear pathway for creating an evidence portfolio and developing their products or services.

The report's guiding questions

Across the sections of this report, which align with each of the five thematic pillars of the EdTech for Good Framework, two questions guide the discussion:

1. **Is EdTech a 'good' investment for education?** In other words, does the investment provide cost-effective gains that are meaningful for the many purposes of education – developmental, social, economic, civic – that would not have otherwise been achieved without the use of the technology in question? More specifically, who experiences these gains, where and under what conditions?

2. **Is investing in EdTech an investment 'for good'?** In other words, is investing in EdTech serving the common good by improving, not harming, social equity and collective flourishing both within and beyond education?

These questions rarely have a binary answer of 'yes' or 'no'. As demonstrated by the variety of perspectives captured in this report, they require careful consideration of context-specific opportunities and risks, and trade-offs between contrasting visions of education.

These are also not new questions. They have been debated for many years by educationalists and technologists and those working at the intersection of the two. The EdTech evidence base has strengthened considerably in recent years through the work of EdTech Hub, UNICEF and many others, but it remains uneven. Much of the research and many of the implementation models shaping the field come from settings that do not reflect the realities of many education systems, especially those in the Global South.

A note on how to engage with the report

Engaging with the use of digital technologies and AI within a specific domain – such as education – requires an analytical awareness of the underlying presuppositions each of us holds regarding the nature of technological progress. It is inevitable that the professional perspectives each of us has regarding how technologies are used in education are shaped by broader, sector-agnostic views of the future of society and the nature of human identity. It is important to acknowledge the challenge for each of us to engage simultaneously in multiple levels of processing these topics. We should not ignore our sector-agnostic existential questions – and should aim for a mature, professional discourse with analytical humility and self-awareness regarding how personal hopes and fears may inform our technical perspectives.

In this report, we seek to do this by moving regularly between high-level conceptual issues and highly applied technical issues. There is content about digital education that is likely to provoke broad thinking regarding philosophy, geopolitics, economics and the nature of the kind of societies we want to nurture and inhabit. There is other content about the specific technical application of digital technologies in education, such as how AI can best scale structured pedagogy, improve the cost-effectiveness of teaching at the right level, or improve on-demand teacher coaching. Both are important, and we hope that the report weaves the two together in a way that is useful for the reader.

This report critically assesses and provides practical examples of how digital and AI-powered tools influence and affect the many multifaceted purposes and goals of education. This introductory chapter highlights the tension between EdTech as a common good and EdTech as a profit-driven commodity. Beginning the report with this political economic lens is important for providing insights into the global market within which much EdTech and AI decision-making takes place. The five thematic chapters that follow explore the best of the current evidence, examining the points of tension, welcoming expert reflections and, ultimately, presenting a series of recommendations for a more equitable future that goes 'beyond digital as usual'.[13]

Overall, we hope that this report helps each reader to reflect deeply on their own context and make wise decisions about how technology can be used in education – for good.

Think piece

Rethinking ‘EdTech’ and ‘impact’: Towards a clearer, contextual understanding

Beth Havinga, Niko Lindholm and Anna Lindroos Čermáková

Beth Havinga is a UNICEF consultant for the EdTech for Good Initiative, Niko Lindholm is EdTech Innovation Lead at Helsinki Education Hub, and Anna Lindroos Čermáková is a Senior Researcher at Lancaster University. Beth and Anna are expert advisors to the Council of Europe’s development of its regional EdTech evaluation framework. This think piece offers a critical reflection on how ‘impact’ is defined and measured in digital education. It is placed in the introduction to frame the report’s wider discussion of evidence and practice by establishing a nuanced understanding of outcomes – who benefits, under what conditions and at what cost.

Introduction

Billions of dollars have been invested in digital education, yet what those investments have achieved remains unclear. ‘Impact’ is widely invoked in investment and procurement decisions, but rarely defined with sufficient precision to guide them. In fact, the predominant measurement of impact has only focused on learning outcomes, which leaves other, equally important, forms of impact under-examined.[14] Because EdTech encompasses diverse tools, platforms and infrastructure under a single umbrella term, it collapses fundamentally different functions into a single category.[15] Treating infrastructure, content delivery channels and pedagogically designed tools as interchangeable forms of EdTech risks distorting both expectations and evaluations. The conceptualization of EdTech therefore directly shapes what outcomes are considered feasible and what evidence can be produced to align with these outcomes.

Four key propositions guide the discussion on impact in this think piece:

- First, impact in EdTech is multidimensional: it encompasses learning outcomes, teaching quality, equity, safety and system readiness, and it cannot be assessed independently of the conditions in which technology is deployed.
- Second, what counts as ‘what works’ is always conditional: on infrastructure, governance, pedagogy and local capacity; and evidence must be transparent about these conditions rather than presenting context-free claims.
- Third, the translation of evidence into good decisions does not happen automatically: it requires deliberate intermediary structures that help different actors, including policymakers, educators and providers, develop shared language, align their expectations and connect evidence to practice.

- Fourth, impact and evidence are contextual, and contextualization and localization should be treated as prerequisites for credible evaluation.

Impact is multidimensional

Impact in digital education is best understood not as a single artefact or outcome but as a constellation of effects that operate across different domains of educational value, each requiring different forms of evidence and serving different decision-making needs. While measuring learning outcomes remains important, a more complete picture includes, for example, teaching and learning quality, equity, inclusion across learner groups, safety, well-being, digital citizenship, system readiness, sustainability and institutional capacity. A tool that produces measurable short-term gains in a controlled trial may still fail to reach marginalized learners, place unsustainable demands on teachers or create data governance risks that undermine institutional trust. Conversely, a tool with a modest effect size may transform classroom practice in ways that matter deeply to educators but are invisible to standardized assessment. Neither picture is complete on its own.

Multidimensional understandings of impact are increasingly reflected in major international frameworks, including UNICEF's EdTech for Good Framework 2.0.[16] Drawing on this and other major international standards, the Needs-Based Evidence Mapping conducted by the European EdTech Alliance identifies five domains in which educational impact in EdTech is commonly organized across major international standards: learning impact and effectiveness; experience, usability and pedagogical fit; safety, ethics and data governance; equity, accessibility and inclusion; and scalability, implementation and sustainability.[17] These domains are not a hierarchy, but a shared interpretive structure that helps different actors ask more precise questions of evidence. Comprehensive evidence should, therefore, capture multiple dimensions, trade-offs and implementation conditions rather than privileging a single metric. This multidimensional approach supports targeted investments and more equitable outcomes by making visible what a narrower focus on learning gains alone would obscure.

Impact is conditional

The question of 'what works' has shaped education policy debates for decades, anchored by a preference for experimental methods (particularly randomized controlled trials) as the gold standard for establishing effectiveness.[18] The appeal is understandable: causal evidence should, in principle, guide investment towards effective interventions. In practice, however, the 'what works' framing is limited because it assumes that evidence generated for one purpose can answer all others,[19] treating educational interventions as if they were stable, transferable and independent of context.

In EdTech, this limitation is particularly acute because effectiveness is rarely straightforward to interpret. A recurring challenge is the gap between efficacy and effectiveness:

results achieved under controlled pilot conditions frequently do not persist when interventions are scaled without careful adaptation to local contexts. A related tension exists between access and quality: expanding connectivity or device access may be necessary but may be insufficient without aligned pedagogy, content and teacher support. Likewise, fidelity to a particular model is often less important than achieving the intended learning processes and outcomes in a given setting. What matters is not replication but adaptation with intent.

Ultimately, the question 'what works?' must be reframed as 'what works here, under these conditions, for these learners?' For procurement and financing decisions, this reframing has direct implications: investments should be targeted not only at tools with strong evidence portfolios, but at explicitly named implementation conditions, including teacher capacity, infrastructure, governance and support, that determine whether that evidence will translate into outcomes in a given system.

Impact often requires translation and travels beyond its original purpose

Impact is not only multidimensional and conditional but also subject to multiple interpretations. The same EdTech intervention will be assessed differently depending on who is doing the assessment and what decisions they need to make. When an evaluation is completed, different actors will ask different questions of the same data. Policymakers and system leaders often foreground population-level outcomes, scalability, cost-effectiveness and long-run governance implications. A teacher wants to know whether a tool will work in their classroom, with their learners, given their curriculum constraints. A procurement official wants to know whether it meets compliance requirements and represents value for money. An investor wants signals of market traction and scalability. All these questions and perspectives are valid. Each perspective is legitimate, but none is complete on its own. These differences do not simply reflect divergent priorities; they reflect that the same evidence is being used to answer fundamentally different questions.

Evidence generated in one context, for one purpose, by one set of actors, often travels across institutional boundaries, professional cultures and decision-making systems, shifting meaning as it moves from the context in which it was generated to the context in which it is used, before it can inform a procurement choice, a financing decision or a policy recommendation. Evidence needs to be translated, and often simplified, and sometimes it becomes distorted in that process as it moves from the context in which it was generated to the context in which it needs to be used.[20] However, these meaning and context shifts and distortions are not merely inconvenient; they may jeopardize the allocation of scarce resources and systematic equity considerations by focusing on what is easiest to measure.

To ensure that evidence and impact outcomes can be translated and travel beyond their initial environment, deliberate infrastructure is necessary: shared frameworks for interpreting evidence, a common vocabulary for describing outcomes and implementation conditions, and structured spaces where different actors can align their expectations before decisions are made. An example of this can be found in the Needs-Based Evidence Mapping.[21] The Mapping contributes to a common vocabulary, providing communication templates to assist in understanding required and produced evidence regardless of what framework of evidence or quality assurance is being used. As a successful translation infrastructure, the Mapping begins from the decisions different actors need to make and continues by locating evidence types and claims against five domains of impact, which contribute to an understanding of what specific evidence can and cannot actually prove or support. It highlights what the evidence is actually intended to show and who it is intended for, rather than allowing evidence to silently substitute for a claim it was never designed to make.

Impact can be an embedded, multi-stakeholder process

In the same way that a deliberate infrastructure is necessary to ensure the translation of evidence and impact, ensuring that evidence and impact are contextually implemented requires a comprehensive, multi-stakeholder approach. The challenge in EdTech is rarely the absence of educational intent; rather, it is the conditions under which this intent is transferred into design, implementation and evidence. A successful example of this can be found in the Helsinki Education Hub (HEH), based in the Faculty of Educational Sciences at the University of Helsinki and funded by the City of Helsinki. Crucially, HEH operates around a triple helix model that brings together Educational Sciences at the University, the City's Economic Development and Education divisions and early-stage EdTech companies.

The public sector dimension of this model is fundamental. HEH is a vital municipal infrastructure investment. HEH uses several instruments to engage directly with key stakeholders. They include an incubation programme, facilitated through faculty researchers and structured teaching to ensure a clear, pedagogically grounded theory of change is developed for any products. Importantly, this requires founders to make their pedagogical assumptions explicit before they are built into a product.

A further crucial and connected process is the HEH testbed.[22] This live testing environment, comprising over 100 education environments across Helsinki, enables co-creation with educators and learners, ensuring products are shaped by and for real classroom conditions before reaching the market. In this way, educators and learners are not passive research subjects. Instead, they participate actively in shaping products during development. This means that by the time a product reaches the market, it has been tested against the realities of classroom practice and experience in context.

Additionally, an alignment with the local education strategy, Helsinki Learns 2030,[23] ensures that EdTech products developed within the HEH programme are created in response to identified system needs rather than market opportunities alone. Furthermore, this multi-stakeholder approach generates economic returns: new ventures create employment, which generates tax revenue and reduces social costs – a virtuous cycle in which public investment in innovation infrastructure yields both educational and socioeconomic value.

Developing approaches like this, however, can be time-consuming. The development of HEH took almost 13 years from conception to its final structure through a process of trial and error.[24] However, as HEH shows, investing in development and testing conditions, rather than only evaluation, improves what reaches education systems.

Comprehensive, multi-stakeholder approaches should embed impact from the beginning and consider it as multidimensional: attending to pedagogical fit, but also to wider system needs and the socioeconomic returns on public investment. These approaches should include local classroom conditions in development from the earliest stages, rather than testing for them afterwards. And they should be multi-actor by design, embedded in public sector processes, governance and structures, and bringing science and entrepreneurial development together by including EdTech founders, faculty researchers, teachers and pupils to jointly shape their digital ecosystems. The impact of these approaches is not the property of any single tool, but of the system that produces it.

Impact is contextual

For impact to make a difference in practice beyond being embedded in multi-stakeholder approaches, it must also be anchored in contextual relevance. UNICEF’s EdTech for Good Framework 2.0,[25] as an evaluation and developmental support mechanism, underwent a 12-month review process with feedback from over 140 organizations from 60 countries worldwide. This review highlighted that EdTech cannot be meaningfully evaluated against one single interpretation of ‘good’ evidence. For example, version 1.0 of the Framework required proof of functionality without internet connectivity as an exclusion criterion. However, in review, it was found that this could disadvantage otherwise appropriate products operating in contexts where connectivity is provided as a bundled service with the product but is not part of the product.

Nuanced findings such as these showed that evidence and impact measurements must assess whether a product is appropriate for its intended users, purpose and conditions of use, rather than assuming the same forms of proof will be appropriate in all settings. In fact, the suitability of an EdTech product cannot be inferred just because it performed well elsewhere or in a different evaluation process. Version 2.0 of the EdTech for Good Framework consequently asks explicitly about contextual constraints to understand whether a product can appropriately be educationally, culturally, technically and institutionally situated within the intended environment.

Conclusion: Towards a more systemic understanding of impact

The persistent ambiguity surrounding EdTech impact is not primarily an evidence problem; it is a conceptual and structural one. As shown in the examples within this think piece, it is important to develop structured translation and communication methods to ensure that impact is understood both in the way it was intended and for its intended audience.

This points to four priorities for decision makers: reframing procurement questions from 'does this product have evidence?' to 'what kind of evidence, for whom?'; investing in intermediary infrastructure at both ends of the development cycle; ensuring contextual relevance and resisting importing evaluative standards without interrogating their fit; and understanding how to engage all relevant stakeholders while aligning financing with implementation conditions, not only end-point measurement. The socioeconomic returns on investment in digital education cannot be captured by any single metric. But they can be shaped by the quality of the comprehensive, multi-stakeholder approaches and intentional investment into contextually relevant support mechanisms.

Think piece

Trends shaping the future of the EdTech industry

Maria Spies

Dr. Maria Spies is the co-founder of HolonIQ by QS, an education market intelligence platform with sophisticated global education market data sets to support research, foresight and benchmarking across the learning economy. This think piece provides Maria's data-driven assessment of EdTech trends, business models and potential futures. It is included at the outset of this report to provide an overview of the global market that shapes EdTech and AI product trajectories and decision-making around procurement and service provision.

When interpreting the investment figures in this piece, it is important to note that HolonIQ's education-market taxonomy understands EdTech as a category broader than digital tools used in schools. Rather, it covers four sectors: early childhood education, K–12 education, post-secondary education, and workforce training and development. Its market sizing covers hardware, software and services.

Introduction

The insights presented in this think piece draw on HolonIQ's[26] market intelligence data and methodology, which captures and organizes millions of global market signals through its education market taxonomy.[27] This includes analysis of hundreds of thousands of organizations, funding rounds, partnerships, policy developments, product launches, mergers and acquisitions, and other indicators of market activity. Together, these signals help provide an evidence base for identifying the trends most likely to shape the future trajectory of the EdTech industry.

These signals indicate that the EdTech market continues to evolve, shaped by advances in AI, changing investment patterns, shifting consumer behaviours and growing demands for interoperability, governance and equitable access. While investment has become more selective, the signals point less to contraction than to a reconfiguration of value: away from undifferentiated solutions and towards platforms and specialized applications that can demonstrate clear educational impact.

Investment conditions remained steady, but investors are prioritizing AI innovation, sustainability and workflow efficiency. In 2025, investor interest grew in tools that support educators, align with curricula and provide actionable insights into student learning.

Signals indicate that investors view solutions that enable teachers to monitor progress and adapt instruction as more sustainable than standalone AI tutoring tools.

Emerging trends suggest that future growth will be concentrated in areas that combine technological innovation with deep educational expertise, including teacher support, curriculum-aligned tools, integrated institutional systems and personalized learning experiences. At the same time, the expansion of AI across education is bringing renewed attention to data governance, learner agency and the risk that existing inequalities could be reinforced if access, oversight and local control are not intentionally addressed.

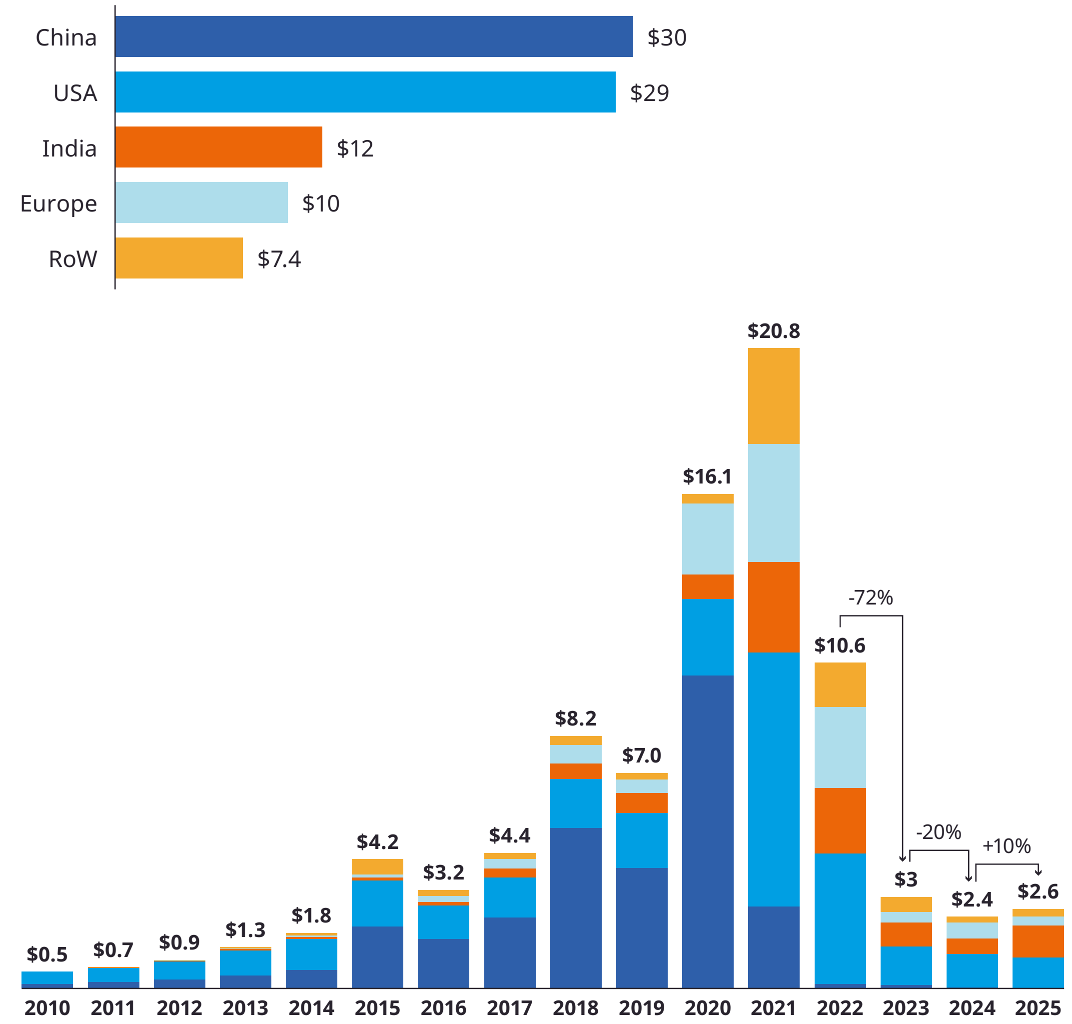
This think piece begins by examining EdTech capital flows and business models, in particular looking at the K–12 sector and the emergence of platform ecosystems. It then explores how AI is reshaping the education market, concluding with an analysis of emerging trends within this changing landscape.

EdTech capital flows

Total global venture capital investment into EdTech increased by 11 per cent from 2024 to reach US$2.6 billion in 2025, but the tone of the market was far from exuberant. Pricing stayed disciplined, investors pushed for profitability, and companies demonstrating real demand signals captured the bulk of attention. The EdTech investment landscape is marked by pragmatism, as investors look for products that solve discrete problems and have sustainable paths to revenue.

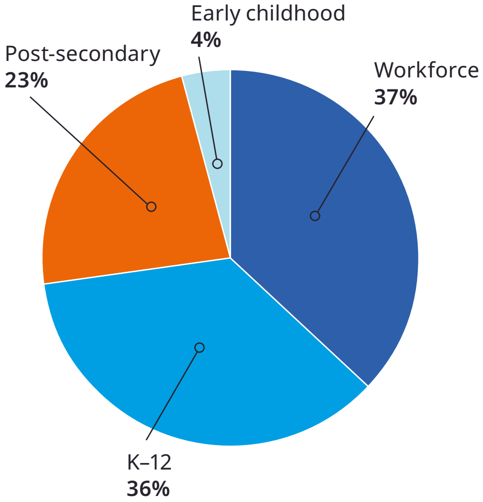
As shown in Figure 1, capital investment between 2010 and 2025 varied substantially across regions, with China and the United States of America the highest contributors with US$30 billion and US$29 billion of venture capital funding, respectively, followed by India with US$12 billion and Europe with US$10 billion. Notably, the EdTech venture capital funding from the Rest of the World (RoW) combined only amounts to US$7.4 billion.

Figure 1. Global EdTech venture capital funding by region, 2010–2025 (US$ billions)



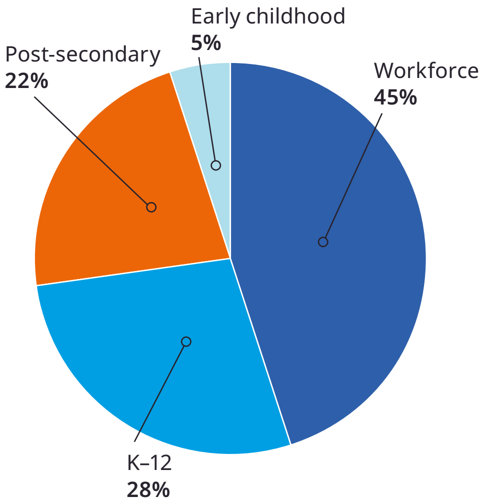
Source: HolonIQ by QS, All numbers rounded and may not sum exactly due to rounding. Excludes PE transactions. All years calculated at historic FX (spot rate on funding date).

Figure 2a. Global EdTech venture capital funding volume, by sector, 2025



Source: HolonIQ by QS.

Figure 2b. Global EdTech venture capital funding value, by sector, 2025



Source: HolonIQ by QS.

In 2025, capital concentrated around companies demonstrating credible market traction, especially in AI-enabled platforms and solutions tied directly to employability or educational outcomes. While the United States and China have dominated venture capital investment over the last 15 years, the market's next phase will likely be shaped by emerging regional hubs for AI innovation, with Europe, East Asia and parts of the Middle East and North Africa attracting an increased share of capital.

Sector patterns in 2025 largely mirrored the previous few years, with venture capital investment in K–12 education accounting for 36 per cent of total funding volume but only 28 per cent of total funding value, indicating smaller average deal sizes relative to other segments. In contrast, workforce training represented 37 per cent of total deal volume but 45 per cent of funding value. Investments in post-secondary education were more balanced, with 23 per cent of deal volume and 22 per cent of total funding value, while early childhood education remained a smaller segment, accounting for 4 per cent of deal volume and 5 per cent of total funding value.

Across sectors, signals indicate that investors favoured digitally integrated systems that sit inside institutional and employer workflows, such as learning management, assessment, finance and data platforms. This suggests that the focus of EdTech capital is likely to remain disciplined, with a preference for workflow-embedded, AI-integrated platforms and solutions that deliver measurable outcomes.

K–12 EdTech investment

Of all K–12 venture capital investments in 2025, the dominant category was K–12 support, encompassing tutoring and homework help, student well-being and success instructional support tools, and teacher preparation and development, followed by K–12 content and curriculum solutions. K–12 management systems focused largely on school administration platforms and learning management systems. Smaller but notable segments included K–12 education financing solutions concentrated in emerging economies, and K–12 hardware, particularly science, technology, engineering and mathematics (STEM) and robotics technologies.

Geographically, K–12 investment was concentrated in Europe and Central Asia (28 per cent) and North America (26 per cent). Activity was also evident in East Asia and the Pacific (21 per cent) and South Asia (18 per cent), where funding extended into classroom technologies, management systems and virtual schooling models. Notable, therefore, is the absence of 2025 venture capital investments in Africa, the Middle East and Latin America.

EdTech business models: Direct-to-consumer, institutional sales and platform ecosystems

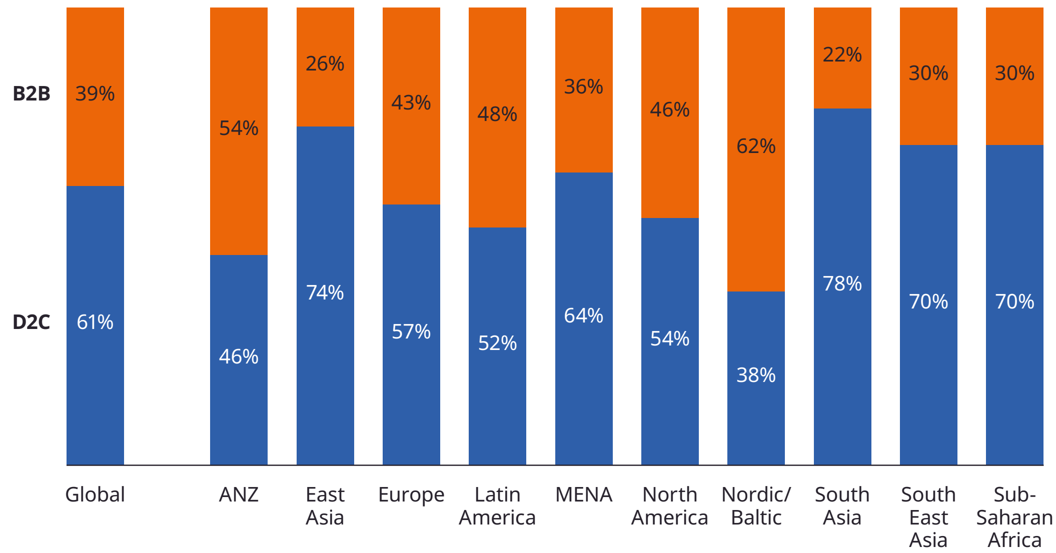
The EdTech sector is evolving from a market defined primarily by distinct direct-to-consumer (D2C) and business-to-business (B2B) models towards one increasingly shaped by interconnected platform ecosystems, institutional adoption of digital platforms, and growing emphasis on measurable learning outcomes.

Market structure and distribution of business models

Almost two thirds of EdTech companies operate a D2C model, selling directly to learners or parents, with the remainder focusing on institutional customers, including schools, governments, universities and employers. However, regional differences are notable, as shown in Figure 3, with markets such as South Asia, Southeast Asia, China and parts of Latin America dominated by D2C models. These businesses have typically concentrated on areas such as language learning, tutoring or learning support services and adult upskilling where household demand for supplemental education is strong.

As EdTech markets mature, regulation and changing investment conditions reshape business models. Examples include South Asia, China and other emerging regions where regulatory intervention in consumer tutoring has reduced the growth trajectory of this D2C segment and prompted investors and entrepreneurs to explore more institutionally aligned solutions.

Figure 3. HolonIQ Global EdTech 1000: Distribution of companies by business model, 2025



Note: ANZ, Australia and New Zealand; MENA, Middle East and North Africa.

Source: HolonIQ by QS.

An example of this shift is the growth of the K–12 management systems category in South Asia. This trend reflects expectations that schools will continue to digitize their operations.

Consumer technology taking market share

Developments in consumer technology are also reshaping the outlook for D2C EdTech solutions. The rapid integration of AI into consumer platforms means that personalized tutoring, language learning and study support could increasingly be delivered through general-purpose consumer technologies. As personalized agents become more sophisticated, they may be perceived as ‘good enough’ alternatives to dedicated EdTech products.

However, while these general-purpose tools offer scale and accessibility, they could be less responsive to learners’ specific linguistic, educational and social contexts, and they may introduce greater risks than tailored, purpose-built solutions.

Nevertheless, this dynamic may accelerate the decline of some EdTech categories as investors question the value of EdTech solutions where similar capabilities can be delivered at scale by large consumer technology platforms. As a result, capital may shift towards differentiated EdTech products and highly tailored AI applications designed for specific educational contexts.

The emergence of platform ecosystems

Despite the traditional distinction between D2C and B2B models, the market is increasingly blurring these boundaries through the emergence of 'platform ecosystems', sometimes described as 'school-in-a-box' solutions or integrated education platforms, which host multiple specialized EdTech solutions. Specialized EdTech solutions are integrating their products into these platforms and using them as a distribution channel to schools, institutions, teachers and learners, and in doing so may alter revenue models, with companies operating through platform marketplaces or revenue-sharing arrangements.

Examples of integrated platforms include providers such as Instructure, Pearson, PowerSchool, LEAD, Ellucian and Workday. Instructure, for example, has over 1,000 partners across over 20 categories ranging from career services and student advising to campus experience and adaptive learning solutions. These platforms increasingly curate ecosystems of integrated applications, enabling institutions to access multiple specialized tools within a single digital environment, presumably including learner data visibility and enterprise-level security and compliance.

Drivers of ecosystem integration

Regulatory and cybersecurity requirements are becoming more complex, particularly regarding privacy, identity management and protection of learner data. For smaller EdTech companies, meeting these standards independently can be costly and operationally challenging. Integration with established platforms – where compliance frameworks, security systems and single sign-on infrastructure are already in place – offers a more efficient route to institutional markets. However, the growing concentration of data within these comprehensive ecosystem platforms also raises important questions around data privacy, security and institutional control that require careful governance and oversight.

Platform ecosystems also function as distribution channels, allowing specialized EdTech providers to reach institutional customers more efficiently. These integrated data environments are also becoming the foundation for AI-driven tools and analytics. AI applications can draw on a wider range of learner data to provide personalized learning pathways, offer predictive insights, and support decision-making for educators and institutions.

AI and the reshaping of the education market landscape

Over the past year, large-scale integrations across universities and national school systems have signalled a shift in which AI is no longer a specialist capability but a baseline expectation. As a result, EdTech companies must position themselves within ecosystems dominated by large AI platforms, where the competitive advantage lies not in having AI, but in how it is applied, integrated and differentiated for specific learning contexts.

The rise of agentic AI

One of the most significant emerging developments in education is the rise of agentic AI, or systems capable of acting autonomously on behalf of users. With these systems, learners may rely on personal AI agents to perform tasks, interact with applications, and even take initiative without explicit instructions. This shift points towards a future where learners interact less with individual applications but delegate tasks to AI systems that operate across multiple tools and data sources. Agentic systems may also enable deeper personalization by gaining access to broader aspects of a learner's digital life, including emails, messages and search patterns. This raises significant ethical and privacy concerns, particularly for younger learners.

This development presents significant implications for some EdTech tools that are being displaced by general-purpose AI tools that can perform similar functions at little or no cost. This disruption has already contributed to the decline of established EdTech companies. In contrast, more resilient areas are emerging. These include teacher-focused tools that enable educators to better understand student progress through learning data and plan more tailored interventions, deep skills development platforms in specialized domains, and solutions that are closely aligned with curriculum and learning context.

Personalized learning, long discussed as a core promise of EdTech, is being rapidly advanced through AI-powered engines that can adapt to a particular student or teacher's learning level and preferences with great precision. However, this also raises fundamental questions about the nature of learning itself, particularly whether deeply personalized systems risk bypassing essential cognitive processes or the social and collaborative purposes of education.

Implications for data governance and equity

These shifts have significant implications for data governance in education. As AI tools become embedded within learning environments, they generate vast amounts of learner data, raising questions about privacy, consent, security and ethical use, particularly for children and vulnerable groups. D2C models can exacerbate these risks, especially where free access is underpinned by data collection and monetization practices that learners may neither understand nor meaningfully consent to. These dynamics underscore the need for robust governance frameworks, transparency and accountability to ensure learner data are protected.

There are also important implications for equity. Learners in low-resource settings may depend most heavily on free or low-cost AI-powered tools while having the least protection against exploitation, and weaker infrastructure, institutional capacity and local oversight. Without deliberate efforts to promote local control, culturally relevant solutions and equitable access, AI risks leaving already vulnerable learners more exposed to harm.

Six signals shaping the future of the EdTech landscape

Examining the trends emerging from the millions of global EdTech and education market signals tracked within HolonIQ's unique market intelligence engine reveals a regionally unbalanced, rapidly evolving investment landscape that can be described by the following six signals:

1 **AI adoption with guardrails.** AI adoption is moving beyond isolated pilots to more strategic 'bets', often in partnership with technology and education services companies. Use cases encompass student support, course design, content and assessment, along with initiatives to strengthen infrastructure and interoperability. Looking ahead, investment and procurement are likely to place greater emphasis on ethics, transparency, strong data governance and demonstrable educational value as AI becomes more deeply embedded in education workflows.

2 **From innovation to accountability.** As AI becomes more deeply embedded, the conversation around efficacy is gaining urgency. Educational leaders, investors and policymakers seek clearer evidence of what works for learning, employability and institutional outcomes. Europe is building evidence ecosystems through testbeds and evidence marketplaces, while countries such as China, the Republic of Korea, Singapore, Ukraine and the United States are embedding evidence into policy, procurement and innovation agendas.

3 **Displacement of some EdTech as general-purpose AI reshapes demand.** As consumer technology platforms increasingly offer learning and language support at scale, some standalone EdTech categories may face declining demand. Capital may therefore shift towards differentiated products and tailored AI applications that respond to specific curricular, linguistic and inclusive learning needs and educational contexts. Affected EdTech categories such as tutoring are also exploring modified digital or physical solutions.

4 **Engagement as a lead indicator.** Learner engagement is increasingly treated as a lead indicator for outcomes as institutions address motivation, persistence and relevance. Schools, universities and employers are investing in tools that strengthen participation, well-being and retention. While usage data can provide a more granular understanding of EdTech implementation than simple reach statistics, they are not a proxy for learning. In K–12, this may point to

an increase in demand for teacher platforms and adaptive learning systems that can assess learning and provide feedback at scale.

5 **Workforce-aligned and career-connected learning.** Governments are strengthening early-career, technical and vocational pathways, while employers, universities and technology companies are expanding work-embedded learning, industry-aligned credentials and AI-enabled upskilling. Recent developments, such as employability-related policy changes in Germany, India, Indonesia, Japan and the Republic of Korea, Workday's US$1.1 billion acquisition of Sana Labs, and cloud-enabled upskilling partnerships, illustrate growing interest in real-time skills visibility and industry-aligned learning. Across education sectors, the broader shift is towards learning that is increasingly integrated into work and more directly aligned with career pathways and labour market opportunities.

6 **Integrated platform ecosystems may reshape distribution, revenue and governance.** The shape of B2B business models is becoming less clear as specialized EdTech products become distributed through integrated education platform partners. These ecosystems can provide companies with access to schools, institutions, teachers and learners through marketplaces or revenue-sharing arrangements. The resulting concentration of learner data within these interconnected platforms raises critical questions about privacy, security, consent, data-driven monetization practices, institutional control and equitable access. Accordingly, a growing number of governments are increasing demand for evidence of learning outcomes and safe and responsible technology use.

Within the evolving EdTech ecosystem, characterized by growing institutional adoption, platform ecosystems and increasing private investment, there is a critical need for shared standards, principles, governance frameworks and public infrastructure that guide how digital learning solutions are selected, deployed and scaled within education systems. As demonstrated by the UNICEF EdTech for Good Framework 2.0 and the UNESCO–UNICEF–ITU Charter for Public Digital Learning Platforms, international organizations play an important role in the evolving EdTech ecosystem to support the integration of public-interest principles into governance to ensure that digital learning is equitable and inclusive, especially in low-resource contexts where market-driven solutions alone may not address systemic needs.

Part 1

Contextual readiness

“Everyone’s participation is needed – children themselves, parents, teachers, government, police.”

Child, India, 10–13 age group[28]

Evidence review

Context

This section addresses the issue of contextual readiness, one of the five pillars of UNICEF's EdTech for Good Framework 2.0. The topic encompasses the educational, technological, institutional, cultural and infrastructural conditions for responsible implementation. It synthesizes evidence specific to low- and middle-income countries (LMICs) and crisis settings across sub-Saharan Africa, South and Southeast Asia, and the Middle East and North Africa.

The following analysis addresses the central question:

What evidence do we have about how digital and AI-powered tools can be implemented and scaled responsibly within real education systems and environments?

Key insights

- Contextual readiness, spanning **pedagogical and cultural fit, infrastructure and cost, operational and financial sustainability, and human capacity,** determines whether EdTech investments in LMICs and crisis settings translate into equitable learning gains.

- **No technology can substitute for context-appropriate pedagogy:** investments focused narrowly on devices or connectivity consistently underperform.

- Without **deliberate, co-designed adaptation to local languages, curricula and cultural norms**, EdTech risks widening rather than closing inequities.

- System fragmentation and poor interoperability remain among the most persistent institutional barriers, underscoring the need for **digital tools that integrate with existing workflows and generate the right** data at the right time for decision-making.

- **Gaps remain in cost-effectiveness, infrastructure and data governance, systems capacity,** evidence-based AI deployment and timely evidence generation. Closing them requires treating contextual readiness as a continuous commitment, not a one-off precondition.

What the evidence says to date on contextual readiness

The rapid growth of digital technologies in education, accelerated by the COVID-19 pandemic and sustained by increased government and donor investment, has generated strong momentum behind EdTech's potential in LMICs and crisis settings. Yet questions remain about whether investments are translating into equitable learning gains at scale,[29] and whether the conditions to sustain them are being built alongside the technologies. In many contexts, digital gaps have widened for poor, rural and linguistic minority communities, for girls and for children with disabilities.[30]

Drawing on the available evidence, four contextual readiness factors consistently shape whether EdTech is effective when implemented: educational and cultural fit, infrastructure and cost, operational and financial sustainability, and human capacity. Each is examined in turn below.

Educational and cultural fit

Effective EdTech, like all interventions aimed at supporting children's learning, begins with good pedagogical practice.[31] However, while good instructional principles are broadly applicable,[32] their application must be tailored to context. The literature highlights a recurring failure where EdTech developed under Global North assumptions is deployed without genuine localization.

To be effective, EdTech content must be relevant to both learners and educators[33] **and available in a language children understand.**[34] Standardized models that do not resonate with local realities cause learners and parents to disengage.[35] Cultural misalignment, from imagery to pedagogical frameworks that ignore local social norms, compounds exclusion, with girls and displaced learners affected disproportionately.[36] Effective EdTech depends not only on sound pedagogical principles but on genuinely localizing their application to the specific context in which it is deployed.[37]

Infrastructure and costs

The infrastructure gap remains a significant contextual challenge when introducing EdTech in LMICs. **Reliable electricity, connectivity and affordable devices are absent or severely constrained across many national education systems.** In sub-Saharan Africa, just over half of the population (53 per cent) had access to electricity in 2023.[38] In Sierra Leone, 75 per cent of schools lacked electricity, and over 90 per cent of students had no school-based internet access as recently as 2023.[39] Across 10 Asian countries, an entry-level smartphone accounted for more than 20 per cent of per capita gross national income in all but one.[40] The implications of these infrastructural challenges are often most severe for girls, children with disabilities and remote communities.

Box 1. The Giga Initiative: Connecting schools and shaping markets

Nearly half of the 6 million schools in the world are not connected to the internet today, mostly in the poorest countries and areas. The majority of the estimated 2.2 billion disconnected people are women and girls.

Giga, a collaboration between UNICEF and the International Telecommunication Union (ITU), is a global initiative to connect every school to the internet. It provides a framework to identify connectivity gaps, deploy technological infrastructure and monitor access in real time. Giga extends support in four areas: school mapping, infrastructure modelling and cost analysis, financing and contracting.

Real-time monitoring tools, such as the Giga Daily Check App or the Giga Meter, have been deployed in many countries to ensure monitoring of consistent internet performance in connected schools. This data-driven approach allows the government to verify actual speeds, identify outages and address gaps reported by service providers, thereby ensuring uninterrupted access to online resources for schools and addressing internet challenges in a timely manner.

This support is anchored on capacity development, which includes empowering ministries during negotiations with telecommunications companies. In this way, Giga plays an important role in positively influencing the market by increasing access to market information, financing and technology for affordable and quality school connectivity while reducing transaction costs through combined contracting or pooled procurement to enable a comprehensive approach to connectivity – from electricity and school internet to devices and training.

Given these constraints, **the choice of technology matters as much as its availability**. Appropriate technology selection is a significant and complex decision.[41] A guiding principle in any context is to choose the simplest feasible approach that still meets the agreed learning objectives – for example, prioritizing low-tech, offline or asynchronous options before more complex models.[42] Radio broadcasts, offline applications and SMS-based tools each serve different access conditions, and radio remains among the most feasible and equitable choices where connectivity is limited. In crisis contexts where learning continuity is threatened, bridging to lower-tech ‘fallback’ options can help sustain learning without the need for costly infrastructure investment.[43]

Yet even where technology choices are well matched to local conditions, EdTech carries costs beyond infrastructure and access – not least environmental ones. While digital learning can bring sustainability benefits, including less reliance on physical materials, reduced travel and lower facility costs, these **benefits are offset by ecological trade-offs**.[44] Electronic waste is a particular concern: 2022 saw a record 62 million tonnes generated worldwide. By 2030, **volumes are expected to reach 82 million tonnes, with only 20 per cent predicted to be formally recycled**.[45] The systems underpinning digital education, including data centres, cloud services and an expanding array of AI-driven tools, also consume substantial and rising amounts of energy and water.[46] Buying fewer devices, extending their usable life through maintenance and reuse, prioritizing energy-efficient options and ensuring proper disposal at the end of life are all potential mitigation strategies.[47] How such mitigation options can be best employed in LMICs remains unclear and requires further research.

Operational and financial sustainability

Even where devices and connectivity exist, many education systems in LMICs lack the operational capacity to use them effectively.[48] Across 10 surveyed countries, the Asian Development Bank (2023) found that most schools still rely on paper records; even where digital systems exist, they are frequently fragmented and non-interoperable, preventing data from reaching those who could use them for decision-making.[49] A structural response lies in operational, including procurement, decisions made before EdTech services are deployed.

The UNESCO–UNICEF–ITU 2026 Charter for Public Digital Learning Platforms offers important guidance for national education systems when making these choices. Public digital learning platforms should be **governed as public goods** and **digital public infrastructure**, overseen by public authorities accountable to the public, and **financed with consistent and sustainable streams of public revenue**.[50] They should be open: built on an interoperable, modular architecture that avoids vendor lock-in, using openly licensed content and software that can be freely reused and adapted, and being accessible without requiring users to create accounts or share personal data. Platforms should focus on real educational needs, rather than technological novelty, and be trustworthy, with rigorous safeguards for accuracy, data and AI use.[51]

Complementing the initial procurement considerations above, both software and content components require active stewardship over a public digital learning platform's operational lifespan to ensure adaptations in response to technological, curricular and education-system governance changes.[52] Even when appropriate software and hardware are secured, procurement frameworks must account for their long-term financial sustainability. Focusing on initial device costs while overlooking maintenance, connectivity and replacement leads to predictable failure.[53] Using a total-cost-of-ownership approach over the lifespan of a solution, covering devices, software, content, training and operations, can help avoid these failures.[54]

Human capacity

Across the evidence base, **human capacity, not just infrastructure and operational and financial capacity alone, emerges as the decisive variable shaping EdTech outcomes in LMICs**. This holds true at every level of the system, from ministry officials interpreting data to teachers using devices in classrooms. At the system level, a significant capacity challenge exists around the use of EdTech, and particularly data for decision-making, within many ministries of education. Middle-tier officials often lack the digital literacy and institutional mandate to act on the data they hold.[55] Where monitoring is experienced as punitive compliance, **data become a performance of accountability rather than a resource for improvement**.[56] Resolving this requires investment in governance, professional development and organizational culture.

At the classroom level, teacher preparedness is equally decisive. Effective implementation requires training that integrates technical and pedagogical skills: teachers must know not only how to use devices, but how to integrate technology meaningfully into lessons.[57] **Continuous professional development directly affects instructional quality and adoption.**[58]

Evidence gaps relating to contextual readiness

Despite growing evidence on EdTech in LMICs, several critical gaps constrain ministries' ability to invest and implement with confidence. This section examines five interrelated areas: the tools available to capture cost and cost-effectiveness across the EdTech life cycle; the state of infrastructure and data governance research; the evidence base for systems capacity development and change management; emerging questions around effective AI deployment in LMIC contexts; and the shift towards context-responsive, iterative approaches to evidence generation.

Capturing cost and cost-effectiveness over the EdTech life cycle: Cost-effectiveness analysis gives ministries a common yardstick to compare EdTech investments against other uses of scarce education funds, so decisions are driven by learning gained per dollar spent, not by the appeal of the technology itself. Cost-effectiveness analysis brings together learning outcomes analysis findings with an understanding of intervention provision costs in a particular context. There remain significant gaps in the ability of ministries to conduct this analysis,[59] even though it is a key tool in supporting contextual readiness preparations within national systems.

The evidence base on learning outcomes is increasing as illustrated above, but significant gaps remain – for example, **longitudinal outcome evaluations in crisis settings remain rare**.[60] On the cost analysis side, initial EdTech acquisition costs can represent a smaller proportion of total expenditure than operational costs that accumulate over time.[61] Studies consistently warn that cost analyses undercount true expenditures by focusing on hardware while leaving recurrent costs unmeasured.[62] Life-cycle assessment and total-cost-of-ownership approaches are ways to expose hidden environmental impacts before large-scale roll-out.[63]

Gaps in infrastructure research: Although data management systems are expanding across LMICs, the governance structures shaping how these systems interoperate with assessment platforms, learning management systems and other education data sources remain comparatively under-examined, with most attention going to system roll-out rather than coordination and data-sharing arrangements.[64] Similarly, systematic cross-regional data sets on digital infrastructure and its use in schools across LMICs are limited,[65] even as innovative, national-level assessments, such as a recent UNICEF survey mapping digital readiness across 80 per cent of secondary schools in Uganda, begin to model how to fill local data gaps.[66] Rigorous research on governance and data management mechanisms is needed to resolve this evidence gap.[67]

Building an understanding of systems' capacity development and change management processes: There is limited evidence on integrating and scaling EdTech within national systems – work that requires an understanding of system capacities, adaptive management and the ability to navigate complex political dynamics.[68] Understanding these mechanisms is essential to develop strategies to improve contextual readiness as a prerequisite for developing and deploying EdTech interventions successfully.

Keeping pace with rapid AI adoption in LMIC contexts: AI usage is outpacing the evidence base, creating a fast-growing cluster of research needs. With AI-enabled investments increasing, and teachers in LMICs actively accessing AI tools, whether as part of structured education system training and capacity development programmes or on their own initiative, there is a need for continued research to ensure evidence-based AI uptake.[69] One particularly pressing gap within this broader landscape is an understanding of how AI tools adapted for local language use can be best developed and deployed for teachers' use.[70]

Promising approaches for contextual readiness

A growing body of evidence identifies practical innovations demonstrating a genuine impact of EdTech in low-resource and fragile contexts. The most promising approaches share a common logic: designed from the outset for the constraints and opportunities of the environments they serve, not retrofitted to them.

A prominent and well-evidenced trend is the use of **'offline-first' or low-tech architectures** to reach the most marginalized learners.[71] Evidence suggests that low-tech, offline-first platforms can deliver meaningful and scalable learning gains at low cost, particularly in LMICs.[72] For example, the ConnectEd programme, a low-tech phone-based tutoring solution, first demonstrated positive learning effects in Botswana and was subsequently tested through randomized controlled trials in India, Kenya, Nepal, the Philippines and Uganda. Across the five-country study, targeted phone call tutorials improved foundational numeracy by an average of 0.30–0.35 standard deviations across all sites, at a low cost.[73] Phone-based tutoring can also provide a resilient learning model during education emergencies and other disruptions.[74]

Other low-tech, low-cost options include low-cost micro-servers which can host learning management systems for an entire classroom at a fraction of the cost of conventional device configurations, providing curriculum-aligned and locally relevant teaching and learning content in the most constrained settings.[75] **The same logic is now extending to AI:** tutoring tools operating through low-bandwidth messaging infrastructure are demonstrating that intelligent teacher support is no longer dependent on high-connectivity environments.[76]

The advances in generative AI introduce both opportunity and risk for education in LMICs. The use of AI has reduced the time and cost of content development, generating exercises, workplans and accessible formats quickly.[77] However, a **significant performance gap between African languages and English persists**.[78] An analytical overview by the Building Evidence in Education (BE^2) working group reiterates this point, stressing that biased, non-representative data sets and a lack of robust and accessible open-source tools are constraining AI use in LMICs.[79] When combined with hallucination rates of 15–40 per cent in common educational tasks,[80] the importance of human-in-the-loop guardrails becomes clear.[81]

Understanding which approaches have the most promise requires a commitment to **context-responsive evidence generation in real-world settings**. The timing of evidence generation and dissemination is crucial. All too often, implementation failures only become visible once tested at scale, by which point resources may be depleted. Traditional multi-year randomized controlled trials are often too slow and siloed to measure readiness effectively.[82] Any experimental or quasi-experimental research on impact should be complemented by an investigation of the implementation of the programme in real-world conditions, with resources that would be available at larger scale and not in ideal conditions.

The sector is increasingly shifting towards **rapid, iterative methodologies drawn from implementation science** to catch failures early and adapt quickly. Approaches such as 'teacher-in-the-lead' sandboxes[83] and design-based implementation research[84] ensure evidence is grounded in the realities of classroom practice rather than idealized conditions. Furthermore, emerging tools such as the Building Evidence in Education guidance on using implementation research[85] and the What Works Hub for Global Education's measurement framework[86] provide structured ways to evaluate real-world delivery. These methods allow for more frequent review based on pre-set evaluation triggers, real-time course correction and increased opportunity for engaging education stakeholders.

Think piece

From aid to infrastructure: Why education technology in emergencies must be built with governments

Luke Stannard and Eszter Nagy

Luke Stannard is Director, and Eszter Nagy is Partnerships Lead, at Can't Wait to Learn, a digital platform developed by War Child for children in conflict zones. This think piece draws on 15 years of designing, testing and scaling a game-based, adaptive digital learning platform across eight crisis-affected countries, revealing why working with governments to think long term is essential, both for children's outcomes and the systems they make up. It is included here to bring a fragility, conflict and violence (FCV) perspective to contextual readiness, showing what durable EdTech infrastructure looks like when it is built for, and with, the governments operating in the hardest contexts.

Introduction

An estimated 258 million crisis-affected children and young people's education has been disrupted, and around 93 million of them are out of school entirely,[87] due to conflict, climate events or displacement. These interrelated factors[88] now generate protracted emergencies that are lasting on average over 30 years – 16 years longer than they were in 1990.[89] UNICEF's *Learning Interrupted* report stated that 242 million children across 85 countries had their schooling disrupted by climate events in 2024 alone.[90] Compounding this, analysis from UNICEF's Children's Climate Risk Index reveals that the countries at high risk of experiencing climate-related disasters are those already facing the lowest levels of learning, with learning poverty around 60 per cent.[91]

Yet the FCV sector's instinct remains to treat education in FCV settings as a sprint: rapid, fundable, pre-packaged and time-bound. This approach has delivered real reach, but as the duration and nature of shocks to education service delivery change, so must the education community's response. Much has been written about technology's role as a tool for improving the resilience of education systems, and the Organisation for Economic Co-operation and Development (OECD) has dedicated an entire handbook to supporting system resilience, defining it as an ability to "withstand and recover from adverse events",[92] yet for many the role of technology in supporting education continuity has, with some justification, been coloured by our collective experience of COVID-19, exemplified by the United Nations Educational, Scientific and Cultural Organization (UNESCO) 2023 report *An Ed-Tech Tragedy?* [93]

Can't Wait to Learn[94] has been supporting governments with the co-creation of bespoke, offline-first digital personalized learning platforms, facilitating meaningful improvements in foundational skills in FCV settings for over a decade. The use of technology to support education delivery in FCV settings is not new; it ranges from radio to television, SMS tutors, tablet-based learning and the emergence of AI-supported chatbots.[95] However, as the duration of these crises grows longer, more attention must be given to the role of government as the site for longer-term system resilience, and its role in the ownership, governance and delivery of education technology platforms, building on the lessons of a largely unprepared world in early 2020.[96] Calls for a greater focus on government priorities in education in emergency response[97] are not new either, but as funding falls and crises grow, the need for long-term thinking in digital education provision in FCV contexts becomes more difficult for the sector to ignore.

The argument here is simple. Digital initiatives to support learning in FCV settings should be designed, from the first opportunity for use in each context, as public learning infrastructure, not as humanitarian programming or short-term free access from a private company, with a handover or sustainability plan bolted on at the end.

Digital public learning infrastructure

Digital public learning refers to infrastructure "systems that are integral components of wider systems of education".[98] The UNESCO-UNICEF-ITU Charter for Public Digital Learning Platforms established seven principles to guide governments in how to effectively support the development of systems that are in the public interest: **public**, ensuring a 'public good' and public governance focus; **inclusive** of learners with additional needs; systems that are **pedagogical** – broadly defined as teacher first, and pedagogically diverse, so as not to champion a single form of learning; **complementary**, in the respect that they work with the system that exists already, not the one a provider wished existed; **open** and interoperable from licensing to modular architecture; **focused** – on specific needs of stakeholders – for example, foundational reading and numeracy, or supporting greater parental engagement in their children's learning; and, finally, **trustworthy** – accurate, reliable and age-appropriate.[99] Taking time to focus on such principles could be what leads to a tool outliving its grant, and whether a system is better placed for the next shock to provision.

How you design digital tools with government is critical. To examine this, we will draw from the experience of Can't Wait to Learn – our offline-first, adaptive personalized learning platform designed with governments that has helped over 500,000 children improve their reading and numeracy in FCV contexts over the last decade, in contexts including **Jordan, Lebanon, the Syrian Arab Republic, Uganda** and **Ukraine**.

Before doing so, it is important to reflect briefly on why it is critical in crisis contexts that educational tools offer governments, teachers and parents a range of options for opportunities for use, as standard instruction fractures.

What crisis demands of education systems

Crisis does not merely interrupt delivery; it restructures the whole system.[100] All primary stakeholders in a child's education – teachers, caregivers and others – are subject to the impact of the crisis on a personal level. They are often displaced, or unpaid or absent,[101] which has significant impacts on teachers' well-being and beyond, as is well documented.[102] Caregivers have greater expectations placed on them to support their 'learners' while also managing the wider disruption to their lives,[103] as we saw during the COVID-19 pandemic, and the existing inequities that surfaced.[104]

For classroom delivery, the impacts are diverse and hugely impactful, with large internal displacement often placing excess demand in some regions, and a drop in demand in other geographies. Teachers have to adapt their practice; flexibility in delivery is therefore critical. Work by Bhatt and Radford (2025) documents the multidimensional delivery methods for teachers working in Ukraine, juggling face-to-face, hybrid learning (blending face-to-face and distance students), as well as distance learning (remote students) and dial schooling (displaced Ukrainian children keeping in touch

242 million

children across 85 countries had their schooling disrupted by climate events in 2024 alone."

with their system from abroad via digital platforms).[105] In other contexts the impacts of double-shifting (two different cohorts: one in the morning, one in the afternoon) are well documented.[106] What these examples aim to briefly demonstrate is that the tools teachers deploy need to be multi-use and support both synchronous and asynchronous learning.

This makes flexibility non-negotiable, but flexibility without an anchor produces fragmentation: a proliferation of apps and content that no ministry recognizes and no system absorbs only complicates matters. This issue was well demonstrated during the COVID-19 pandemic.[107] This is where supporting solution providers and governments to build on the principles for public digital learning platforms offers tangible steps to reduce fragmentation, build with the system as it is found, and support long-term system resilience and recovery.

At Can't Wait to Learn the first anchor is the national curriculum; the second pedagogy. They enable a displaced child to re-enter formal schooling, keep those still in the system progressing, provide the teacher with the playbook for continuity, and constitute the foundation for government-led systems of education provision. Curriculum in crisis is more than a set of objectives, competencies or themes; it is a direct link to culture and identity.

Practical lessons: Embedding digital solutions as public-good infrastructure

The fundamentals of the principles in the Charter generalize across contexts: working with the system that exists; integrating into government standards; supporting practical teacher use cases; and building digital self-efficacy among teachers, rather than mere familiarity with a single platform. This requires patient, long-term investment, alongside active partnership with national organizations, as well as with the government departments whose mandates intersect with digital education.

Curriculum is critical, and the remaining considerations are most usefully examined through the seven principles of the Charter for Public Digital Learning Platforms. Can't Wait to Learn's experience across a range of contexts offers real-world examples of what each principle requires in practice, but other examples will be drawn from. All uses of Can't Wait to Learn start with co-creation, working with multiple partners and government departments across eight countries.

Public good and public governance

In Ukraine, Can't Wait to Learn's host organization, the War Child Alliance, was engaged by the Ministry of Education and Science within weeks of the full-scale invasion of 2022. Rather than deploying a pre-packaged response, the first Memorandum of Understanding, signed in July 2022, established Can't Wait to Learn Ukraine as a government-endorsed intervention from the point of activation. That decision shaped every subsequent choice: curriculum alignment, data governance, content ownership and server architecture. Platform content co-designed with governments become national assets; platforms presented to governments after the fact become parallel systems, dependent on continued external support. In Jordan, the same process was used in 2018, with an agreement from the outset to share ownership of content developed together. The exact components of this process differ from context to context, but the goal is to find the best model, from both a governance and a technical perspective, with the partner government for its education system.

Co-design becomes ownership only where the architecture is built for transfer from the outset. In Ukraine, three distinct government counterparts were identified from the start: content ownership was assigned to the Ukrainian Institute of Education Development, technical administration to the Institute of Education Analytics, and teacher professional development certification to the State Service of Quality Education.

In Uganda, we continue work with the Ministry of Education and Sports, the National Curriculum Development Centre and the Ministry of ICT and National Guidance. In Ukraine, intellectual property, server infrastructure, platform credentials and full technical documentation were each transferred through specific legal instruments. Each decision was oriented towards the point at which the government would no longer require the implementing partner. A key test for Can't Wait to Learn is whether each choice increases or diminishes the government's capacity to own or lead the deployment of the platform independently.

Complementarity with existing systems

In Jordan, Uganda and Chad, each component of the content was signed off by the respective department focal points. In Ukraine, every learning sequence was developed against the national curriculum and submitted to formal ministry experts for content verification, not as an end-stage compliance measure, but as a design requirement embedded from the outset. This determined whether the content could be absorbed by the government's designated content administrator at the point of transition, without rework. In the absence of curriculum alignment, ministries have no structural reason to integrate a platform, teachers have limited confidence in or opportunity to use it, and children have no assurance that their learning will translate into formal schooling.

Pedagogical soundness and diversity

Alignment also renders a platform usable by teachers, rather than merely available to them. Vesting teacher professional development certification in the State Service of Quality Education in Ukraine, or the Ministry of Education processes in Jordan, establishes the platform's standing within the profession, rather than alongside it. Because crisis obliges teachers to work across several modalities simultaneously, a pedagogically sound platform must support both synchronous and asynchronous learning, and must adapt to the individual child, rather than privileging a single mode of use or a single model of learning. Training that supports teachers to build digital self-efficacy, not just platform competency, is critical.

Inclusion of learners with additional needs

In Ukraine, Can't Wait to Learn is delivered on both Android and iOS and operates with the operating systems' built-in accessibility components, with specific provision for children with visual impairments, among others, though scope for further development remains. In Jordan, a technology delivery model allows it to work on any device that can launch a browser. These choices again build on device accessibility features, while the game's structure also supports inclusion. Adaptive personalization extends this reach further, enabling children who are over-age for their grade, or who have missed years of schooling, to progress at their own level, rather than from the point at which a fixed curriculum presumes them to be.

Openness and interoperability

In Ukraine, the transition from offline, tablet-based deployment to device-agnostic distribution, available for direct download from the App Store and Google Play, was not a technical pivot but a deliberate design decision intended to remove hardware procurement as a barrier to access. This option exists in Ukraine but not in every context; the selection of an appropriate and open technology stack, however, is available in all. Interoperability further determines what may subsequently be handed over: content, infrastructure and credentials transfer cleanly to government only where they are built to open, documented standards rather than locked to a single vendor. This requires vendors to be open to transfer intellectual property to governments, which many are not keen to do.

Focused rather than comprehensive

Can't Wait to Learn is deliberately focused rather than comprehensive: it concentrates on foundational skills – the competencies whose loss during displacement is so difficult to recover and most consequential for subsequent learning[108] – rather than attempting to digitize the curriculum in its entirety. A focused platform is more readily absorbed by a ministry, more readily deployed by teachers against a specific gap, and more readily evaluated, since its purpose is legible to all those who must use or govern it.

Trustworthiness through accuracy and evidence

Trustworthiness is established on two fronts: accuracy and evidence. Accuracy is derived from the same formal content verification that secured curriculum alignment. Evidence is derived from research designed to explain rather than merely to report: a randomized controlled trial in Uganda,[109] quasi-experimental studies demonstrating learning gains in the Sudan[110] and Lebanon[111] and a quasi-experimental study currently being concluded in Ukraine, during active conflict, as well as implementation science-focused optimization work in Lebanon, in partnership with EdTech Hub, local universities and the War Child Alliance's research and development department. Such studies do not simply demonstrate that the platform works; they establish why it works, under what conditions and for which children. Research that can only report impact cannot drive improvement; research that explains the conditions of effectiveness is what enables a programme to improve and a sector to learn.

Conclusion

As crises grow longer, the cost of fragmented, parallel digital systems falls hardest on the children in the systems least able to absorb it. Even in crisis, systemic change is possible, if collectively we have the will to make long-term commitments while serving immediate needs. The evidence from Can't Wait to Learn's decade of work demonstrates that designing digital tools as public learning infrastructure from the outset is not idealistic; it is achievable.

Case study

Jamaica and the Philippines: Digital education in climate-affected contexts

These case studies examine how Jamaica and the Philippines are using digital education to support learning continuity in systems recently affected by climate and environmental hazards. Across different regional, income and institutional settings, the two case studies show that contextual readiness depends not only on connectivity and devices, but also on government systems, teacher capacity, curriculum-aligned delivery, data use and locally adaptable crisis response mechanisms. Each case study draws on a desk review and an interview with a senior government education official.

Turning digital education into a crisis-response asset in Jamaica

Context

Jamaica has faced successive education disruptions, due to the COVID-19 pandemic and hurricanes Beryl (2024) and Melissa (2025). Rather than responding reactively, the Ministry of Education, Skills, Youth and Information (MOESYI), together with UNICEF and development partners, has gradually and systematically invested in digital infrastructure, data systems, teacher and school leader capacity and inclusive student content, beginning with the pandemic and expanding thereafter. These investments have significantly strengthened the education system's ability to absorb shocks and maintain learning continuity, offering valuable lessons for crisis-prone countries worldwide.

Jamaica is building a layered digital education ecosystem through coordinated public, multilateral and bilateral investments and corporate social responsibility partnerships on the island and in the diaspora. The MOESYI adopted an Information and Communications Technology (ICT) in Education Policy (2022), outlining four strategic goals and a five-year financing plan, complemented by an Education in Emergencies framework to guide learning continuity during crises, and guidelines to oversee AI use in schools.[112]

Device programmes, including one laptop per teacher and the Bring Your Own Device initiative, expanded access to devices for administrators, teachers and students.[113] National broadband expansion, supplemented by satellite connectivity (Starlink) in rural and hurricane-affected areas, helped close persistent connectivity gaps. Under the Digital Jamaica programme, funded by the European Union, more than 1,000 public schools are being equipped with wi-fi.[114]

Curriculum-aligned digital tools further diversified how and where learning could take place. They include the UNICEF Learning Passport Jamaica (supporting foundational literacy and numeracy for Grades 1–3+),[115] and featuring Accessible Digital Textbooks (ADTs) designed using Universal Design for Learning principles, the WhatsApp-based FunDoo life-skills chatbot[116] and the 24-hour U-Matter counselling chatline. The US$3.7 million Sustainable Development Goals (SDG) Joint Programme (2024–2027),[117] led by UNICEF with UNESCO, the World Food Programme and the Food and Agriculture Organization of the United Nations, is anchoring the roll-out of the national Education Management Information System (EMIS) and expansion of the Learning Passport, targeting over 450,000 students.[118]

To ensure these initiatives were effective, continuous online teacher professional development was delivered through the National College for Educational Leadership and the Jamaica Teaching Council, enabling upskilling in mental health and psychosocial support, the principles and practice of child-friendly schools, safer school methodologies and Education in Emergencies.

Spotlight on practice

When hurricanes Beryl and Melissa struck, digital readiness made a measurable difference. Schools with an operational EMIS used student records to identify children who had stopped attending and coordinate re-enrolment.[119] Hybrid learning models that combined classroom attendance with online sessions allowed schools to function even when physical facilities were partially or fully destroyed. Teacher-led evening webinars on Zoom brought hundreds of displaced students together for exam preparation, often on a voluntary basis outside school hours. U-Matter provided psychosocial support throughout both emergencies; teachers participated in virtual and online courses, including the Return to Happiness programme and psychosocial first-aid sessions, while Learning Passport Jamaica enabled continued learning through offline-compatible printed workbooks with QR codes linking to digital content for students and teachers from early childhood through Grade 6. Special education units also ensured children with disabilities retained access to devices and teacher contact.[120]

Reflections and lessons learned

Jamaica's experience also revealed recurring barriers. Connectivity loss was one of the most severe consequences of both hurricanes: six months after Melissa, parts of western Jamaica still lacked full-time electricity, underscoring the fragility of infrastructure in vulnerable communities. Not all schools had a fully operational EMIS at the time of the hurricanes, which constrained the reach of data-driven response efforts.

Promoting digital tools in the face of significant competition from private sector-led, fee-based online platforms and sustaining digital tools also remains a persistent financial challenge. Greater strategic focus on generating sector-wide buy-in for digital tools, such as Learning Passport Jamaica, FunDoo and U-Matter is needed, while replacing devices, renewing teacher laptops and maintaining laboratory equipment require predictable, recurring funding that is often difficult to secure.[121]

The rapid integration of AI into education presents both opportunities and governance challenges. The Ministry of Education, Skills, Youth and Information's 2025 Policy Guidelines for the Use of AI in Public Schools note that AI's potential has "outpaced policy debates and regulatory frameworks", highlighting four persistent barriers: infrastructure gaps in rural schools, structured teacher training in AI literacy, equity risks for disadvantaged learners, and data privacy obligations under Jamaica's Data Protection Act.[122] AI is already being used to accelerate accessible content production for learners with disabilities through the creation of ADTs, reducing production time and costs. However, full implementation of the guidelines remains in early stages and will require sustained investment in infrastructure and school-level capacity.

Jamaica demonstrates that investments in digital education generate returns well beyond the classroom: when infrastructure, data systems and teacher capacity are built and maintained consistently over time, they become crisis-response assets. Policymakers should treat an EMIS as both an education management and an emergency preparedness tool; ensure device and connectivity programmes systematically prioritize the most vulnerable learners; and commit to teacher professional development as a recurring budgetary line, not a one-off project. Hybrid learning models, designed in advance rather than improvised under pressure, are essential for climate-vulnerable education systems.[123]

Connectivity and continuity in the Philippines through Hayo, Hinay, Hinga and Hinto

Context

The Philippines' digital education agenda is being shaped by persistent infrastructure gaps and an increasingly urgent need for learning continuity. In 2026, the Department of Education was allocated ₱1.5 billion to improve connectivity in public schools, while around 12,000 public school campuses still lack internet access.[124] The country has set an ambitious direction for digital transformation: universal school connectivity and device access across the public education system.[125]

"We're quite aggressive in terms of providing technology... [The goal is] all 100 per cent of schools connected to the internet, 100 per cent of schools have devices."

– Senior official, Bureau of Learning Delivery, Department of Education, Philippines

This agenda sits within a high-risk climate context. UNICEF's Children's Climate Risk Index[126] classifies the Philippines as 'extremely high risk', reflecting children's exposure to multiple hazards such as typhoons, flooding and extreme heat.[127] For a country serving around 47,000 public schools across an archipelago, with some schools enrolling as many as 16,000 students and others as few as 20,[128] contextual readiness with EdTech solutions depends on whether schools have a shared way to make safe and locally appropriate decisions during disruption.

Spotlight on practice

Children and families in the Philippines continue to cope with the effects of destructive typhoons and earthquakes that have hit the country in close succession. In November 2025, Super Typhoon Uwan and Typhoon Tino triggered widespread flooding, landslides and damage to homes, schools and critical infrastructure. Many affected areas had already been struck by strong earthquakes in October and two typhoons – Nando and Opong – in late September.[129] Climate and environmental shocks threaten the minimum standard for digital learning, as schools and communities face interruptions to power, water, and telephone signal and internet connectivity.

When schools shut down during such emergencies, digital platforms are part of the response, but they are not always the most feasible option. Although the Philippines has a national Moodle-based learning management system, an estimate of fewer than 5–10 per cent of learners can shift seamlessly to online learning during disruption. This mirrors findings from the EdTech Hub's case study research in Valenzuela, Leyte and Albay, where printed modular learning was used by 85% of teachers during closures and, in some divisions, 75 per cent of learners had no home internet connection at all.[130] Most schools instead move towards 'modular learning', a low-tech approach that expanded during the COVID-19 pandemic. Schools, districts or regional offices prepare short, printed learning modules with reading materials, instructions, worksheets, reflection questions and quizzes for students to finish when they return to school. Most teachers use mobile group chats to guide learners and families on which modules to use when classes are suspended.

Recognizing that learning continuity depends on more than one delivery channel, the Department of Education's 2026 Learning Continuity Framework organizes education responses in emergencies into four levels: **Hayo (continue), Hinay (ease in), Hinga (check in) and Hinto (stop)**. Rather than responding to emergencies with a single solution, the framework codifies different learning priorities according to the severity of disruption and the level of access available to learners and teachers. It provides teachers, school leaders and local offices with a shared language for jointly determining whether instruction can continue, should be adjusted, should shift towards student support such as well-being checks and trauma-informed resources, or should pause until conditions improve.

When the 7.8-magnitude Mindanao earthquake struck on 8 June 2026,[131] shortly after the framework was released, individual schools were able to apply the codes according to local conditions. In Sarangani, all 330 schools initially stopped classes; by 15 June, some localities had resumed, while more severely affected communities remained in Hinto mode because classrooms were still damaged and families were displaced. As the senior official explained, *"Unfortunately, but fortunately that we had the policy, then we were able to test it immediately the first week that it got released. And we saw how it was easier for teachers to communicate. It was easier for schools to communicate with one another.*

It was also easier for them to do a bit more localized decision-making."

This localized discretion is not always straightforward to exercise in practice. EdTech Hub's research elsewhere in the Philippines found that although the Department of Education formally grants school heads authority to suspend classes, most defer to the local government unit first, citing accountability structures and a 'blame culture' that discourages independent judgement.[132]

Reflections and lessons learned

Does 100 per cent school connectivity or device access automatically translate into an education system ready to reach every learner? The Philippines' ambitious investment in school infrastructure is essential for successful EdTech product implementation, but the Learning Continuity Framework demonstrates that the effectiveness and sustainability of EdTech also depend on when schooling is disrupted.

Even where infrastructure investment succeeds, Mazari et al. (2026) found that schools have almost no reliable way to determine whether learning actually took place during a closure.[133] Monitoring during suspensions tracks task completion, such as photo submissions via Messenger, returned modules and dashboard entries, rather than learning quality. Proxy completion, where parents or siblings complete a learner's work on their behalf, was described as widespread and largely unaddressed across all research sites, and genuine learning was only verifiable once students returned to school.

With classrooms damaged, schools converted into shelters, devices left at school or families with a low-bandwidth connection, the following lessons on contextual readiness are at the heart of making tools accessible across diverse learning contexts:

Anchor EdTech in curriculum-aligned delivery: The Philippines has a dedicated Bureau of Learning Delivery responsible for translating curriculum standards into lesson plans, assessment guidance and technology integration, especially during emergencies.

Build resilience around communication between teachers, parents and students: Learning continuity in low-resource and fragile contexts often depends on teachers' ability to keep families connected; around 90 per cent of teachers in the Philippines report using mobile messaging apps (e.g., Facebook Messenger and Viber) to share scanned lesson plans and homework modules in group chats during a crisis.

Ensure contextual readiness is co-developed: Government investment in education technology cannot sit with one unit or platform; it requires shared ownership across learning delivery, ICT, school leadership and disaster risk management, with roles defined before a crisis hits.

Think piece

Rethinking student device strategies: What governments decide when they buy computers for schools

Ekua Bentil and Cristóbal Cobo

Dr. Ekua Bentil is a Senior Education Specialist and Global EdTech Lead, and Dr. Cristóbal Cobo is a Senior Education and Technology Specialist (Europe and Central Asia). The authors would like to express their gratitude for the thoughtful comments and feedback provided by Michael Trucano, Senior Education Specialist at the World Bank, and Frederico Jose Antunes de Carvalho, World Bank consultant. Their think piece frames the debate on digital devices – not around how many have been procured, but around what kind of system investment makes technology use in schools effective, equitable and sustainable. It grounds the report's exploration of contextual readiness in a key EdTech decision governments have to make, often with little evidence: how to put devices in schools.

From hardware ratios to system readiness

Decisions on digital devices in education are not simply procurement exercises; they are policy choices about **how** and **for what purpose** learners and teachers will use technology, with sustainability as a consequence of those choices, not a separate decision. The strongest evidence from large-scale device programmes consistently shows that providing access might improve digital skills but does not necessarily improve learning outcomes without deeper changes in how teaching and learning happen in classrooms. This piece reframes the debate: away from **how many devices** towards **what kind of system investment ensures effectiveness and sustainability**.

Beyond counting devices in schools

Governments have been investing heavily in school devices, often expecting laptops, tablets or computer laboratories to expand access, improve learning and build digital skills. Experience across education systems in LMICs shows a more complex reality. Access is insufficient unless it reaches the right users: the 'who' – teachers, specific student groups or underserved communities – shapes every subsequent decision about model, content and support. Devices can support learning only when they are connected to clear instructional goals, teacher preparation, curriculum-aligned digital content and software, reliable maintenance and sustainable financing. These conditions should be coupled with foundational enablers such as reliable and affordable electricity and, for secondary school students and above, internet connectivity, where the evidence for connectivity-dependent instructional tools is stronger and screen-time concerns are comparatively less acute. The central risk is not the hardware as such, but the assumption that providing infrastructure will, by itself, transform classroom practice.

Different access models carry different pedagogical, financial, logistical and equity implications. One-to-one device programmes (e.g., One Laptop per Child – OLPC) expand individual access, but they require strong technical support and can widen equity gaps when home connectivity, family support and digital literacy vary widely. Shared classroom devices can reduce costs, but their impact depends on scheduling, classroom routines and purposeful use. Computer labs can offer more structured and supervised learning environments, but only when electricity, internet connectivity, staffing, maintenance and timetables are reliable. These choices also interact with procurement and financing models. Outright purchase, leasing, managed service contracts and public–private partnerships each assign responsibility for maintenance, replacement, device uptime and long-term cost in different ways.

Drawing on multi-country experience, predominantly in pre-tertiary education across LMICs, this subsection asks four questions: What does each device access model enable or constrain? Under what conditions does technology improve learning, rather than merely increase access? How can governments procure, maintain and replace devices sustainably over their full life cycle? And how can policymakers choose models that fit instructional goals, institutional capacity, budget realities and equity priorities, rather than defaulting to a single hardware solution?

How devices are distributed and what that enables

Governments investing in education technology face a strategic choice, not a simple procurement decision. One-to-one devices, shared classroom sets and computer labs each have different implications for learning, equity, cost, supervision and sustainability. No single model works best in every context. The conditions under which each model is most likely to work are examined below, helping policymakers choose based on context rather than a single standard solution.[134]

One device per student

The 1:1 model gives each student a personal laptop or tablet to expand access and reduce the digital divide. It has been widely adopted across Latin America, sub-Saharan Africa and the Middle East, making it one of the most evaluated education technology interventions.

World Bank engagement has increasingly emphasized pedagogy over procurement. In **Rwanda**, the government launched an OLPC initiative in 2008 – later supported and evaluated by the World Bank – distributing hundreds of thousands of laptops to primary students as part of a national strategy to build a knowledge-based economy.[135] The Bank's Independent Evaluation Group found that successful integration required sustained teacher training in digital pedagogy and reliable infrastructure – which emerged as persistent structural challenges – and concluded that technology must be embedded in a holistic educational strategy that includes curriculum integration and ongoing institutional support. In **Peru**, the Inter-American Development Bank co-evaluated the OLPC programme (2008), finding that hardware alone did not improve learning – a conclusion reinforced by a 10-year follow-up showing no effects on test scores or school completion.[136] In **Türkiye**, the World Bank's Safe Schooling and Distance Education Project (2020) built on the digital infrastructure of the government's earlier FATIH initiative. The Bank's intervention successfully scaled the national platform (EBA) and heavily integrated teacher capacity-building alongside its classroom technology investments.[137]

The evidence is clear: take-home devices can widen inequality through differences in family support, and long-term follow-up shows no delayed academic gains from hardware-first approaches.[138]

Shared classroom devices

Shared classroom models vary: whole-class smartboard instruction, mobile labs or charging carts that rotate across classrooms, and fixed-station rotation. Each variant carries different implications for time on task, scheduling, supervision and device management.

Research suggests that shared devices can improve learning when software supports students' learning and use is carefully supervised – as shown in after-school computer programmes in India, where structured, level-appropriate practice produced large learning gains.[139] Broader reviews confirm that the delivery medium matters less than the instructional method: programmes using equivalent content in computer-based or paper-based formats tend to produce similar results.[140] Without managed routines, however, stronger students tend to dominate device access, reducing time on tasks for weaker learners.

World Bank operations highlight structured use. In **Guyana**, the Education Sector Program introduced smart classrooms in rural primary schools to support mathematics and other core subjects.[141] In **Nigeria**, the AGILE project combined shared access with digital literacy training for adolescent girls, linking technology to both learning and empowerment.[142] In **Argentina**, PROMER II trained more than 30,000 teachers to use shared devices in multi-grade rural classrooms for differentiated instruction.[143]

Dedicated computer labs

As a shared-device model in which students rotate through a dedicated room, computer labs have produced some of the strongest evidence for academic gains when they combine structured time, supervision and adaptive software aligned with students' actual learning levels.[144]

World Bank engagement reflects this logic. In **India**, the Bank evaluated Mindspark, an adaptive computer-assisted learning programme that produced test score gains equivalent to several additional months of learning in both mathematics and Hindi, with improvements sustained at scale when implemented within public schools.[145] In **Uzbekistan**, the Transforming Public Education for Economic Growth Project upgrades regional teacher training institutes with computer labs to strengthen digital pedagogy training, with outcome evaluations under way.[146]

Supervision is especially powerful here: a dedicated lab supervisor increased active learning time substantially and produced improvements comparable to a full school term's worth of additional progress at very low cost per student.[147] Their main risk is fragility, since failures in staffing, maintenance or electricity can shut access down entirely, and unsupported technology can actively reduce learning.[148]

Device heterogeneity

Regardless of the device distribution model adopted, heterogeneity across devices introduces a distinct set of challenges. Device heterogeneity means schools use a mix of hardware, including government-procured laptops, tablets, desktops and smartphones, alongside student-owned, donated and refurbished devices. These devices may differ in operating systems, screen size, processing power, software compatibility, security requirements and replacement cycles. This approach can help expand access when a single national device type is too costly or impractical, and it can allow different devices to serve different instructional purposes across grades, subjects and school settings.

The risk, however, is that device diversity can reproduce or deepen inequality. Students with newer, faster or better-connected devices may have a smoother learning experience, while others work with outdated or unreliable equipment. Teachers may struggle to design and support activities that work equally well across different screens, keyboards, browsers and software versions. Governments therefore need minimum specifications, compatibility standards and device management licences procured with the hardware so that devices are monitored, maintained and secured, rather than left to degrade after deployment, and so that flexibility does not undermine equity, reliability or learning quality.[149]

How governments pay for devices and why it matters

Whichever device access model a government adopts, the choice of procurement methodology remains a critical determinant of how effectively those devices are used. Procurement is fundamentally about sustainability, usability and equity – informing the total cost of ownership or operation, not just the upfront hardware price, which typically represents only 25 per cent or less of total cost.[150] The right approach must align with a government's technical capacity to manage large-scale deployment and support better classroom integration, learning and a consistent standard of access. A few of these approaches are discussed below.

Outright purchase

For LMICs, the most common and straightforward method for large-scale device acquisition is outright purchase. Its prevalence in development is partly driven by its relative simplicity and also by time-bound donor financing structures that favour discrete capital expenditure. For example, outright purchase remains the most common approach across World Bank-financed projects supporting device acquisition, but newer projects are starting to use service-based models that include technical support, maintenance and replacement. A government pays the full hardware cost upfront, taking immediate ownership. While straightforward, this approach structurally encourages a focus on the lowest initial price while often obscuring the much larger long-term total cost of ownership or operation. Many countries overlook these long-term costs, contributing to frequent deployment failures.[151] A key driver of those failures is the absence of device management at the point of procurement. Device management software licences should be bundled with every purchase and installed at deployment; without them, ministries cannot monitor, maintain or secure their fleets. Device choices are also security choices, with implications that vary across operating systems and deployment contexts. The result is often unsupported hardware that depreciates rapidly in both performance and pedagogical relevance, leading to the 'locked computer lab' phenomenon of expensive equipment sitting broken or unused[152] or, where ownership has been transferred to students, an increasingly heterogeneous device environment as families struggle to afford maintenance and upgrades.

Pay-to-own

Pay-to-own models often see governments act as guarantors, facilitating private sector arrangements through which students receive devices and repay costs incrementally over time, typically at little or no interest. This model is politically appealing: it distributes financial burden, extends access to households that cannot afford upfront costs, and fosters personal ownership that can encourage device care. However, as with the outright purchase approach, ongoing costs of maintenance and replacement are frequently underestimated, and when lower-income households drop out of payment schemes or cannot afford upkeep, the result is the same device heterogeneity that complicates school-level support and undermines the standardization that effective large-scale deployments require.

Leasing and managed service-based contracts

Leasing and service-based contracts shift the financial structure from a large, one-time capital expenditure to a predictable operational expense. Under a lease, governments pay periodically for device use, while the vendor retains ownership, with devices returned or upgraded at the end of the contract. Service-based contracts go further by bundling in maintenance, technical support and replacement –

transferring operational responsibility to the vendor. For example, Device-as-a-Service represents a convergence of both the periodic payment and vendor ownership of leasing with the managed service and outcome-based accountability of service contracts; it often bundles Software-as-a-Service subscriptions alongside hardware. Their success depends on governments' ability to commit to multi-year budgets and craft enforceable service-level agreements. Based on World Bank experience, equally important is the willingness of vendors to engage – a confidence that, in practice, favours lower-risk contexts and explains why these models remain more common in advanced economies.

Public–private partnerships

Public–private partnership (PPP) approaches leverage private sector finance and expertise for national education programmes. Importantly, leasing, pay-to-own and managed service models can all be structured as PPPs, making the PPP framework less a procurement model in itself and more an overarching governance arrangement through which any of the above can be delivered more sustainably. When well designed, PPPs can accelerate roll-out and distribute investment risk more equitably. When poorly designed, they risk weak accountability, vendor lock-in and policy misalignment where commercial goals overshadow public education objectives such as equity.[153] Transparent contracts that clearly define roles, risks and performance metrics are essential.

Country examples of innovative device procurement approaches in education

The cases listed below illustrate the procurement principles discussed in this section and extend them to additional models used in practice. They are illustrative rather than exhaustive, and not every model maps to a single approach described above.

- **Costa Rica's managed service provider contract (World Bank-funded CORE project):** Rather than purchasing outright, Costa Rica's Ministry of Education is procuring hardware, software, maintenance and training across all primary and secondary schools through a single performance-based contract with a private managed service provider.[154]
- **Senegal's pay-to-own with PPP arrangement:** Students could pay for a computer (with technical support included) in full or in monthly instalments over 12 months at US$10–16/month, at below-market cost, thanks to subsidies from the Digital Solidarity Fund of Senegal, with World Bank financing acting as a guarantee fund. The programme was backed by Ecobank, Samsung and Intel, in partnership with the Government of Senegal.[155]
- **Portugal's bundled device–connectivity PPP (e-Escola/e-Escolinha):** Portugal distributed over 500,000 laptops to students through telecommunications operators, bundling devices with connectivity subscriptions on an income-sliding scale, cross-financed through spectrum auction proceeds to avoid a one-time fiscal spike.[156]

- **Uruguay's centralized device life-cycle management (Plan Ceibal):** Uruguay established a dedicated government institution, the Ceibal Centre, to centrally handle procurement, maintenance, repair and technology refresh for nearly 3 million devices across all primary and lower secondary schools.[157]
- **Rolling procurement cycles:** A World Bank working paper recommends replacing or upgrading 20–25 per cent of devices annually over a four-to-five-year cycle by region or grade level, ensuring continuous upgrades, greater budget predictability and more manageable deployment.[158]

These approaches are not exhaustive. Other financing and delivery mechanisms, including Universal Service Funds[159] and results-based instruments such as Program-for-Results,[160] can also support device provision, though each carries distinct design and implementation requirements beyond the scope of this chapter.

What decision-makers should take away

The evidence and operational lessons across device models and procurement approaches point to a consistent conclusion: the binding constraint in most failed education technology programmes is not access, but the assumptions built into how access is designed and sustained.

- **Device ratio alone is also the wrong metric.** Evidence suggests that how devices are used matters as much as how many there are. Structured use, time on task and adequate supervision are stronger predictors of improved learning outcomes than the device distribution model itself.
- **No distribution model or procurement approach delivers equity by default.** Every model and approach carries its own exclusion risks; without deliberate design choices in geographic reach, scheduling, supervision, software calibration and targeting, those risks go unaddressed.
- **Device heterogeneity compounds these risks.** When schools rely on a mix of government-issued, donated and Bring Your Own devices, minimum specifications and compatibility standards are equity decisions, not merely technical details.
- **Procurement planning and coordination are as consequential as the devices themselves.** Rather than infrequent lump-sum purchases, rolling replacement cycles for 20–25 per cent of devices annually by region/district or grade level improve budget predictability and deployment manageability. In decentralized systems, coordinated framework agreements with vendors negotiated collectively across education clusters can replicate the price leverage of centralized procurement with related managed services, while preserving local flexibility.

- **Private sector involvement can add value**, but only where accountability and transparency run both ways and procurement terms protect the public interest beyond the initial purchase transaction.
- **Before committing to a device programme, governments should be asking different questions, not just about hardware, but about systems, sustainability and equity.** Not how many devices, but what instructional purpose do they serve, and is the system ready to support that use? Not what is the unit price, but what is the total cost over the device life cycle? Past programmes are instructive: where governments overlooked system readiness and long-term costs, results disappointed. But the same experiences show that governments that address these questions early are better prepared to focus on what really matters for learning gain.

"The binding constraint in most failed education technology programmes is not access, but the assumptions built into how access is designed and sustained."

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Case study

Pakistan: Financing beyond the hardware

This case study draws on two key informant interviews (KIIs) with the Government of Pakistan – one with a senior public official and another with a technical lead – to provide information about digital education financing in Pakistan. Both interviews were triangulated against a desk review of publicly available policy documents, including Pakistan's draft Federal Education Policy 2026 and the Ministry's Public Financing in Education report, to ground the narrative in verifiable, on-record evidence.

Building the systems behind digital education and e-Taleem

Context

In Pakistan, education spending has fallen from 1.5 per cent of GDP in 2022–2023 to a provisional 0.8 per cent in 2024–2025, against a 4–6 per cent UNESCO benchmark, and 77 per cent of what remains is consumed by recurring expenses such as salaries.[161] Digital education leans even further on development partners' support: development partners typically provide key resources to launch digital interventions, while federal and provincial governments provide the financing to sustain them from there. "If initial infrastructure is developed… at provincial and federal level… [it] can help the system to make a start and continue [digital education]" according to a senior public official.[162]

A historical analysis of education policy, however, shows that for most of the past two decades there was no updated comprehensive national plan to guide that investment: neither the federal government nor the provinces developed a complete education policy between 2009 and 2024.[163] That vacuum has only recently begun to close, with a national policy development framework endorsed in 2024 and a first federal education policy circulating in draft this year, including its first dedicated chapter on technology integration.[164] Against this backdrop – heavy reliance on donor infrastructure financing, a policy system still catching up, and a devolved governance structure that has made inter-provincial coordination politically difficult – e-Taleem, the platform meant to anchor Pakistan's national digital learning effort, has had to prove that a good idea can outlast the project that built it.

Spotlight on practice

e-Taleem was built in the aftermath of COVID-19 with development partner funding of multiple interventions, including Teleschool, intended to give teachers and students a national bank of free learning resources. The launch itself succeeded. What followed left questions to be answered where the platform's usage remained limited and no recurring budget line or official plan existed, for an extended period of time, to keep the system current once the original project financing period ended. "The system was somewhat complicat[ed], with issues faced in registration, logins, and, for the administrative side, licensing… the teachers and students were not optimally us[ing] those resources" (senior public official).[165]

He traces the shortfall to how digital education is financed more broadly, not to e-Taleem specifically. Development partner support typically arrives as time-bound project financing, matched by a government side that has, until recently, lacked the multi-year strategic planning needed to receive and institutionalize it. "We need to give those facilities across the system, not only some specific project mode," he said, describing the gap directly and reflecting the government's updated understanding of financing digital education. Pakistan's own 2026 draft federal education policy reaches a similar conclusion about its own technology programme, warning that there is no central organization with the capacity to coordinate all related efforts, ensure follow-up services, and guarantee long-term sustainability of what has already been built. To address this, the policy recommends developing an EdTech Cell that fulfills all these functions.[166]

This is not a uniquely Pakistani problem, and global evidence backs the Director's diagnosis. The World Bank's EdTech Readiness Index (ETRI 2.0) splits its six pillars evenly between 'actors' – school leaders, teachers and students – and 'inputs' like devices and connectivity, on the premise that infrastructure alone predicts little about outcomes.[167] Pakistan's own Federal Directorate of Education (FDE) made the same point from the inside: at EdTech Hub's April 2026 cross-country policy dialogue, Director Riffat Jabeen named teacher capacity, not hardware, as "a decisive reform lever" for scaling EdTech.[168]

The Ministry has now developed a Roadmap for Advancing Digital Learning and Technology Integration in FDE 2026–2030,[169] as a response to contextual readiness challenges, where digital infrastructure is just one domain among six others designed to provide the sector-wide support required for effective implementation of technology.[170] This is one of the first steps Ministry of Federal Education and Professional Training (MoFEPT) is taking towards a long-term strategy to build in-house capacity to counter vendor lock-in and interoperability issues, addressing, as the senior official put it, a structural gap as much as a contractual one: "Government has to take ownership… we have to allocate some significant budget and some matching grants." This understanding of gaps in structural support and the decision to continue with the brand e-Taleem, regardless of whether a new vendor is engaged, reflects the government's desire to take digital education beyond projects and into standard practice while investing in supporting structures required to facilitate its designed usage.[171]

Reflections and lessons learned

Can a platform outlast the project that built it, if the systems around it were never given a permanent budget line? Can time-bound interventions succeed in developing the supporting structures required to take digital education to scale in an effective and equitable way? These are critical questions to consider as ministries of education in comparable contexts aim to leverage technology to counter the challenges that they face whether they are due to climate disruptions, teacher shortages or learning crises.

- **Curated pilots do not provide a true reflection of system-wide readiness needed for scaled usage:** e-Taleem's complications are exacerbated by a missing investment in the recurring functions – training, curriculum integration, device and digital learning material upkeep and maintenance – that let a platform graduate from a demonstration project into standard practice.
- **A policy vacuum limits structured financing required for the effective implementation of digital education programmes:** without a comprehensive, multi-year education strategy until 2024, digital initiatives had no institutional home to be absorbed into once project funding ended, so they stayed as limited projects. A cogent long-term policy and commitment is required to leverage the benefits that technology can provide in education.
- **Readiness assessments should evaluate human and institutional capacity as much as hardware and infrastructure:** global frameworks like the ETRI, UNICEF's EdTech for Good Framework 2.0, and officials' own accounts from Pakistan and beyond, agree that teacher capacity and institutional coordination decide whether an EdTech investment scales – a lesson e-Taleem's second act will have to apply.

Think piece

Building pathways to scale: Advancing research-infused learning for all

Isabelle C. Hau and Susanna Loeb

Isabelle C. Hau is the Executive Director of the Stanford Accelerator for Learning. Susanna Loeb is a Professor at the Stanford Graduate School of Education, and Faculty Director at the Stanford Accelerator for Learning, leading the SCALE Initiative. This think piece outlines four complementary pathways that enable research-informed digital learning at scale, using the Stanford Accelerator for Learning as an illustrative model. It is included in this chapter to emphasize that true contextual readiness requires building 'circular learning systems' and investing in the human capacity needed to continuously adapt digital education innovations to local realities.

Introduction

Across the world, education systems face a profound paradox. Knowledge about how humans learn has advanced dramatically, yet learning outcomes remain deeply unequal and often stagnant. New findings in development, cognition, motivation, feedback, social belonging and system improvement have expanded what educators and researchers understand about learning.[172] Even so, many classrooms, training programmes and digital platforms still reflect older assumptions about how learning happens and what educational systems are designed to support.

AI has intensified this challenge.[173] It is changing how people access knowledge, solve problems and demonstrate understanding. It is entering homes, classrooms and workplaces faster than most institutions can evaluate its effects or guide its use. It is also changing who and what we learn with. These developments create real possibilities for more personalized, creative and responsive learning experiences. They also create serious risks. Systems that adopt AI without a clear account of learning, development and equity may deepen dependency, reward superficial performance or widen existing inequalities. The challenge extends beyond innovation to translation and diffusion, at a pace commensurate with technological change.

Research produces insight; systems require implementation.[174] The distance between the two has become one of the central bottlenecks of educational progress. Without mechanisms that connect discovery to practice, knowledge accumulates without improving lived learning experiences. In the age of AI, this gap risks widening further. What is needed is stronger infrastructure for moving knowledge into the settings where learning happens. Research findings must travel across disciplines, sectors and communities if they are to shape everyday practice.

The Stanford Accelerator for Learning is one such translational infrastructure. Launched in 2021 as a Stanford University-wide initiative hosted at the Stanford Graduate School of Education, the Accelerator was created to bridge the persistent gap between advances in the learning sciences and their application in real-world settings. From the outset, it has drawn on expertise across education, computer science, neuroscience, design, business and public policy to address learning as a system-level challenge.

This think piece uses the Accelerator as an illustrative example of what it means to move 'beyond digital as usual': creating connective infrastructure that links research, practice, technology and policy. By bringing together researchers, schools, communities, industry, policymakers and global organizations, it demonstrates how sustainable educational transformation emerges from the continuous co-evolution of evidence, innovation, human capacity and public systems.

The Accelerator organizes its work across four interconnected pathways that advance digital learning grounded in the learning sciences and infused with research. These pathways aim to turn knowledge about learning into knowledge used for learning, and, more fundamentally, to build digital learning systems that learn themselves, transforming emerging evidence into better learning experiences while adapting to a world in which AI is reshaping how knowledge is created, accessed and applied. Each pathway is addressed in turn below.

Funding discoveries: Investing in research that shapes digital learning

Universities play a unique role in generating new knowledge, yet discovery alone rarely transforms digital learning.[175] Too often, advances in the learning sciences remain confined to academic journals, disconnected from the digital tools, AI applications and classroom practices that shape learners' everyday experiences. Building digital learning beyond digital as usual therefore begins by investing in discoveries with clear pathways towards implementation, ensuring that evidence informs the design of technologies.

The Rapid Online Assessment of Reading (ROAR), developed by Professor Jason Yeatman and colleagues, shows what this looks like in practice. Decades of research have demonstrated that early identification of reading difficulties is critical for improving literacy outcomes,[176] yet traditional assessments are often time-intensive, expensive and difficult to administer at scale. Through interdisciplinary collaboration among researchers in education, neuroscience and medicine, the ROAR translated decades of reading science into a rapid, engaging digital assessment capable of reaching large numbers of learners.[177] In California, the ROAR has been one of the state's approved screening instruments for identifying students at risk of reading difficulties since 2024. Today, the ROAR has reached more than 1.2 million students. Its widespread implementation continues to generate new scientific insights into literacy development and dyslexia, creating a virtuous cycle in which digital learning both applies and advances the science of learning.[178]

The Accelerator supports research discoveries such as the ROAR through thematic seed grants that bring together researchers, educators, technologists, designers, entrepreneurs and policymakers around shared educational challenges. But funding research is only the first step. Through the Accelerator Studio, multidisciplinary teams receive support to transform promising discoveries into research-informed digital learning solutions. The Studio helps projects move from proof of concept to real-world implementation by providing expertise in human-centred design, product development, implementation, evaluation, entrepreneurship, partnerships and scaling. In doing so, it ensures that digital tools are learning science-enabled, grounded in evidence from the outset and refined through practice. This translational approach reflects a growing recognition that educational innovation requires sustained collaboration among researchers, designers, entrepreneurs, educators and implementation partners throughout the innovation life cycle.[179]

Impactful digital learning starts with a deep understanding of how people learn. Technology becomes transformative only when research is intentionally translated into digital experiences, AI-enabled tools and learning environments that can be tested, improved and scaled in partnership with educators and learners.

Building solutions: Co-designing research-informed digital learning

Evidence alone does not transform learning. Decades of research on knowledge mobilization, implementation science, improvement science and research–practice partnerships have demonstrated that educational improvement depends both on generating high-quality evidence and on creating sustained mechanisms that enable research and practice to inform one another.[180] This challenge has become even more urgent in digital education, where technological innovation often outpaces the generation and application of evidence. Recent scholarship argues that effective digital learning requires moving beyond evaluating technology after deployment towards embedding evidence throughout the entire innovation process, from design and development to implementation, evaluation and continuous improvement.[181]

Building research-informed digital learning therefore requires moving beyond a linear model in which researchers generate knowledge and practitioners simply adopt it. Instead, evidence and innovation evolve together through continuous collaboration among researchers, educators, learners, designers, entrepreneurs, technology developers and policymakers. Digital learning environments become living laboratories that generate new evidence about teaching, learning and human–AI interaction.[182]

The Accelerator has applied the same approach to AI-enabled instructional coaching, led by Professor Dorottya Demszky. Decades of research have demonstrated that instructional coaching is among the most effective strategies for improving teaching practice,[183] yet access remains limited because expert coaching is costly and difficult to scale. The project set out to expand access to evidence-based coaching with AI, without displacing teachers' professional judgement. From the earliest stages of development, learning scientists, computer scientists, instructional experts, designers and classroom teachers worked together to translate research on effective teaching into an AI-supported coaching platform.[184] Teachers participated as co-designers throughout the development process, ensuring that both the technology and the pedagogical model reflected authentic classroom practice. Each implementation generated new evidence that informed subsequent iterations, creating a continuous cycle of research, design, implementation and improvement. Early evidence suggests that generative AI can strengthen teacher preparation and lesson planning when designed to complement, not replace, professional judgement.[185]

Successful digital innovation depends on ecosystems where research, design, implementation and ongoing learning reinforce one another. In the AI era, the most impactful digital learning solutions will be learning science-informed, educator-designed, evidence-generating and continuously improving.

Mobilizing knowledge: Translating discovery into decisions

Research creates public value only when it informs decisions.[186] Yet educators and policymakers often face fragmented evidence, competing priorities and rapidly evolving technologies. Even when robust evidence exists, translating it into practical guidance remains one of the greatest bottlenecks in educational improvement.[187] This challenge is especially pronounced in the context of AI, where the rapid pace of innovation and adoption often exceeds the speed at which rigorous evidence can be generated, synthesized and translated into policy and practice. As demand for trustworthy guidance grows, there is an urgent need for infrastructure that can curate, evaluate and synthesize the rapidly expanding body of AI-in-education research.

The AI Hub for Education's Research Repository at Stanford, part of the SCALE Initiative at the Accelerator, curates and synthesizes the rapidly growing evidence base on AI in education.[188] The Repository organizes emerging research into an accessible, continuously updated public resource. By making evidence easier to discover, interpret and apply, it helps decision makers distinguish between promising innovations and unsupported claims, accelerating the responsible adoption of AI in education while identifying important gaps for future research. In a field evolving as rapidly as AI, mobilizing knowledge means generating new evidence and ensuring it is accessible, actionable and available when decisions are made.

Developing talent: Building human capacity for research-informed digital learning

Digital transformation succeeds because people, not technologies, learn, adapt and innovate.[189] Even the strongest evidence and the most promising AI-enabled tools cannot improve learning without educators, researchers, entrepreneurs and leaders capable of translating research into meaningful educational practice. Moving beyond digital as usual therefore requires investing both in digital infrastructure and in the human capacity to design, implement, evaluate and improve research-informed digital learning.

Teachers remain central to this transformation[190] as co-designers.[191] As AI becomes increasingly integrated into education, educators need opportunities to critically evaluate emerging technologies, understand their pedagogical implications and integrate them thoughtfully into teaching and learning. The Accelerator's AI Tinkery provides hands-on professional learning experiences where educators can explore, build and test AI-enabled tools while grounding their work in the science of learning. It empowers them to become informed designers and critical users of AI in education. Research increasingly suggests that one of AI's contributions to education may come by augmenting teachers' expertise.[192]

Equally important is cultivating the next generation of innovators. Through the Education Entrepreneurship Hub, the Accelerator supports students and early-stage founders in transforming research into scalable digital learning innovations that respond to real educational needs, driving democratization in tool building.

These investments build more than individual expertise; they cultivate ecosystems in which educators, researchers, entrepreneurs, technology developers, policymakers and learners learn from one another. Human relationships, interdisciplinary collaboration and shared evidence become the infrastructure that enables digital learning to evolve responsibly over time.

Overall, sustainable digital transformation depends both on new technologies and developing the people, partnerships and institutions capable of ensuring that digital learning remains grounded in research, responsive to educators and learners, and improved through evidence and practice.

Towards circular digital learning systems

These four pathways illustrate a shift from digital as usual, where technologies are developed, deployed and periodically updated, to digital learning systems that learn and improve. Research, technology, implementation and capacity-building become part of a continuous cycle of evidence generation, adaptation and innovation.

Discoveries in the learning sciences generate new knowledge about how people learn. That knowledge informs the design of digital tools, AI-enabled learning experiences and educational policies. As these innovations are implemented in classrooms and communities, they generate new evidence about what works, for whom and under what conditions. Those insights, in turn, inform the next generation of research, technologies and professional learning. In this model, implementation is not the end of innovation; it is the beginning of the next cycle of learning.

This represents an important shift in how educational systems think about digital transformation.[193] Too often, scaling is understood as replicating successful technologies across larger populations. Yet effective digital learning must regularly adapt to learners' needs, educators' expertise, local contexts, emerging evidence and the rapid evolution of AI itself.

Circular digital learning systems embrace this reality.[194] They create continuous feedback loops that connect researchers, educators, learners, technology developers, policymakers and communities. AI can accelerate this cycle by enabling faster synthesis of evidence, more responsive personalization and richer implementation data, while the learning sciences ensure that technological innovation remains grounded in how people actually learn and develop.

The goals are both to spread digital innovations and to build learning systems that improve themselves, where research informs technology, technology strengthens teaching and learning, implementation generates new knowledge, and every cycle brings digital learning closer to being more effective, equitable and human-centred. This is what it means to move beyond digital as usual.

Lessons for building digital learning beyond digital as usual

The Stanford Accelerator for Learning shows one way to build this kind of translational infrastructure.
Five lessons emerge:

- **Invest in translational infrastructure.** Scientific discoveries create value when institutions and platforms exist to translate learning science into digital learning experiences, practical guidance and policy.
- **Build interdisciplinary ecosystems from the outset.** The ROAR is a case in point: it took expertise in education, neuroscience and medicine, not any one field alone, to turn reading science into a usable assessment.
- **Co-design digital learning with educators and learners.** Teachers, students, families and communities are essential partners in shaping digital tools and AI applications that are relevant, trusted and responsive to local contexts.[195]
- **Invest in human capacity as much as digital capacity.** Successful digital transformation depends both on robust technologies and on educators, leaders, researchers, entrepreneurs and policymakers who can critically evaluate, adapt and improve research-informed digital learning.[196]

- **Build digital learning systems that continuously learn.** The most effective digital ecosystems generate evidence through implementation, use AI and data responsibly to inform improvement, and create feedback loops that connect research, practice and innovation. They enable continuous adaptation as technologies, evidence and learner needs evolve.

These principles extend beyond any single institution. They offer a framework for universities, governments, philanthropies, industry and international organizations seeking to build digital learning ecosystems that are grounded in the learning sciences, informed by research and designed to evolve alongside advances in AI. The Accelerator's model assumes resources, including in-house AI, design and neuroscience expertise, that most ministries of education and lower-resourced school systems do not have. These same functions can still be built at a smaller scale, through a research–practice–partnership unit, a regional intermediary organization or an existing government implementation research body.[197] What a system needs is some structure that connects evidence to practice and feeds implementation back into further discovery, sized to what that system can actually sustain. Moving beyond digital as usual means moving beyond technology adoption towards systems that translate evidence into better learning for every learner.

Conclusion

This piece began with a paradox: we know more than ever about how people learn, yet outcomes have not improved. AI does not close that gap on its own. Technology alone will not transform education. The real opportunity lies in creating digital learning ecosystems that are grounded in evidence, designed around how people learn, and improved through research, implementation and responsible innovation.

The Stanford Accelerator for Learning is a single institutional example. The principles behind it are transferable across countries and education systems seeking to move beyond digital as usual. Its four interconnected pathways – funding discoveries, mobilizing knowledge, building solutions and developing talent – illustrate how learning science, digital innovation, implementation and human capacity can reinforce one another in a continuous cycle of improvement. Research, technology and practice as separate endeavours become part of a shared system for advancing learning.

These examples are also still at an early stage. Most of the evidence so far documents teacher practice, tool adoption or reach, rather than long-term causal effects on student learning, and the four pathways described here have so far operated within a single, well-resourced research university rather than as an integrated system tested elsewhere. Whether this approach improves student outcomes at scale, and does so outside a context with Stanford's resources, remains an open empirical question.

No single institution or country has discovered the definitive model for the future of digital learning. Every context will require its own partnerships, priorities, technologies and pathways. Schools and systems need adaptive learning ecosystems that connect discovery with practice, evidence with innovation, technology with human development, and local implementation with global learning.

In the age of AI, the greatest opportunity is to build digital learning systems that learn – systems that evolve as rapidly as the science of learning, advances in AI and the needs of learners themselves. When research informs practice, practice generates new knowledge, and technology is intentionally shaped by evidence and human values, digital learning can move beyond delivering content to becoming a powerful engine for lifelong learning, equity and human flourishing.

Part 2

Educational impact

Technologies are neither good nor bad in themselves."

Child, Spain, 14–17 age group[198]

Evidence review

Context

This section explores the evidence on educational impact, a multifaceted pillar of the EdTech for Good Framework 2.0. Impact in education means several things at once.[199] The recent literature has separated two questions that used to blur together: whether children received a device, and whether children actually learned. Attention has moved decisively towards the latter.[200] While the EdTech for Good Framework 2.0 defines educational impact as encompassing system outcomes and pedagogical change, these topics are addressed in detail in other parts of the report.

The following analysis addresses the central question:

What evidence do we have about how digital technologies can have a meaningful impact on student learning and broader educational outcomes?

Key insights

- **Genuine impact on education is not easy to determine.** To understand true value, evaluations should not focus on output indicators such as platform engagement metrics, but should instead assess long-term and sustained changes in student learning.

- Assessing the impact of digital technology on education requires **paying attention to the detail of how an implementation takes place** at a specific time and place, not simply on the adoption of 'good practice'.

- **Digital education should improve instruction, not just distribute devices.** Deploying hardware without focusing on how learning takes place does not lead to impact on learning outcomes.

- **Cost-effectiveness analysis is central to understanding educational impact and should incorporate foundational infrastructure.** While low-tech, interactive models currently offer the clearest value for money, realistic return-on-investment calculations should consider the substantial funding required to establish universal access to basic electricity and connectivity.

- **Teachers, not automated tools, are the central enablers of learning.** Evidence consistently demonstrates that human interaction is the essential mechanism for converting digital access into educational achievement.

- Strategies for improving learner well-being can support better learning and other developmental outcomes for children. The mechanisms for how well-being-focused activities and interventions can best support children's learning are, however, not fully understood and will be an important focus for the education sector in the future.

What the evidence on education impact says to date

This section focuses on the products children and teachers use directly: content, activities, assessment tools and devices. It does not focus on broader components of digital education such as EMIS, learning management systems, online teacher professional development and attendance early-warning systems.[201] These broader components can have a significant impact on learning, but this usually happens indirectly.[202]

Recent EdTech research indicates that the extent to which a tool has the intended impact is determined both by its quality and by how it is adapted and adopted within a specific context. Both are significant, but often too much emphasis is placed on the tool and not enough on how it is used. This is a challenge across the education sector,[203] and is particularly pronounced in relation to EdTech because of its specific characteristics.[204]

The evidence synthesized below spans government and non-formal settings, and pre-primary through upper-secondary education, across sub-Saharan Africa, South and Southeast Asia, Latin America and crisis-affected systems. It draws on randomized controlled trials, quasi-experimental designs, meta-analyses and case studies.

- **Impact is produced by the interaction between tool and context:** The school, households and communities in which a tool is deployed shape what it achieves; therefore, the same tool can produce different results in different places.[205] A recent scoping review of 56 meta-analyses found that the effects of EdTech on learning vary according to children's age and development, the fit between the technology's design and the learning domain, and the pedagogical approach through which it is used.[206] Where systems have been deployed without adapting to context or resourcing implementation, average effects have been close to zero, and for some groups, including girls, negative effects have been observed.[207] Relatedly, the evidence suggests that buying tablets or computers without the structures to use them effectively does not improve learning cost-effectively.[208]
- **Learning gains achieved through digital tools are dependent on targeted, differentiated teacher instruction:** Angrist et al. (2026) report five randomized controlled trials in India, Kenya, Nepal, the Philippines and Uganda, testing mobile phone interventions in primary numeracy while schooling was disrupted by COVID-19. All participating children received weekly SMS numeracy problems. A second group also received 20-minute phone tutorials, in which a tutor assessed the child's level through short, frequent checks and taught at that level rather than to the grade curriculum. SMS alone produced mixed results across the five countries, whereas SMS with targeted tutorials produced pooled gains of 0.30–0.35 standard deviations (SD) at 3.9 learning-adjusted years of schooling per US$100.[209] A comparable telephone-based programme in Sierra Leone that delivered untargeted lessons produced no gains.[210] What separated the programmes that worked from those that did not was whether someone assessed each child and taught to that level.
- **Learning gains depend on the teacher's role in instruction:** Teaching quality is the most significant school-based determinant of student learning.[211] Whether a digital tool is designed to support teachers or replace them shapes whether access translates into learning. Tools intended as a substitute for the teacher tend to erode professional judgement and narrow instruction towards outcomes that are readily

assessed automatically, at the expense of problem-solving and critical thinking. Where interventions have produced sustained gains, a teacher has remained responsible for the full instructional cycle: setting tasks, giving instruction, assessing learners, interpreting the results and deciding what follows. Current evidence suggests that this is the mechanism through which digital tools are most likely to lead to learning.[212]

- **Tech-enabled psychosocial well-being support and social and emotional learning can improve access, engagement and learning outcomes, particularly in crisis-affected contexts:** This potential is greater still when digital content embeds local languages and socialization norms, is paired with supportive teacher presence and caregiver involvement, is co-designed with the communities it serves, and training is provided for the adults who mediate.[213] Ahlan Simsim offers a promising example. Its Remote Early Learning Programme, built using participatory, community-based approaches, supported caregivers to deliver an 11-week pre-primary curriculum in Lebanon through WhatsApp coaching, interactive digital tools and physical learning kits. A randomized controlled trial with hard-to-access 5–6-year-old Syrian refugee children found significant effects on all six outcomes measured, including emerging literacy, numeracy and social-emotional skills, at costs comparable to other LMIC pre-primary programmes.[214] Findings such as these remain the exception rather than the norm, however, and the wider evidence base is limited *(see 'Evidence gaps relating to educational impact' below)*.

- **Spending decisions on digital technology are often taken without evidence of impact, and crisis widens the gap:** This is a pattern documented in LMICs.[215] School closures during the COVID-19 pandemic pushed education systems towards technology-first responses at speed, with decisions taken before evidence on impact was available.[216] The programmes that followed were often characterized by weak teacher training, technology that did not fit the classrooms they were designed for, and low engagement.[217]

- **Headline effect sizes can mislead as much as they inform:** A single pooled figure averages across outcomes that are not comparable and contexts that are not alike. For example, a meta-analysis of ICT in early and primary education reports an overall effect size of 0.45 SD, but that headline is composed of subject knowledge at 0.59 SD, language at 0.24 SD, and social and emotional development at 0.18 SD.[218] A ministry procuring against the headline may be expecting an effect the evidence does not support for the outcome it actually wants to prioritize. Moreover, where studies lump insights together, contrasting realities between girls and boys, rural and urban classrooms, or higher- and lower-performing learners may be masked. Insights into teacher mediation, gender, performance distribution, geography and socioeconomic status would inform implementation decisions, yet they rarely travel with the headline numbers into policy summaries and procurement documents.[219]

- **Measurement of usage has advanced faster than measurement of cost or mechanism:** Monitoring, evaluation and learning practice is moving away from self-reporting towards increased use of platform telemetry, matching back-end signals such as login rates and time on task against local test performance.[220] Telemetry captures what happens inside the product, while much of what determines impact – teacher mediation, targeting accuracy, the conditions of access – is visible only through observation and implementer reporting; therefore, effective monitoring, evaluation and learning often depend on an appropriate combination of the two.

- **Most impact evaluations report no cost data at all,** and those that do tend to record the single largest line item, understating true cost and overstating true cost-effectiveness.[221] Major LMIC syntheses have omitted costs,[222] and when reporting exists, it is non-standardized.[223]
- **Tools must be evaluated in light of their implementation context, not in isolation:** Implementation encompasses the protocols and processes governing use, the capabilities and practices of the teachers applying them, and the infrastructure the system depends on.[224] Changing these, even where the tool and the setting stay the same, changes the intervention. A tool evaluated with trained, supported teachers is not the same intervention as the tool rolled out without them. The same logic explains why tools developed in high-income systems frequently produce no gains when transferred to LMIC classrooms without pedagogical scaffolding, and may reinforce educational inequality.[225] For procurement, the relevant question is therefore not whether a tool has an evidence base, but whether the conditions under which that evidence was generated can be reproduced.

Evidence gaps relating to educational impact

The evidence base on educational impact has grown quickly, but it remains uneven in ways that matter for decision-making. The gaps below explore how much evidence exists, and how that evidence can actually inform someone deciding where to invest.

Measurement of implementation is a major gap. An EdTech intervention encompasses considerably more than the tool at its centre: integrating one into a learning setting requires change to teacher training, lesson planning and protocols for device management, among others. Yet a review of randomized controlled trials in education found that just 12 per cent included any measurement of how the programme was actually implemented.[226] Evaluations rarely examine the pedagogy a tool embeds or the teaching practices built around it; therefore, programmes can be shown to work without establishing which of the design choices was effective. This particular dimension is addressed in Part 5 of this report. The field needs to move from testing whether a tool works to testing under what conditions and through what mechanisms it works at scale. Where programmes have matured enough to support experimental evaluation, that evaluation should be paired with investigation of their implementation so that a result comes with an explanation of why it occurred. Practice is beginning to move in this direction, supported by emerging guidance such as Building Evidence in Education's Implementation Research Guidance Note[227] and the What Works Hub for Global Education's Implementation Measurement Insight Note.[228]

Measurement validity is a second gap. Much measurement happens at the programme level, using ad hoc content tests that limit comparability and reward optimizing for what is easy to measure.[229] What is lacking is measurement of learning outcomes against established benchmarks. Programmes often measure what happens inside an EdTech tool such as quiz scores, module completion and progress against their own content. Yet these measurements cannot show how that learning compares with children outside the programme, or with any established benchmark. That requires an assessment administered independently of the programme, against standardized instruments.[230]

The evidence base remains geographically skewed. Africa and the Middle East are under-represented. Research concentrates on high-income developed countries and STEM. Where it exists, evidence from LMICs in the Global South disproportionately reflects flagship donor-funded implementations rather than typical government-run systems.[231]

Iterative, multi-stage measurement is not yet routinely conducted. Failures are often only seen at scale, by which point resources are already spent, and multi-year randomized controlled trials are too slow to inform live decisions.[232] Apart from testing the overall impact of a programme, there is a need to answer programmatic questions as they arise. Rapid iterative models are gaining ground,[233] but are not yet routine. These help programmes develop and refine as they progress.

Measurement does not often include non-academic outcomes. Research remains concentrated on academic outcomes, with much weaker evidence on non-academic dimensions of children's learning and development, including safety and well-being, and on differential effects by disability, gender, socioeconomic background and other forms of marginalization.[234]

Individual programmes have produced strong results, but what is known about tech-enabled psychosocial well-being support and social and emotional learning relates more to reach than impact. Technology shows clear potential to expand access to psychosocial support, but most interventions lack rigorous evaluation or long-term outcome tracking.[235] The research that does exist is concentrated in high-income education systems rather than the humanitarian and low-income settings where the need is greatest,[236] and reviewers of that literature report weak study quality, heavy reliance on descriptive accounts of interventions that were never evaluated, and limited data on younger children and children with disabilities.[237] Gender appears mainly as a barrier to access rather than as a dimension along which outcomes differ. Comparison is difficult even where studies exist, because social and emotional learning is defined differently from one programme to the next, and frameworks are often imported from high-income contexts without being rethought for the settings they are used in, with the communities served largely absent from design.[238]

Evaluation of AI-enabled interventions is still limited, and what exists requires careful reading. A World Bank evaluation of an after-school generative AI programme in Edo State, Nigeria, reported substantial average gains despite internet disruptions and power outages.[239] Yet the gains were unevenly distributed, positively affecting students with higher prior attainment and from higher-income households more than those meeting a computer for the first time. This pattern was repeated in a trial of an AI tutoring tool in Sierra Leone.[240] Evaluations that report only average effects will not show this.

AI evaluation frameworks lag behind deployment. AI-enabled tools are entering classrooms faster than the methods of assessing them are being established,[241] which limits both what individual evaluations can establish and how far findings can be compared across them.

Promising approaches for evaluating educational impact

Several developments respond directly to the gaps set out above, changing what implementers and funders are able to see and when they are able to see it. How impact is measured determines what can credibly be claimed about it.

Evaluation is being increasingly embedded in delivery rather than solely conducted at baseline and end-line: Where digital education programmes allow experiments to be run and analysed quickly, evidence on programme components can feed back into design decisions while implementation is still under way. This type of research, such as iterative A/B testing, was once available only in high-income countries, but these approaches are now being used increasingly in LMICs. For example, a phone-based tutoring programme in Botswana ran 12 rapid randomized A/B tests to experiment with reducing costs and enhancing effectiveness across successive rounds.[242] Each round tested a change against the version of the programme then running, with successful changes carried into the next round. Seven of the twelve modifications yielded efficiency improvements, a rate higher than is typical in the technology sector. Similar approaches are being used elsewhere, including A/B tests run within a national roll-out of a digital personalized learning application in Kenya (see the Kenya case study). A range of other A/B tests complemented this study, including the impacts of content repetition, session duration and involving teachers in content suggestion.[243] Testing embedded in delivery is what makes these findings visible during implementation rather than after it. Problem-Driven Iterative Adaptation applies the same logic to roll-out more broadly, structuring it as feedback loops across pilot and scale phases so that weak designs fail before reaching classrooms.[244]

Ministries are taking increasing ownership of evidence generation and use to inform decision-making: Monitoring and evaluation frameworks are increasingly written by ministries and maintained as living documents, rather than contracted out as end-line audits. Pakistan developed a blended-learning monitoring, evaluation and learning framework over a two-month iterative process with government, teachers and content providers.[245] The United Republic of Tanzania is applying design-based implementation research to refine a national teacher development reform, with observation and self-report data feeding back into each redesign cycle within the ministry's own reform process.[246] Where this has been done, evaluation becomes part of the infrastructure a programme runs on, which changes how governments and donors can hold provision accountable.

Frameworks are expanding and nuancing the concept of impact: Broader scoring frameworks are gaining ground. The EdTech for Good Framework 2.0 on which this report is structured is one example. Another is the Multiple EdTech Impact Index and its 5Es (efficacy, effectiveness, ethics, equity, environment) being tested through the global EduEvidence repository,[247] with the explicit aim of pushing certification beyond efficacy alone and writing equity and ethics into the criteria. This direction of travel is consistent with wider efforts over the past decade to broaden what is considered in the design and delivery of digital tools, such as the Principles for Digital Development, which set expectations around user-centred design, sustainability, data responsibility and reuse rather than effectiveness alone.

Digital assessment systems open new feedback loops: The OECD (2023) reports that many contexts have digitized system-level standardized evaluations.[248] Linking assessment results to longitudinal student identifiers provides policymakers, school leaders and teachers with granular information across learning pathways, opening the way for sustained system-level feedback loops.

> The question is no longer simply whether technology can improve education, but what works, for whom and under what conditions. We need to build evidence into implementation from the start, so education systems can learn, adapt and scale what works while ensuring no child is left behind."

Thomas Dreesen
Education Research Chief (OiC)
UNICEF Office of Strategy and Evidence – Innocenti

Think piece

What drives learning gains in digital education: The role of targeted instruction

Heather Leigh Kayton, Michelle Kaffenberger and Noam Angrist

At the What Works Hub, Heather Leigh Kayton is a Senior Education Specialist, Michelle Kaffenberger is Director of Evidence Translation, and Noam Angrist is Academic Director. Their think piece explores why targeting digital instruction to a child's actual learning level is a worthwhile investment. While investment in EdTech in LMICs has grown substantially, evidence of impact on learning outcomes remains modest and variable across programmes. Positioned at the outset of this chapter on educational impact, this piece presents the evidence base behind the claim that digital approaches are most effective when they support instruction targeted to children's learning levels.

Introduction

In many LMICs, the majority of children are still not acquiring foundational reading and mathematics skills.[249] Investment in EdTech in LMICs has grown considerably over the past two decades as part of the response to this challenge, yet evidence of the impact of this investment is highly variable across programmes, with many interventions yielding no impact on children's learning. A common pattern among effective approaches is that they target instruction to children's current learning levels.

Many EdTech approaches do not produce learning gains

Much investment in EdTech has focused on the provision of devices, such as laptops and tablets, to students – an approach that has been implemented and evaluated across multiple LMICs and contexts.[250] Device provision alone, however, has shown little to no effect on learning outcomes.[251] A recent comprehensive review of the EdTech evidence base in LMICs found that higher investment in digital education does not reliably produce stronger learning returns, with hardware-heavy programmes consistently among the most expensive and least effective approaches.[252]

Furthermore, technology-based approaches that deliver standardized content, such as content aligned to grade-level curriculum, rather than matching content to each child's demonstrated learning level, typically do not improve learning outcomes. In Sierra Leone, a randomized trial found that radio lessons following the grade-level curriculum paired with regular teacher phone calls produced no measurable learning gains.[253] A similar pattern was seen in Kenya, where weekly tutoring calls organized around grade-level content showed no effect on learning outcomes at end-line, and negative effects at follow-up.[254] In both cases, tutor contact was maintained throughout, but content was organized around grade level rather than each learner's demonstrated learning level.

EdTech that improves learning typically targets instruction to children's learning levels

A consistent pattern emerges among digital education programmes that have improved learning outcomes in LMICs: programmes that assess children's learning levels and deliver instruction at that level, rather than at the level of the grade-level curriculum, are the most likely to produce measurable gains. This pattern holds true across a wide range of delivery mechanisms, including phone-call tutorials, WhatsApp messaging groups and adaptive software. In each effective programme, instruction, content or pacing is aligned with the students' learning levels.

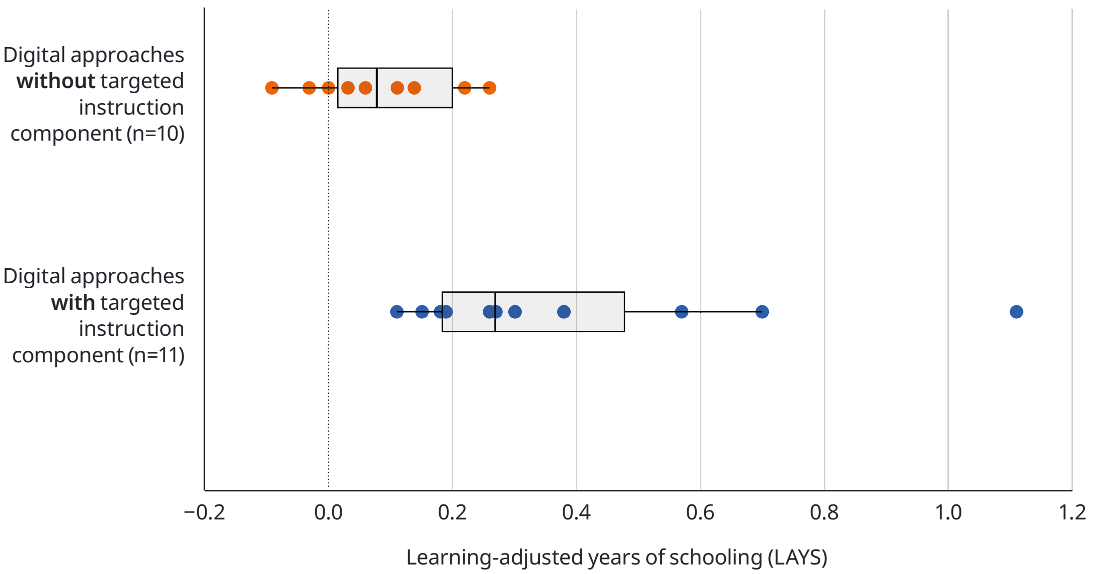
Evidence from a single study that held the delivery mechanism constant and varied only whether instruction was targeted illustrates this directly. A five-country trial sent weekly SMS messages containing multi-level mathematics problems to all participating students. One group of students in the study (known as a treatment arm) was provided with SMS content supplemented with weekly phone tutorials in which a tutor first assessed each child's current learning level, then worked through problems from that week's SMS at that level. The phone tutorials produced consistent learning gains across all five countries, while SMS-only delivery of the same content without the assessment and targeted tutorials showed mixed results.[255] This is consistent with the wider evidence base. A review of 30 studies of mobile phone-based education programmes found that light-touch texting alone was cheap but rarely enough to shift outcomes, while more interactive approaches layered onto proven interventions were the most effective in low-resource settings.[256]

Learning-adjusted years of schooling (LAYS) offer a useful way of illustrating what this difference means in practice. LAYS express programme effects in terms of how much learning an intervention produces relative to a year of high-quality schooling.[257] Across Kenya, Nepal, the Philippines and Uganda, SMS delivery alone produced an average of 0.10 LAYS. Adding a targeted instructor call, in which the tutor first assessed each child's learning level before working through the mathematics problems at that level, produced an average of 0.49 LAYS across the same countries – a difference equivalent to almost half a year of globally benchmarked quality learning. A subsequent study testing iterative modifications to the same intervention model found that incorporating caregivers into targeted calls more than doubled the impact at minimal additional cost, which suggests that once a targeting mechanism is in place, its returns can be further improved through additional support.[258]

Figure 4 applies the LAYS metric to a subset of 21 evaluated interventions from the publicly available LAYS database in which digital delivery was the primary mechanism. Interventions are grouped into two categories: those that incorporated a mechanism for targeting instruction to students' demonstrated level, and those that delivered digital content without specifically targeted adaptations.

The without-targeting group includes laptop provision, broadcast SMS messaging and computer-assisted learning delivering standardized grade-level content. The with-targeting group includes adaptive computer-assisted learning, remedial computer-assisted learning and phone tutoring with real-time adjustment to each child's learning level. Approaches without targeting produce an average return of 0.09 LAYS, with negative effects for some interventions. Approaches incorporating targeting produce an average return of 0.38 LAYS, and cluster more consistently above zero.

Figure 4. Comparison of 21 digital interventions, with and without a targeting component (LAYS)



Source: Angrist et al. (2025).[259]

Note: Boxes show median and interquartile range. Group means are 0.09 and 0.38, respectively.

One approach through which targeted instruction has been implemented effectively is personal adaptive learning software, which adjusts content to each learner's demonstrated learning level. A meta-analysis of 16 randomized controlled trials found that approaches that adjusted content difficulty, pace and objectives to learners' demonstrated level produced nearly three times the effects of those that matched content to learners' interests or provided feedback without adjusting to their learning level.[260] For personalized adaptive learning programmes, design and implementation matter more than the specific technology. A meta-analysis of 27 personalized and adaptive learning interventions found effects ranging from negative to strongly positive across studies, with programme design and implementation context explaining more of the difference than the type of technology used.[261]

The Mindspark adaptive learning platform in India provides a key example of an effective programme. In Delhi, students using software that continuously adjusted to their demonstrated learning level made greater gains in both mathematics and Hindi than those in the control group.[262] When the programme was subsequently implemented at scale across public schools in Rajasthan, these gains held across a larger and more representative sample.[263]

The learning gains resulting from the use of personal adaptive learning software appear greatest where the gap between grade-level content and children's learning levels is the widest. This pattern is consistent with what the curriculum mismatch literature would predict: where that gap is widest, the potential gains from closing that gap through targeted instruction are largest.[264] In a separate computer-adaptive programme in Rajasthan, individualized instruction produced no average effect on learning outcomes across Grades 6–8; however, the lowest-performing students showed meaningful gains relative to the control group.[265] Similarly, lower-performing students using individual adaptive tablet-based software in Sierra Leone showed substantially greater gains in reading and mathematics than their higher-performing peers.[266]

Realizing these gains at scale, however, required more than the software itself. In the Mindspark scale-up in Rajasthan as well as a trial of Khan Academy adaptive software in Uttar Pradesh, supporting implementation at scale required dedicated personnel (called 'lab-in-charges') to schedule sessions for students to use the adaptive platform, troubleshoot technical problems, monitor student progress and ensure consistent platform use.[267] In both cases, gains were consistent where these lab-in-charges were in place, and attenuated where that support was reduced or absent. These implementation conditions carry costs, particularly the personnel required to sustain them, that are not always visible in programme cost estimates but are central to whether returns are realized.

The principle of targeting instruction, however, does not necessarily require expensive devices, software or dedicated in-person support. Text-based approaches have been used to deliver targeted instruction effectively by leveraging low-cost mobile platforms such as WhatsApp. In Pakistan, a messaging-based intervention that organized students into WhatsApp groups by demonstrated skill level, with instructors reviewing submitted work and providing targeted feedback, produced substantial improvements in reading outcomes over three months.[268] Early evidence from an AI-assisted WhatsApp tutor in Ghana (called Rori), which assessed and then delivered level-matched mathematics practice according to Teaching at the Right Level principles, suggests that targeted AI-assisted delivery can also produce gains through low-tech messaging platforms.[269]

Beyond delivering targeted practice through existing platforms, AI may offer new mechanisms for diagnosing learning levels and adjusting instruction more precisely and responsively than earlier approaches allow. A wide-ranging review of EdTech evidence from LMICs argues that AI is best approached as an extension of computer-assisted learning, with potential to enhance the quality and responsiveness of practice, but risks reducing learning where pedagogical design is weak.[270]

Early evidence points to particular promise in AI-assisted assessment for foundational reading. In South Africa, an automated assessment system accurately evaluated children's letter and word recognition in isiXhosa, a language with limited digital resources.[271] In West Africa, speech recognition models assessed children's oral reading fluency with accuracy approaching that of human assessors, including in contexts where children's speech patterns and regional accents had previously posed challenges for automated tools.[272] In Ghana, GPT-4 graded open-response reading comprehension questions from students aged 9–18 with similarly high accuracy.[273] While this emerging evidence on AI-assisted assessment is promising, the extent to which accurate assessment of learning levels translates into improved learning outcomes depends on whether teachers are able to effectively use those results to adjust instruction to each learner's learning level.

EdTech is more effective when teachers are involved in how it reaches learners

EdTech can support teachers in aligning instruction to children's learning levels. Across a range of interventions, technologies that support teachers to do this have shown positive results, while those designed to reach children directly have not always been effective.

A pair of randomized trials in Pakistan demonstrates this finding. The studies tested the same video content through two different delivery mechanisms. When teachers used the videos as part of their classroom lessons, secondary students' mathematics and science scores improved substantially; when the same videos were given directly to students to use on personal tablets, without teacher involvement, there were negative effects on learning.[274] The evidence suggests that digital programmes are most effective when they support teachers – not when they operate independently of teachers.

Similar principles have been found to apply to additional technology-based approaches. Interactive Radio Instruction, which delivered interactive learning content to children with activities that teachers led in the classroom, improved learning across a range of contexts, subjects and grades, with the clearest gains in foundational reading and mathematics.[275]

Early evidence on AI-assisted instruction indicates it is also more effective when it involves teachers in the set-up and facilitation of instruction, though evidence on AI use is still limited. An AI-assisted after-school programme with secondary school students in Nigeria where teachers selected and adjusted prompts, reviewed student work and kept students on task throughout produced meaningful gains in English.[276] In Sierra Leone, a randomized trial in which teachers integrated Gemini's Guided Learning feature into structured secondary mathematics lessons, prepared the prompts and led the discussion produced promising learning gains.[277] It is not yet clear whether similar results would hold in primary schools or programmes focused on foundational skills.

Emerging tools designed explicitly around teacher involvement, supporting teachers to diagnose learning levels, regroup students and adjust instruction accordingly, reinforce the importance of keeping teachers central to how digital instruction reaches learners.[278] The involvement of a teacher, however, is not sufficient on its own for EdTech to be effective.

A trial in India encouraged secondary teachers to blend video-based grade-level curriculum content into their lessons. Despite training and ongoing support for the intervention, there was a negative effect on student learning, which the study attributes to the costs of adjusting to an unfamiliar way of teaching.[279] Integrating digital tools well is itself a demand on teachers, and realizing their benefits depends on how teachers are prepared and supported to integrate them into their practice. That support can itself be delivered digitally as a means to manage costs, but the evidence suggests that the effectiveness of digital training or support for teachers depends on what teachers are being asked to learn, and over what period.[280]

Conclusion

The principle of targeted instruction underlying effective EdTech is not new. Teaching at the Right Level – the approach of grouping children by demonstrated skill level and delivering instruction accordingly, rather than following the grade-level curriculum – has produced consistent gains in non-digital contexts across LMICs.[281] The evidence reviewed here suggests that EdTech produces its strongest returns when it supports the adaptation of instruction to children's demonstrated learning levels. The digital education programmes that have done this most effectively are those that have placed targeted instruction at the centre of their design.

Think piece

Why cost-effectiveness matters

Joel Mitchell

Joel Mitchell is a Research Advisor at EdTech Hub. This think piece examines Why cost-effectiveness matters in EdTech, and why existing evidence often falls short of what decision makers need. It is included here as a key component of educational impact, highlighting the methodological complexity of measuring cost-effectiveness and showing why clearer standards for comparing costs and outcomes are essential for evidence-based decision-making.

Introduction

Evidence-based decision-making is critical to ensure that money is not wasted on ineffective technology in education. We know that EdTech can be effective, but what is the cost of the digital transformation of education, and how can we ensure that EdTech interventions deliver sufficient learning outcomes to justify their expense?

Across LMICs there is widespread integration of plans for EdTech and digital transformation into educational strategies, curricula and more. Yet the evidence for what is most cost-effective has not kept pace with the demand for new technology. The focus on unit costs of technological devices obscures the fuller cost of training, implementation and support. Even when EdTech programming accounts for the total cost of ownership and ongoing commitments to software licensing and maintenance, links between costs and outcomes are not standardized. This means that decision makers rarely have access to the reliable, transparent, consistent cost calculations that would equip them to compare the likely cost-effectiveness of different interventions.

Cost-effectiveness standards

Recent work across EdTech Hub's portfolio has highlighted the methodological complexity of evaluating cost-effectiveness across diverse digital education interventions, whether student-centred, teacher-centred or system-centred. At all three levels, technology providers, education implementers and those evaluating them lack a common vocabulary and shared standards for articulating what educational outcomes should be expected from different types of investment into education. The cost-effectiveness work of EdTech Hub has been focused on building an evidence base that can establish such standards to inform evidence-based decision-making about EdTech.

Current cost-effectiveness landscape

To provide a foundation for understanding cost-effectiveness in EdTech, EdTech Hub conducted a landscape review of approaches used across the sector. This work resulted in a review of key methodological approaches used in the field,[282] and an analysis of good practices and guiding principles for conducting cost-effectiveness research.[283] Table 1 outlines the ways that cost and effectiveness are measured by some of the leading stakeholders within the education sector. These approaches demonstrate the priorities valued by different stakeholders, and the reporting requirements that drive decisions around how and when cost-effectiveness data are collected, analysed and used.

Together, these outputs[284] highlighted several persistent challenges to understanding costs and cost-effectiveness within digital education. A key learning is that when projections based on budgeted costs are prioritized for planning purposes, actual programme costs are under-reported and rarely reconciled with budgeted expenditure. This approach fails to account for externalities such as infrastructure costs, which are incorporated inconsistently across studies. In addition, many studies[285] articulate costs ambiguously, particularly in distinguishing between fixed and recurrent expenditures.

Table 1. How cost and effectiveness are measured by some of the leading stakeholders within the education sector

Cost-effectiveness analysis approach	When are costs captured? (budgeted ex ante vs. paid ex post)	How are costs captured? (disaggregated vs. holistic)	What learning outcomes are prioritized? (contextual vs. standardized)
World Bank LAYS approach[286]	Paid (in SIEF stream, both)	Disaggregated	Standardized
BE^2 CE approach[287]	Budgeted	Holistic	Contextualized
USAID CE guidance	Paid	Disaggregated	Contextualized
GEC VfM guidance[288]	Budgeted	Holistic	Standardized
OPM VfM guidance[289]	Budgeted	Holistic	Contextualized

Source: EdTech Hub.

Structural incentives to under-report costs

A particular challenge in gathering reliable data is that implementation costs are regularly under-reported because of differing reporting priorities between vendors, funders and implementers. While this is a challenge across the education sector, it is particularly complex in relation to digital education for three main reasons. First, pricing structures and models from technology vendors aim to tie in governments and schools to proprietary systems which have longer-term cost and maintenance implications. Second, purchasers and end users are incentivized differently, as governments and donors make decisions about hardware, software and infrastructure. On the other hand, end users such as students and teachers are minimally consulted on the utility and quality of the products, which they then may not be able to return or repair. The priorities of those implementing and maintaining an EdTech intervention lie in ensuring that as much cost can be recovered as possible, both in expense and in time. When interventions or systems do not align with their priorities for use, they can cause frustration and wasted time.

Third, implementation costs rarely properly account for externalities and existing personnel costs, especially as they relate to scale. The initial investment needed to implement a project, especially in pilot stages, is usually much lower than the full cost, and sensitivities around financing and cash flow can incentivize pricing models that mask long-term costs.

An example: Cost-effectiveness of low-cost nudge messaging

Low-cost nudge messaging has often been cited as one of the most scalable and cost-effective EdTech interventions. Yet this promise clashes with the nuanced reality uncovered by 10 studies across West Africa, compared by EdTech Hub in a recent publication,[290] demonstrating that an intervention that is merely 'low cost' is not inherently 'cost-effective' if it fails to deliver measurable learning outcomes.[291] This case study demonstrates the value of interrogating the headline findings on cost-effectiveness to understand the underlying data and contextualize findings.

A review of 10 interventions in countries such as Côte d'Ivoire, Ghana and Sierra Leone found that 6 resulted in negative, null or insufficient effects on student learning. Messaging faced severe contextual hurdles, including pervasive low caregiver literacy, and financial pressures on families where short-term necessities often trump long-term educational goals. In Côte d'Ivoire, efforts to nudge both teachers and caregivers simultaneously backfired, leading to decreased teacher motivation and attendance as external monitoring increased.[292] Moreover, the benefits proved inequitable: one study in Ghana noted that SMS nudges only supported engagement among caregivers who already had exposure to formal schooling, and sometimes had negative effects on those who did not.[293]

This evidence points to a critical ceiling for standalone messaging:

structural barriers such as child labour, lack of infrastructure and low device access are too profound to be altered by simple informational campaigns. Success only emerged when messaging was integrated into a comprehensive programme, acting as a small component to reinforce broader, more costly investments.

Isolating the cost-effectiveness of a cheap messaging component, while ignoring the high sunk costs of the entire supporting programme, can drastically overstate its true impact. Ultimately, cost-effective EdTech must recognize the need for contextualized, integrated solutions, not just low-cost delivery methods. Going more deeply into these examples with regard to messaging in West Africa unveils a more nuanced understanding than the headlines on cost-effectiveness have afforded.

Principles for good practices in cost-effectiveness analysis

EdTech Hub's analysis of approaches to measuring cost-effectiveness across the sector[294] identified nine areas in which practices could be improved, focusing on increasing comparability, replicability and sustainability:

Increased comparability between interventions: Cost-effectiveness is about measuring and analysing data that are comparable.

- Define learning and cost data carefully so that a meaningful dialogue can take place on the basis of agreed definitions.
- Ensure that cost-effectiveness intersects with equity, rather than treating equity-driven interventions as exceptional and outside the requirements for cost-effectiveness analysis.
- Contextualize points of comparison by explicitly stating when, where and how an intervention was carried out.

Replicability of learning interventions: EdTech costs and outcomes must be expressed in replicable terms to be useful for decision-making across contexts.

- Account for uncertainties robustly by representing cost-effectiveness values in relative terms, rather than presenting a false sense of precision.
- Conduct short- and long-term analysis so that pilots and short-term interventions are not assumed to be scalable and replicable beyond the scope of their implementation.
- Represent data in relative terms that ensure the location and time period are clear and not taken out of context.

Sustainability of costs and impacts: Cost-effectiveness analysis must consider the broader impacts of EdTech, and ensure they can be sustained financially, socially and environmentally.

- Consider the full life cycle of a programme, from conceptualization, planning, software design and implementation to shutdown and responsible disposal of devices.
- Incentivize transparent reporting by ensuring accountability, so that market incentives of minimizing costs do not override realities of support and maintenance for implementation.
- Ensure intervention cost is proportional and can be justified relative to national education budgets and cost of living.

Recommendations for future directions

Momentum within the sector indicates an encouraging trajectory towards increased alignment with the type of good practices reflected in the nine principles above. However, ongoing work is needed for rigorous and transparent reporting practices to benefit the broader sector (including education, and not just EdTech) by facilitating common language and data when talking about programmes implemented or funded differently.

Increased good practices in rigorous cost capture and consistent measurement of learning outcomes through LAYS are already seeing adoption within the sector, primarily for assessing completed projects. Building on these practices and the nine principles identified in the literature, EdTech Hub identifies five priorities for expanding the use of cost-effectiveness analysis across planning, procurement and accountability for programmes in the future:

1 **Capture all data relevant to costs, including externalities,** to articulate cost-effectiveness in categories (e.g., 'marginal cost above business-as-usual' or 'post-pilot cost at regional scale') that allow comparison across contexts and interventions. This builds on emergent good practices of cost capture by enabling clearer understanding of relative and marginal costs.

2 **Develop a benchmark of minimum standards for evidence-based EdTech decision-making,** giving stakeholders a reference point for what they can reasonably expect in terms of learning outcomes, at what cost per child, for different forms of EdTech. This benchmark should draw on the fuller cost data captured in the first recommendation.

3 **Strengthen the assessment and research base that cost-effectiveness analysis depends on.** This means adjusting outcome measurements to incorporate greater nuance based on learner trajectories and national curricular aims, so that they remain relevant to local, national and international stakeholders and assess learners against what they are actually being taught; and embedding cost-effectiveness research within longitudinal EdTech research studies to continue building a critical mass of practical, comparable data.

4 **Ground cost-effectiveness analysis in localized factors and the full engagement of local stakeholders.** This should be supported by practical tools for decision makers, such as templates mapping expected costs to desired outcomes, with benchmarks, features and cost categories aligned – to enable better targeted planning, procurement and future accountability.

5 **Require accountability for EdTech suppliers** to meet targets for both provision and outcomes for a given cost, so that agreed standards for cost-effectiveness are the starting point for accountability and implementation fidelity. This allows donors and governments to hold vendors to account, not only for delivering devices but for delivering results.

Case study

Kenya: What implementation research at scale revealed about digital personalised learning

This case study examines how learning gains were measured as digital personalized learning (DPL) scaled across Kenyan pre-primary classrooms through an expansion driven by county governments. The case offers a meaningful lesson on measuring impact during implementation, and how research can inform decisions about digital learning at scale. It was developed through a review of published journal articles, evidence briefs and blogs from a partnership between EdTech Hub, EIDU and Women Educational Researchers of Kenya.

Context

Kenya has invested in digital education for over two decades. Since the Digital Literacy Programme in 2015, successive administrations have continued to build and strengthen the policy architecture, including the ICT in Education and Training Policy 2021[295] and the National Digital Master Plan 2022–2032. This architecture anchors digital integration across the sector. The Competency Based Curriculum sets what digital content must align to, and the Kenya Institute of Curriculum Development approves what enters classrooms.[296]

One digital learning programme has scaled rapidly through this system.

EIDU delivers digital personalized learning (DPL) through an application on low-cost Android smartphones. Learners work through curriculum-aligned numeracy and literacy content, which the software sequences for each child. Teachers use digitized structured pedagogy lesson plans and a dashboard that shows how much each learner has used the tool and how far they have progressed. Classrooms share one or two devices, and teachers decide when learners use them during the school day.

EIDU first moved from low-cost private schools in Nairobi into government pre-primary classrooms through a partnership with Mombasa County in 2021. By 2022, 46 of Kenya's 47 county governments had signed agreements to roll the programme out to their government pre-primary schools, with the counties themselves contributing funding.[297] Today, EIDU partners with 32 county governments across Kenya, supporting 790,000 children and their teachers.[298]

In the EIDU model, learners use the software inside a curriculum-aligned lesson, sharing a device and working under their teacher's direction. However, most existing evidence describes a different situation. Research on DPL comes largely from high-income countries. In low- and middle-income countries, studies have mostly looked at DPL used outside regular lessons, for example in after-school sessions or dedicated technology slots. UNICEF conducted a global review of 40 personalized learning tools and found that 35 were used this way.[299] This limits what the evidence can tell governments and implementers. A tool trialled in an after-school session and the same tool used within a teacher-led lesson are, in practice, two different interventions. Results from one do not necessarily transfer to the other. The expansion of the EIDU application to numerous county governments therefore created an opportunity to build understanding of how to integrate DPL in government school settings, and a research partnership between EdTech Hub, EIDU and Women Educational Researchers of Kenya formed as that expansion began.

Spotlight on practice: Building evidence while the programme grew

The study investigated the effectiveness of classroom-integrated DPL in Kenya. A cluster-randomized controlled trial in Murang'a County followed 1,955 pre-primary 1 and 2 learners aged 4–6 across 291 government pre-primary schools over four school terms (October 2022 to October 2023). In treatment schools, teachers led numeracy and literacy lessons using the digitized lesson plans and oversaw the distribution of the shared devices between learners, implemented in partnership with the local governent authorities; the trial therefore tested software and teaching working together rather than software alone. Control schools continued teaching as usual without the tool and received it once the trial ended. Learning was measured using the International Development and Early Learning Assessment (IDELA), a tool developed by Save the Children, validated for children aged 3–6 years and piloted across 11 countries.[300] The study used IDELA's emergent numeracy and literacy items. The motor development and social-emotional development components were not included, which limits comparison with other studies using the full instrument.

Learners in treatment schools gained 0.450 SD in numeracy and 0.449 SD in literacy, with an overall effect of 0.534 SD (all $p < 0.001$). The effect was significant on 11 of the 14 assessment items, covering number identification, one-to-one correspondence, addition and subtraction, letter names, letter sounds and oral comprehension.

The three exceptions were two early sorting and comparison tasks and emergent writing where no significant difference was observed. Subgroup analysis found no significant differences in how the programme affected higher and lower achieving learners, small and large classes, or girls and boys. Girls gained 0.526 SD overall and boys 0.543 SD, with near-identical gains in literacy (0.450 SD and 0.480 SD respectively, and a slightly wider margin in numeracy, 0.429 SD against 0.471 SD).[301]

The trial also identified where the gains slowed. Numeracy improved by 0.445 SD in the first half of the study and by 0.011 SD in the second. Usage of the tool was consistent throughout, but learners solved fewer new content units per hour in the second half. This may suggest that learners had worked through most of the material suited to them in the first half, as with only 214 learning units available for pre-primary 2, the personalization algorithm had a limited pool to select from. The researchers point to the quantity and type of content, and the question of how long a DPL programme should run before returns diminish, as priorities for further investigation.[302] They also note an established phenomenon, that some of the early gain may reflect the novelty of a new tool.[303] Post study the pool of content on the platform has expanded to over 4,000 content units from mulitple content providers.

The software adapts, but teachers set the direction. The tool uses a Long Short-Term Memory (LSTM) neural network, a machine learning model that selects learning units for each individual learner, and is offline compatible.[304] The LSTM draws on each learner's attainment, progress and engagement within the app to select the activity most likely to keep them engaged, and personalizes the order of content. Teachers can choose the substrand the algorithm draws from, aligning it with the lesson they have just taught.
As user numbers grew, the partnership tested this design directly through A/B testing inside the live programme. One test compared personalization algorithms and found that formative learning outcomes across a range of literacy and numeracy substrands varied depending on the type of algorithm used, although no differentiated impact was observed in summative assessment scores.[305] Another A/B test found that digital learning scores were higher when teachers had the agency to override the system-recommended learning strand, indicating the potential of teacher–AI synergy in DPL design.[306]

Reflections and lessons learned

These findings point to four considerations for governments and partners investing in digital learning:

Validated assessment makes findings comparable. Measuring with an instrument already tested across contexts allows results to be set against other studies, and gives them credibility with ministries, funders and technical partners considering similar investments.

The depth, variation and quality of content influence how long a programme can be sustained. Gains slowed once learners had worked through most of the material suited to them. Governments assessing digital learning tools can ask how much curriculum-aligned content sits behind the algorithm, and how quickly a class is likely to move through it.

Teachers determine what the technology achieves. The software sequenced activities, but teachers led the lessons, chose the content area the algorithm drew from and decided when learners used the shared devices. Governments can assess whether a tool strengthens teaching or works around it.

Measuring frequently during implementation shows how gains change over time. Assessing three times across four terms showed a change that a start-and-end study would have missed. Research designed alongside implementation can return findings while decisions are still open. In this case, design-based research enabled adaptation during the trial.[307]

Part 3

Inclusive access

"I want a digital world without judgement, prejudice and inequality."

Child, Brazil, 14–17 age group[308]

Evidence review

Context

Drawing on recent global evidence, this section synthesizes findings across five intersecting themes reflected within the inclusive access pillar of UNICEF's EdTech for Good Framework 2.0: gender equality, disability inclusion and assistive technology, bias identification and mitigation, ethical deployment and governance, and adaptive design. Rather than treating these as discrete concerns, the analysis focuses on how they interact to shape systemic inclusion outcomes, particularly in LMICs. Throughout, four related terms are used distinctly: **EdTech** (digital tools and platforms used by all learners), **accessible digital content** (mainstream materials that learners with disabilities can use), which is achieved through **accessibility features** such as audio narration, captions or image descriptions, and **assistive technology** (the products and devices an individual learner uses to function and participate, such as screen readers or hearing aids).[309]

The following analysis addresses the central question:

What evidence do we have about how digital and AI-enabled tools and services can be used to support equitable access to and participation in education for diverse learners?

Key insights

- **Accessibility is shaped not only by digital content and devices, but by wider systems and enabling conditions.** It is achieved when these conditions align: affordable connectivity and reliable electricity; inclusive policies, regulation and financing that embed accessibility, prevent discrimination and provide reasonable accommodations and individualized support; open standards and procurement approaches that avoid vendor lock-in; data systems that capture learners with disabilities; and efforts to address stigma and discrimination. Teachers, schools, publishers and governments also need the capacity, support, incentives and accountability to use, maintain and continuously improve accessible resources at scale.

- **Barriers to accessing and safely using digital and AI-enabled technologies can be compounded by exclusionary, biased design and gender dynamics in schools and households.** Girls' use of digital tools can be restricted by male gatekeeping and domestic workloads, while learners with disabilities face a severe shortage of assistive technology and platforms lacking basic accessibility features. Data also point to lower access to mobile devices among girls and adolescents with disabilities, compounding these barriers.[310, 311] Moreover, adolescent girls and children with disabilities face threats of technology-facilitated and gender-based violence and exploitation that schools and education systems need to specifically address.[312]

- **Meaningful participation of persons with disabilities is essential for inclusive digital education.** Learners with disabilities, teachers with disabilities and organizations of persons with disabilities (OPDs) should help shape the design, implementation and evaluation of interventions, ensuring their experiences inform the evidence, case studies and recommendations.

- **In contexts where constant connectivity is not assured, low-tech and offline-first designs are the most accessible inclusion pathways.** In such contexts of intermittent or absent connectivity, tools built for constrained environments (e.g., SMS-based platforms, offline mobile apps and SD-card media) can drive greater participation and learning gains than high-end technologies that rely on constant connectivity.

- **Algorithmic bias and governance gaps are systemic issues that undermine inclusion and reinforce inequalities related to gender and vulnerability.** The large majority of educational AI systems lack basic bias-testing protocols and demonstrate performance disparities across demographics, leaving marginalized learners highly vulnerable to algorithmic stereotyping, surveillance and commercial exploitation.

- **Safely using technology to narrow inequality gaps requires educators to have opportunities to develop knowledge and practical skills** in accessibility, inclusive pedagogy, Universal Design for Learning and differentiated instruction. Teacher preparation and professional development should therefore incorporate accessibility and inclusive digital pedagogy and provide ongoing support for applying these approaches in practice.

What the evidence says to date

Marginalized groups, including out-of-school children, girls, learners with disabilities and those in crisis-affected contexts, remain systematically excluded from both access to and meaningful participation in digital education.[313] Inclusive access must therefore be understood not simply as equal distribution of technology, but as the ability of all learners to participate meaningfully, safely and equitably in digital learning systems.[314, 315] This reframing aligns with a rights-based perspective on education and with principles such as Universal Design for Learning, which emphasize designing systems that accommodate learner diversity from the outset rather than retrofitting accessibility.[316] Recent evidence increasingly conceptualizes inclusion as a socio-technical challenge, in which infrastructure, pedagogy, system design, market incentives and governance interact to determine who benefits from digital transformation and who is left behind.[317, 318]

The strongest finding across the evidence is that inclusive access is fragile and highly conditional. Globally, **approximately 1.3 billion school-aged children lack internet access at home**, and school connectivity remains uneven, particularly in rural and low-income settings.[319, 320] Even where devices are available, disruptions in electricity, affordability constraints or inaccessible digital content and platform design can prevent meaningful use.[321]

Affordability remains a major barrier to access and meaningful use. The cost of connecting all schools in LMICs would substantially increase existing education financing gaps, while household-level connectivity costs are often prohibitive. In some contexts, broadband access consumes a significant share of household income, effectively excluding low-income families from sustained digital participation.[322, 323] These constraints highlight the limits of device-centric approaches that fail to address underlying infrastructure and cost barriers.

The digital divide intersects with entrenched gender inequalities. About 280 million more men than women used the Internet worldwide in 2025.[324] In 2023, a UNICEF report estimated that 9 out of 10 adolescent girls and young women are offline in low-income countries.[325] Beyond access, girls may have fewer opportunities to build digital and AI skills and literacies, participate in technology-related fields or become leaders in these fields.[326]Evidence from multiple contexts shows that girls' access to digital tools is often mediated by male relatives and constrained by domestic responsibilities, limiting both autonomy and continuity of learning.[327] The shift to home-based learning during COVID-19 frequently exacerbated these inequalities, reinforcing gendered divisions of time and space.[328]

Learners with disabilities face even greater barriers. Globally, more than 2.5 billion people need at least one assistive product, yet nearly 1 billion lack access, with access in some low-income countries as low as 3 per cent.[329] Beyond gaps in assistive technology, these barriers translate into stark differences in educational participation and outcomes: in LMICs, children with disabilities are 49 per cent more likely to have never attended school; even when enrolled, they are 42 per cent less likely to acquire foundational skills than their peers without disabilities.[330] At the same time, many digital technologies and platforms are designed around the needs of users without disabilities, creating accessibility barriers that can reinforce broader forms of techno-ableism.[331] In education, inaccessible interfaces, inadequate audio and limited teacher capacity can further restrict participation and learning for learners with disabilities.[332]

These barriers are compounded when digital pedagogy is not designed for inclusion from the outset. Digital content, platforms and associated teaching practices can reproduce gender bias and stereotypes, while the absence of diverse and locally relevant examples, role models and multilingual support can make learning difficult to access and less relevant to learners from marginalized groups.[333] Similarly, without features such as subtitles, translations, audio alternatives and screen-reader compatibility, learners with disabilities and those learning in additional languages may be unable to participate fully.[334] The value of inclusive digital pedagogy also depends on teachers' capacity to use and adapt these resources in response to learner variability.[335] This capacity requires sustained professional development that combines digital competencies with inclusive pedagogical practice, including the use of Universal Design for Learning to differentiate instruction, identify bias in content and interaction, and offer multiple means of representation and engagement.[336]

Beyond access and design, systemic data and governance issues are emerging as critical determinants of inclusion. Many education systems lack interoperable data infrastructures, limiting their ability to identify and support vulnerable learners in real time.[337] At the same time, the rapid adoption of AI introduces new risks. Evidence shows that a majority of educational AI tools exhibit measurable bias, with performance varying significantly across demographic groups.[338] These biases are often rooted in non-representative training data and insufficient testing protocols, disproportionately affecting learners in LMICs and those using non-dominant languages.[339]

AI systems trained on big data in educational contexts can reinforce existing gender stereotypes, including assumptions about academic ability, career pathways, leadership and participation, unless data sets, algorithms and governance approaches are intentionally designed to mitigate these risks.[340]

These risks are amplified by weak governance frameworks. In many contexts, regulatory systems have not kept pace with technological deployment, leaving gaps in data protection, transparency and accountability. This creates vulnerabilities related to privacy, surveillance and commercial exploitation, which can undermine trust and disrupt learning continuity.[341]

Meaningful participation is also central to inclusive access. A rights-based approach requires learners with disabilities and OPDs to be involved in decisions, research and processes that affect them, rather than being treated only as recipients or research subjects. UNICEF identifies the full and meaningful participation of persons with disabilities as a strategic priority and calls for children and young people with disabilities and OPDs to be involved in the design, implementation, monitoring and evaluation of programmes and policies.[342] UNICEF's Global Research Agenda further emphasizes co-creation with children and young people with disabilities and OPDs to ensure that research priorities, methods and findings reflect lived experience.[343]

Evidence gaps relating to inclusive access

Despite growing research, significant gaps remain that limit policy confidence and effective scaling of interventions that use technology for inclusive education.

First, many **studies do not fully capture the experiences of the most marginalized learners**. Data systems frequently exclude those who are disconnected, creating a persistent invisibility that undermines inclusive planning.[344] In addition, the lack of longitudinal evidence restricts understanding of whether short-term gains lead to sustained educational outcomes.[345] There is also limited reporting on the meaningful involvement of learners with disabilities and OPDs in setting research priorities, designing studies and interpreting findings, limiting the extent to which the evidence reflects their lived experiences and priorities. Moreover, **studies do not always provide gender-disaggregated findings** to understand whether interventions affect girls and boys differently, especially over time.[346]

Second, the **evidence base on disability-inclusive education interventions in LMICs remains limited**, particularly regarding their effects on access, participation, retention and learning outcomes for learners with disabilities in mainstream settings. While barriers to inclusion and implementation challenges are increasingly documented,[347] there is less robust evidence on which interventions effectively address these barriers and improve outcomes. A recent systematic review found limited and generally low-confidence evidence on the effectiveness of interventions in LMICs.[348] Similarly, although EdTech shows potential to support learners with disabilities, evidence on its effectiveness remains weak, with limited research examining whether and how EdTech improves educational outcomes, particularly at scale.[349] This highlights the need for research examining what works, for whom, under what conditions and at what scale.

Third, there is **limited rigorous comparative research on localization**. Although evidence suggests that locally adapted solutions perform better, systematic comparisons across contexts and subject areas are scarce, which constrains generalizability.[350] Fourth, evidence on cost-effectiveness is insufficient. Few studies compare EdTech interventions with alternative investments such as teacher training, textbooks or school feeding programmes, limiting policymakers' ability to make informed decisions about resource allocation.

Moreover, **governance and political economy** dimensions remain underexplored, including the implications of private sector involvement, platform dependencies and data ownership for equity, sustainability and accountability. Finally, intersectional inequalities remain insufficiently examined. There is limited evidence on how disability interacts with gender, poverty, displacement, language and rurality to shape access to, participation in and outcomes from digital education. Addressing these intersecting dimensions is critical to understanding who benefits from technology-enabled education, under what conditions, and who may remain excluded.

Promising practices in inclusive access

Emerging evidence highlights a set of promising approaches for how technologies can be used for better education inclusion. These approaches share three characteristics: they are designed for constrained environments, they combine technology with human support, and they address multiple dimensions of exclusion simultaneously.

Low-tech and offline-first solutions have demonstrated strong potential for inclusion. Audio-based learning tools, such as the Talking Book programme, have improved learning outcomes in contexts with limited access to teachers and printed materials by leveraging durable, offline devices and local-language content.[351] Similarly, mobile phone-based delivery systems using voice or SMS have achieved high levels of engagement by bypassing connectivity constraints.[352]

Prioritizing localization and contextualization is a critical success factor. Evidence shows that delivering content in local languages can expand participation and improve learning outcomes, particularly for learners with limited proficiency in dominant languages.[353] This highlights the importance of cultural and linguistic alignment in addition to technical functionality.

Multiple delivery models and technologies can help address the different barriers that shape access and participation. Evidence from the COVID-19 education response and contexts of forced displacement suggests that combining delivery channels, including online, offline, mobile, broadcast and face-to-face approaches, can provide multiple entry points for learners facing different connectivity and resource constraints.[354, 355] This reinforces the principle that inclusive access requires a portfolio of complementary approaches rather than a single technological solution.

For digital education to reduce gender-related inequalities, especially related to the digital divide that impacts girls more than boys,[356] interventions that **explicitly address household and community dynamics** are more effective than those that assume equal access. Strategies such as identifying ‘least connected’ learners and combining technology provision with community engagement and gender-awareness initiatives have been associated with improved participation and empowerment outcomes, particularly for marginalized girls.[357]

In disability inclusion, accessible digital content and mainstream EdTech are most effective when supported by **wider enabling conditions**. These include accessibility standards and inclusive procurement, access to assistive technology and reasonable accommodation, teacher and school capacity, and meaningful participation of persons with disabilities in design and implementation.[358, 359] Accessible digital content and features, such as sign language videos, audio narration and text-to-speech, can support participation when combined with teacher facilitation, and wider accessibility measures can enhance participation when combined with teacher training and facilitation.[360] These findings reinforce the importance of treating disability inclusion as a systems issue spanning the accessibility of mainstream digital content and platforms, access to appropriate assistive technology, procurement, implementation, support and accountability, rather than as a feature of digital content alone.

Beyond content formats and teacher training, effective disability inclusion also depends on wider enabling conditions: accessibility standards and procurement, reasonable accommodation and support, the participation of persons with disabilities, and system capacity and accountability. For example, in Viet Nam, the Ministry of Education and Training worked with the World Bank, UNICEF and ATscale to co-design a locally relevant suite of digital learning tools – including a screen reader, text-to-speech in local dialects and a digital library in Vietnamese and eight ethnic minority languages – reaching over 5,000 students, including learners with disabilities.[361] Testimonies from young assistive technology users echo these findings: several describe teaching themselves to use screen readers because their teachers were untrained, and being denied the use of their own devices during exams, showing that access to a device means little without trained educators and inclusive practices.[362]

Finally, **emerging applications of AI** present both opportunities and risks for inclusive education. While AI has the potential to support personalized learning and early identification of learning needs, evidence highlights persistent concerns regarding bias and equity, particularly in applications such as diagnostic tools.[363] This underscores the need for robust governance mechanisms, including transparency, bias auditing and inclusive data set development.[364] Programmes and initiatives that include AI-enabled activities should consider gender in the design as well as the evaluation of the outcomes and impact to understand how the technology either challenges or supports gender-responsive teaching and learning, promotes girls' participation and leadership, and contributes to safer and more inclusive learning environments.

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Think piece

Making accessibility and inclusion an imperative, not an add-on

Marta Carnelli and Ursula Hinostroza Castillo

Marta Carnelli is a Research Specialist, and Ursula Hinostroza Castillo a Research Consultant, at UNICEF Innocenti. This think piece argues that accessibility and inclusion must be embedded into the initial design, financing, procurement and governance of digital learning systems, rather than treated as an often costly afterthought. It is included here, with the practical example of UNICEF's Accessible Digital Textbooks, to demonstrate how decision makers can successfully operationalize inclusive design so that all children – regardless of their needs – can participate and learn equally.

Why inclusive access matters

Inclusive access is, first and foremost, a matter of rights: under the Convention on the Rights of Persons with Disabilities and the Convention on the Rights of the Child, every child has an equal right to quality education, and digital learning systems must uphold that right rather than create new barriers to it. Digital education has the potential to expand learning opportunities for millions of children. Yet without deliberate efforts to address exclusion, it can also reinforce existing inequalities.

Across LMICs, learners continue to face multiple and overlapping barriers to safe and impactful participation in digital learning – from infrastructure and affordability constraints to gendered household dynamics, linguistic mismatches and inaccessible design. Technology does not automatically promote inclusion; its effects depend on how it is designed, governed and integrated into education systems.[365, 366]

Accessibility and inclusion cannot be treated as optional features of digital education. Rather, they must be embedded into the design, financing, procurement and governance of digital learning systems from the outset. When accessibility is integrated early, digital education can be more equitable, more efficient and more effective for more children.

The cost of exclusion

Discussions about inclusive digital education often focus on the perceived additional costs of accessibility. Yet this overlooks a more important question: what are the costs of exclusion?

When accessibility is addressed only after digital systems have been developed, education systems frequently incur substantial additional costs. Textbooks may need to be converted into multiple formats after publication, digital platforms may require expensive retrofitting to become compatible with screen readers or other assistive technologies, and assessment systems often need separate accommodations or alternative administration processes. Teachers are frequently left to develop their own adaptations, source supplementary materials or provide individualized support without adequate guidance or resources.[367] In some cases, governments are required to maintain parallel systems to compensate for inaccessible mainstream provision, including separate content repositories, disability-specific learning platforms or related support services. Support services of this kind are, more broadly, a legitimate and necessary part of inclusive provision under a twin-track approach. The concern here is narrower: the duplication and fragmentation that arise specifically when they are needed because mainstream provision is inaccessible. These fragmented approaches are costly and difficult to sustain, and often provide learners with a poorer experience than systems designed to be inclusive from the outset.[368]

During the COVID-19 pandemic, many digital learning platforms required substantial additional investment to introduce features such as captioning, screen-reader compatibility, alternative navigation pathways and accessible assessments after deployment. The *Global Report on Assistive Technology* similarly highlights how inaccessible mainstream services often create demand for parallel specialist services, increasing costs while reducing opportunities for inclusion.[369]

The cost of exclusion extends beyond the education system itself. When learners are unable to access curriculum materials or participate meaningfully in learning, the consequences often accumulate over time through lower learning outcomes, increased need for remediation and support services, higher risk of grade repetition and dropout, and reduced opportunities for further education and employment. Education generates significant social and economic returns over the life course, while learning losses can have long-lasting consequences for individual earnings, productivity and economic growth.[370] From this perspective, inaccessible digital learning systems do not simply create technical barriers; they risk perpetuating educational inequalities and increasing the costs associated with remediation, exclusion and lost human potential.

The cost of inclusive EdTech should therefore consider not only devices and software, but also content, teacher training, connectivity, maintenance, accessibility and ongoing support.[371] From this perspective, accessibility is not a specialized expenditure; it is part of the infrastructure required for effective and equitable digital learning systems in which all students can equally participate and learn. The policy question is therefore not whether accessibility adds costs, but whether education systems can afford the long-term costs of exclusion, duplication, remediation and lost learning opportunities.

Designing for diversity

A growing body of evidence suggests that designing for learners who face the greatest barriers helps remove exclusionary features of education systems and often improves learning experiences for everyone. This principle is reflected in Universal Design for Learning, which promotes multiple means of representation, engagement, action and expression to accommodate learner diversity from the outset, treating diversity as a defining characteristic of all classrooms rather than an exception to design for later.[372] Universal design should reduce barriers for the widest possible range of learners, but it complements rather than replaces reasonable accommodations, assistive technology and support that some learners with disabilities still require.

Features originally developed to support learners with disabilities frequently benefit many others. For example, audio narration that is originally created for learners who are blind or have impaired vision can support beginning readers and learners studying in a second language. Adjustable display settings can improve usability across age groups, access needs and contexts. Simplified text, visual supports and content in multiple formats can help learners with varying levels of literacy and prior knowledge. In this sense, accessibility is not a niche concern but a broader strategy for improving learning experiences for a wide range of learners.

Designing for diverse learners also requires designing for diverse contexts: digital content that is not adapted to local languages, curricula, cultural norms and teaching practices consistently sees lower uptake and weaker outcomes, underscoring the importance of localization and co-design.[373]

Despite growing recognition of the importance of accessibility and localization, these principles remain inconsistently embedded within mainstream digital education systems. Procurement frameworks frequently lack accessibility requirements, publishers often have limited incentives to develop accessible content, and teacher preparation programmes rarely include substantial training on accessibility and inclusive digital pedagogy. As a result, accessibility continues to depend on individual champions rather than institutional systems. A rights-based approach requires accessibility to be embedded in standards, budgets, procurement, teacher training, monitoring and accountability mechanisms, with the meaningful participation of persons with disabilities and OPDs throughout the process.

Some countries have begun to address this challenge through policy and regulation. Brazil provides a notable example. Through a combination of disability rights legislation, accessibility standards and federal textbook procurement policies under the *Programa Nacional do Livro e do Material Didático* (National Textbook and Teaching Learning Materials

Programme),[374] publishers supplying educational materials are required to provide content in accessible formats. These requirements help create market incentives for accessibility by making it a condition for participation in one of the world's largest public textbook procurement systems. Rather than treating accessibility as a voluntary practice, the Brazilian experience demonstrates how a procurement policy can make accessibility a systemic expectation.

Strengthening inclusive education systems through accessible digital textbooks

While evidence points towards accessibility-by-design, relatively few initiatives have attempted and managed to operationalize these principles within government education systems. The UNICEF Accessible Digital Textbooks for All[375] (ADT) initiative offers one example of how accessibility of content, teacher support, technical standards, inclusive content production, procurement reform alignment and emerging AI technologies can be brought together as a broader strategy for inclusive digital transformation – and how to develop the understanding of what it would take to scale these strategies.

Developed through partnerships between UNICEF, governments, OPDs, publishers, and technical and technology development partners, the ADT initiative was created to address a persistent challenge: how to ensure that all learners can access curriculum-aligned learning materials in formats that meet their needs, enabling children with and without disabilities to learn together in the same classrooms and engage with the same curriculum. Rather than producing separate resources for different groups of learners, the initiative provides the tools and framework to support the conversion of textbooks into digital resources that integrate accessibility features from the outset. The accessibility features may include audio narration, sign language videos, image descriptions, interactive activities, simplified text, navigation supports, a multi-modal glossary and adaptable display options.

The ADT initiative goes beyond converting and adapting learning materials. It supports governments to strengthen the systems needed to sustain inclusive digital access over time, including accessibility standards, government capacity, teacher training, quality assurance, procurement and national content production workflows. In several countries, including the Dominican Republic, Paraguay, Rwanda and Uruguay, the initiative has supported ministries of education to establish validation procedures, develop accessibility guidelines and integrate accessibility requirements into textbook production and approval processes.

These efforts are also beginning to influence wider education reforms. In the United Republic of Tanzania, accessible digital textbooks (ADTs) have been incorporated into the country's forthcoming National

Strategy on Inclusive Education, embedding system-wide accessibility within national policy. In Uruguay, the experience has informed the development of an accessible version of *Lectura, Escritura y Oralidad*, the national Grade 2 literacy assessment, extending accessibility beyond curriculum materials into national learning assessment. Together, these experiences illustrate how work that begins with accessible learning resources can catalyse broader changes in policy, assessment and inclusive education systems.

Evidence from implementation research conducted by UNICEF Innocenti in the Dominican Republic, Nicaragua, Paraguay and other ADT countries[376] found high levels of teacher satisfaction with ADTs and positive perceptions of their pedagogical value. Teachers reported improvements in learner participation, autonomy, engagement and collaboration. Accessibility features originally developed for learners with disabilities were frequently used by emergent readers, multilingual learners and students requiring additional support. Classroom observations and teacher reports also suggested that ADTs helped foster greater interaction and collaboration between students with and without disabilities. Learners were observed supporting one another in the use of accessibility features, participating more actively in shared classroom activities and engaging with the same learning materials and curriculum content. These findings are particularly important because they point not only to improved access, but also to greater inclusion through participation in common learning experiences.

At the same time, implementation is key. Positive outcomes with ADTs depended on teacher support, training and institutional commitment: technology and accessible content alone were insufficient. Across ADT implementation countries, teachers who received training on accessibility features, inclusive pedagogy, Universal Design for Learning and differentiated instruction were better equipped to integrate the materials into classroom practice, support diverse learner needs and foster more inclusive learning environments.

The ADT initiative has now been implemented across Latin America and the Caribbean, Africa, Europe and Asia, generating evidence on how accessibility can be embedded within mainstream education systems rather than delivered through parallel structures.

The promise and limits of AI

Recent advances in AI are creating new opportunities to address one of the significant barriers to inclusive digital education: the cost, time and specialized expertise required to produce accessible learning materials at scale. While evidence is still emerging, early experiences suggest that AI can help reduce production timelines and support accessibility workflows when they are combined with strong human oversight, validation processes, accessibility expertise and clear governance.

Through collaborations with governments, publishers and technical partners, the ADT initiative has jointly developed an open-source, model-agnostic AI-assisted workflow,[377] called ADT Studio, that automates a significant portion of the accessibility conversion process. This includes support for content extraction and structuring, accessible HTML production, image description generation, translation, text-to-speech, interactive elements and accessibility checks. Rather than replacing human expertise, ADT Studio is designed to accelerate the technical production process while keeping educators, accessibility specialists, language experts and ministries of education at the centre of review and decision-making.

The approach is designed not only for UNICEF-supported implementations, but also as a free tool that can be adapted and integrated into mainstream publishing and education content workflows. In contexts where governments are strengthening accessibility requirements in procurement or digital learning policies, AI-assisted ADT workflows can help translate these requirements into practical production processes. For example, in Brazil, publishers and partners working within an accessibility-focused education content environment are exploring how workflows can support the more efficient production of accessible educational materials at scale. This illustrates how technological innovation can complement policy incentives and system-level commitments to accessibility.

Early implementation research results from Uruguay[378] suggest that AI-assisted production can reduce the time and resources required to create accessible textbooks while maintaining quality through human review and validation. However, the ADT experience also reinforces an important lesson from the broader evidence base: AI is not a substitute for accessibility, pedagogical, linguistic or technical expertise; it is an accelerator that must be embedded within inclusive design processes, accessibility standards and rights-based governance, keeping educators, accessibility specialists, language experts, ministries of education and human-in-the-loop validation processes at the centre of review and decision-making.

Human oversight remains essential to ensure pedagogical quality, cultural relevance, linguistic accuracy, compliance with accessibility standards and alignment with curriculum and national education priorities. Meaningful participation of teachers, learners, persons with disabilities and OPDs is also critical to ensure that AI-enabled tools respond to real barriers and do not reproduce exclusion. More broadly, evidence continues to highlight concerns regarding bias, transparency, accountability, data protection and uneven performance across genders, languages and populations.[379] AI therefore has the potential to accelerate accessibility, but only when deployed within robust governance, quality assurance, validation and a ccountability systems.

Conclusion and implications

Inclusive access in digital education depends on a system's ability to enable meaningful, safe and equitable participation for all learners. As the evidence highlights, the most vulnerable groups face barriers such as prohibitive broadband costs, systemic biases and exclusionary designs. Exclusion is an inevitable outcome when any one component of the socio-technical system fails to intentionally accommodate learner diversity.

To bridge these divides, a coordinated effort across the sector is essential. EdTech developers and industry partners need to build tools that work well offline, and centre gender dynamics, local languages and disability accessibility from the outset of their designs. Policymakers need to strengthen governance by instituting safeguards for data protection and bias auditing, while also focusing on building a stronger evidence base through dedicated funding for longitudinal and cost-effectiveness research. And school administrators should invest heavily in teachers to ensure digital tools are effectively integrated through sustained training and support.

Inclusive digital education is an achievable reality. Promising interventions that combine offline platforms, accessible content with accessibility features, local-language instruction, gender-responsive design and strong community engagement have already demonstrated significant potential to reach the most marginalized learners. Scaling these isolated successes into system-wide transformations will rely on deliberate system design, sustained financial investment and an unwavering commitment to equity.

Case study

Uruguay and the United Republic of Tanzania: Producing and evaluating accessible digital textbooks

This case study brings together two complementary experiences from the UNICEF Accessible Digital Textbooks (ADT) initiative in a single country pairing. It draws on key informant interviews with the Tanzania Institute of Education and on an ongoing mixed-methods study in Uruguay – a randomized controlled trial across roughly 130 schools, with classroom observations and interviews – developed by Administración Nacional de Educación Pública (ANEP), UNICEF Innocenti, UNICEF Uruguay and national research partners.

Context

Both the United Republic of Tanzania and Uruguay have placed digital transformation and inclusion at the centre of their education agendas, and both are using the ADT initiative to ensure that all learners, including children with disabilities and those with diverse learning needs, can access curriculum-aligned materials on an equal basis with their peers. In each country, accessibility is being treated not as a separate, parallel activity but as something to be embedded within mainstream curriculum, content production, and, increasingly, assessment and evidence systems.

Producing accessible learning materials and understanding whether they actually improve inclusion are two distinct challenges – and the two countries speak to different points along that path. The United Republic of Tanzania shows how AI-assisted production is being used to create ADTs at pace and to embed accessibility within the national education system. Uruguay shows the next step in the same journey: an impact evaluation that developed an accessible version of a national assessment to test whether ADTs improve learning and inclusion for learners with disabilities. Read together, they trace a single arc – from producing accessible content to generating the evidence needed to understand its effect.

Spotlight on practice

United Republic of Tanzania: Using AI to produce accessible textbooks at pace

The United Republic of Tanzania's revised Education and Training Policy (2023), National Digital Education Strategy and National Guidelines for Artificial Intelligence in Education all emphasize the role of technology in improving learning while ensuring no learner is left behind. For the Tanzania Institute of Education, the body responsible for curricula and learning materials, this commitment extends beyond devices and connectivity to how digital resources can be made accessible to all learners.

Producing accessible learning materials at scale is a practical challenge for many education systems, since materials for learners with visual, hearing and other disabilities have often required separate production processes that create delays and increase costs. The ADT initiative offers a way to rethink this model: by combining AI-powered conversion with human validation, accessibility features can be built into learning materials through a single production workflow rather than a parallel one. The United Republic of Tanzania is the first country in East Africa to adopt this AI-powered ADT approach, with implementation beginning in 2026 and focusing initially on storybooks and primary-level curriculum materials.

For the Tanzania Institute of Education, the initiative is as much about national capacity as about technology. Teams of curriculum specialists, programmers, accessibility experts and validators are being trained to manage the process internally, so that the knowledge and systems required to produce accessible materials remain within national institutions. The potential efficiency gains are notable: internal estimates suggest that approximately 44 revised curriculum textbooks covering pre-primary through Grade 5 could be converted in around 40 days using the AI-powered approach, compared with an estimated 2–3 years using previous methods. These figures are still to be tested through implementation, but they indicate the scale of the opportunity AI may offer for accelerating accessibility.

Uruguay: Evaluating impact through an accessible national assessment

Over the past two decades, Uruguay has built one of the most established digital education ecosystems in Latin America, with Ceibal – its digital technology centre for education innovation – central to expanding access to technology, digital content and innovation in schools. The joint work of Ceibal and ANEP in developing ADTs began as part of a broader effort to ensure all learners could access the curriculum alongside their peers, and the country is now embedding accessibility not only in learning materials but also in assessment and evidence generation.

A recurring challenge in inclusive education is that learners with disabilities are often under-represented in learning assessments, making it hard for systems to know whether all students benefit equally from educational investments. To address this, Uruguay is implementing one of the first large-scale studies to examine the effects of accessible digital learning materials on both learning and inclusion. Led by ANEP, UNICEF, UNICEF Innocenti and national research partners, the study uses a randomized controlled trial across approximately 130 schools spanning inclusive and special education settings, randomly assigned to treatment and control groups. Treatment schools receive an integrated package – ADTs, ongoing guidance through WhatsApp messages and an interactive help menu built on UNICEF Uruguay's RapidPro platform – evaluated as a whole rather than isolating the effect of the textbooks alone, while control schools continue existing practices. The research will also examine whether outcomes vary by gender, alongside disability, learning difficulties and other learner characteristics.

A central innovation is the development of an accessible version of *Lectura, Escritura y Oralidad*, Uruguay's national Grade 2 assessment of foundational literacy skills. By adapting a mainstream national assessment rather than creating a separate instrument, the study seeks to ensure that students with disabilities can participate in national learning measurement, giving education systems a more complete picture of learning, participation and inclusion. Baseline data collection began in 2026, and the study goes beyond literacy outcomes to examine access, tracked through attendance and administrative records, and participation, explored through classroom observations and interviews with students, teachers and families.

Reflections and lessons learned

Across both experiences, accessibility proves most sustainable when it is embedded in national policies and systems rather than treated as a standalone project, and when it is supported by government ownership, technical capacity and long-term planning. Both cases also show that accessibility must be addressed across the entire education system: curriculum materials, assessment tools, teacher support and monitoring all shape whether learners can participate fully and equitably, including across gender and other dimensions of exclusion.

Both countries remain at an early stage, which counsels caution in interpreting results. What has already been demonstrated – policy integration, institutional ownership and in-country capacity-building – can be distinguished from the efficiency gains, expansion plans and impact findings that are still to be tested. In each case, technology acts as an accelerator whose value depends on how well it is embedded in inclusive design, human validation and rights-based governance.

The United Republic of Tanzania's experience underscores the importance of positioning accessible digital education in national policy frameworks. Its inclusion in the revised National Strategy on Inclusive Education (2026/27–2030/31) marks a shift from a promising initiative to a formal policy commitment. At the same time, effectiveness depends on strengthening digital infrastructure, server capacity, internet affordability and sustainable financing – areas where the country is exploring solutions such as improved hosting, partnerships with mobile providers and offline access options.

Meanwhile, Uruguay's experience highlights the importance of linking innovation with evidence: making learning materials accessible is a necessary first step, but understanding whether these efforts improve learning and inclusion requires equally inclusive approaches to assessment and research. Both the United Republic of Tanzania and Uruguay are generating evidence that can inform future decisions on inclusive digital education.

Case study

Lebanon: Strengthening gender equality with digital and STEM skills programmes

This case study examines a 16-week STEM pilot programme delivered in 25 Lebanese public schools to build students' and teachers' coding, robotics and problem-solving skills while narrowing digital skills gaps between girls and boys. It offers a meaningful lesson on how hands-on, applied STEM learning can be introduced equitably in public school settings under challenging conditions, so that girls and students facing greater barriers are included from the outset. The case study draws on implementation research by UNICEF Innocenti, in collaboration with UNICEF Lebanon and Lebanon's Ministry of Education and Higher Education, using a mixed-methods design spanning pre- and post-intervention tests, questionnaires, a principals' survey, focus groups, teacher interviews and classroom observations.

Context

Lebanon's education system has faced prolonged disruption from overlapping economic, health and political crises, resulting in significant learning losses, reduced instructional time and constrained resources.[380] These pressures are reflected in learning outcomes: over half of 15-year-olds did not meet the minimum proficiency level in science (54.5 per cent) or mathematics (55.7 per cent) in the 2022 Programme for International Student Assessment (PISA).[381] Strengthening girls' and boys' skills in STEM is essential for helping students understand new technologies, think creatively and adapt to evolving academic and career pathways.[382] Yet gender disparities in STEM remain persistent and under-researched across the Middle East and North Africa.[383]

In Lebanon, girls and boys perform comparably in mathematics – a gap of just 1 point in PISA 2022, against an OECD average of 9 points – though both perform well below that average.[384] Attitudinal barriers, however, still shape aspirations: research finds that mathematical ability is often associated with boys, while girls' success is attributed to effort rather than talent.[385] To help address these gaps, UNICEF, in collaboration with Lebanon's Ministry of Education and Higher Education, implemented a 16-week STEM pilot programme in partnership with CodeBrave and with funding from the Government of Germany through the KfW Development Bank. Targeting students in Grades 6–9 during the 2024/25 school year, the programme reached 3,012 students, 57 per cent of them girls.[386]

Spotlight on practice

The programme's curriculum was designed to progressively build students' technical and problem-solving abilities through hands-on, real-world applications. Each school received 20 micro:bit devices, 8 AgriTech kits and 15 laptops. Key components included foundational coding, where students created simple games using Scratch to introduce events, loops, variables and conditionals; physical computing, using micro:bit devices and AgriTech kits to prototype solutions to agricultural challenges such as crop-height measurement, temperature monitoring, auto-irrigation and smart light and shade systems; and AI and machine learning, where students trained simple models to grasp basic AI concepts. Sessions were facilitated by CodeBrave educators, while school teachers shadowed them to learn how to deliver the activities independently in future years.

To assess the pilot, implementation research was embedded in delivery using a mixed-methods approach. Quantitative pre- and post-intervention tests measured students' and teachers' skills and confidence, complemented by midline questionnaires, an end-line principals' survey, student focus group discussions, teacher interviews and classroom observation checklists. To estimate the programme's effect, a propensity score matching (PSM) model compared participants with a matched group of non-participants.

The results were substantial. Students' average test scores rose from 1.3/10 in the pre-intervention test to 7.8/10 in the post-intervention test.

Using the PSM model, participating students scored nearly 6.5 points higher on the 10-point post-intervention test than matched peers who were not enrolled, indicating that the learning gains were attributable to the programme and that these skills are not typically taught in participating schools. Teachers also improved markedly, with average scores rising from 4.33/16 to 9.93/16; those with prior experience integrating digital learning achieved higher gains (11.5/16 vs. 8.4/16).

The programme was positively received by students, teachers and principals, who valued its practical, engaging approach, and many girls reported a new interest in pursuing STEM-related fields.[387]

Reflections and lessons learned

Lebanon's experience highlights the value of applied, equity-focused STEM learning. The programme was particularly effective in supporting girls' engagement and shifting perceptions of STEM among girls and boys: girls, who began with lower confidence and scores, caught up by the end of the course, and pre-existing gaps between girls and boys in self-efficacy diminished. Girls also reported the greatest adjustment in career aspirations, moving towards technology-related fields. Students' confidence and enjoyment of coding increased, and the programme sparked wider interest in subjects such as English and physics as learners recognized their relevance to programming.

School leadership proved decisive: schools with strong principal engagement, better access to devices and fewer strike-related disruptions achieved stronger results. Principals' most pressing needs were the ability to customize the timetable and identify student groups from the start of the school year, and further training, for both teachers and leaders, to support delivery of the content. Other challenges included limited lesson time to absorb new concepts, students' limited prior experience with coding and laptops, large class sizes, a lack of familiarity with English terminology and technical interruptions such as power and internet outages.

These lessons point to clear priorities for scale-up: aligning session length and scheduling with the school timetable and starting early in the year; strengthening teacher and leadership capacity through sustained training and coaching; ensuring school-level readiness and adequate resources; and adding preparatory modules on basic computer literacy and English terminology. Encouragingly, the programme aligns closely with the Lebanon Digital Learning Strategy launched in 2025, positioning the pilot as part of a wider system-level effort rather than a standalone intervention.[388]


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Case study

Malaysia: When AI makes exclusion visible

This case study examines Malaysia's AI-powered early warning system for out-of-school children and students at risk of dropping out. It offers a meaningful lesson on how EdTech can advance inclusive access when AI is embedded in government systems, school-level workflows and support mechanisms for marginalized learners. The case study draws from focused discussions, publicly available materials and reporting developed by UNICEF Malaysia in collaboration with the Ministry of Education Malaysia.

Context

Malaysia is undergoing a transition from a middle-income to a high-income economy. In this context, the Government has prioritized educational equity and access, with the Malaysia Education Blueprint 2013–2025 setting out the aspiration that every child should have the opportunity to receive quality education and reach their full potential, regardless of background.[389]

Since 2016, these efforts have included a specific focus on minimizing exclusion from education, encompassing both out-of-school children and children who are in school but silently excluded and exhibit risk factors that may lead to dropout or failure to complete their studies.[390]

To address these issues, Malaysia's Ministry of Education developed a national early warning system known as SiPKPM and, in partnership with UNICEF, integrated

AI capabilities into the system. The AI component is designed to transform how education leaders at multiple levels identify and respond to student dropout risks. As a centralized digital platform that currently covers approximately **5 million students across over 10,000 schools**, the AI component of SiPKPM enables schools and education authorities to monitor attendance, participation and key risk indicators, allowing earlier identification of vulnerable students and more timely and targeted interventions to support student retention and reintegration.

Spotlight on practice

The Global Initiative on Out-of-School Children framework[391] defines out-of-school children and young people not only as children already outside formal education, but also as students at risk of dropping out. Malaysia's SiPKPM applies this prevention logic at a national scale. Before SiPKPM, dropout monitoring was a manual, fragmented and retrospective process, meaning that by the time risk information was compiled, opportunities for intervention were often already limited. With the AI system, raw administrative data are transformed into risk information in real time while students are still visible to schools and public systems.

Forming a structured basis for early intervention

SiPKPM uses machine learning models to score students across seven indicators: attendance, academic achievement, disciplinary record, disability status, household income, distance from school and parents' marital status. These indicators are aggregated into a composite risk index that classifies students as high, medium or low risk and allows for gender disaggregation of the data. The model turns scattered signals of exclusion into a structured basis for early intervention.

The design recognizes dropout as a process shaped by simultaneous and intersecting barriers. Academic performance, attendance, disability, household income, distance and family circumstances may each reveal only part of a child's situation. Together, they provide a fuller profile of exclusion risk and help schools identify where differentiated support may be needed.

In this sense, SiPKPM offers a promising example of how AI can be used at the system level to make education access more inclusive: participation is treated as conditional on the alignment of data, pedagogy, system design and governance, rather than on enrolment status alone.

Exploring SiPKPM's four AI-powered functional modules

Based on an internal report by UNICEF Malaysia (2026),[392] the following outlines the four modules of SiPKPM:

1. **Dropout Risk Prediction:** This module provides continuous AI-driven risk-scoring by analysing student, family and school-level factors. It converts risk signals into actionable alerts for early, localized intervention by school counsellors.

2. **Learning Pathway Recommendation:** This module integrates academic performance with psychometric data (career interest and personality traits inventories) to assess student suitability and engagement potential. It recommends tailored pathways across academic and technical and vocational education and training streams, supporting personalized counselling and reducing dropout risk.

3 **Career Pathway Guidance:** This module links education pathways to long-term socioeconomic outcomes. It combines psychometric inputs, academic and attendance data and contextual socioeconomic factors using machine learning models trained on historical outcomes. Recommendations are aligned with labour market demand and national development priorities, enabling students to visualize realistic pathways to economic mobility.

4 **AMIN AI Intervention Chatbot:** AMIN is an AI-powered assistant that supports school counsellors with real-time, context-aware intervention guidance. It identifies underlying causes of risk such as academic challenges or family disruption, and generates targeted action plans and toolkits. This enables faster, more consistent and practical school-level interventions.

The system is now operational across more than 10,000 schools nationwide and embedded in cross-divisional government workflows, which include role-based dashboards for different users to enable coordinated action across the education system. Access is strictly role-based, ensuring data security, operational efficiency and accountability, with users only able to view information relevant to their responsibilities.

SiPKPM has also begun to extend beyond school-level retention monitoring. By incorporating data from the Ministry of Higher Education and other sources, the initiative sought to anticipate transitions and support longer-term learning pathways. Within one year, from January to December 2025, **SiPKPM enabled 9,077 students, including 3,287 girls,** to return to school through AI-informed targeted interventions.

For example, where absenteeism is flagged alongside family or socioeconomic risk factors, the system can support school counsellors and educators to undertake targeted family outreach and develop an action plan addressing the factors contributing to disengagement. Where disability or learning-related factors are identified, educators can use the information to consider appropriate learning support based on the student's individual needs. The AI does not prescribe the response; rather, it helps education personnel focus attention and tailor their response to the child's circumstances.

Reflections and lessons learned

These results should be interpreted as emerging evidence of a system response, not a technological effect alone: AI made risk more visible; when combined with human and institutional action, this made re-engagement in education more possible. Malaysia's experience points to two lessons for the role of AI-powered early warning systems in supporting inclusive access.

1 **Co-creation and capacity-building are at the core of translating insights into interventions.** SiPKPM was not developed as a standalone AI tool. It was embedded in a structured 'monitor, intervene, monitor' cycle across schools, district and state offices, and the Ministry of Education. Implementation relied on co-development and capacity-building across multiple levels of the education system. The AI models were co-developed through eight workshops with data experts across seven Ministry divisions. The approach was piloted with 670 principals, teachers, counsellors and officials to provide iterative feedback and refine dashboards, workflows and interventions. It required ongoing

coordination across schools, district and state offices, and the federal Ministry.

Variation in staff familiarity with data-driven decision-making initially affected consistency across zones, showing that practical support for interpreting dashboards, embedding risk information in school workflows, and linking alerts to locally relevant intervention triggers is central to improving implementation. Without clear roles, feedback loops and institutional support mechanisms, predictive systems risk adding another layer of reporting rather than improving support for students. SiPKPM's **'monitor, intervene, monitor'** cycle is therefore important, not just as a technical feature but as a governance mechanism for turning risk identification into coordinated action.

2 **Safety-by-design is critical at every stage.** Several technical and governance safeguards were incorporated into the design. From a modelling perspective, class imbalance was addressed using a synthetic minority oversampling technique (SMOTE) to ensure that minority dropout outcomes were adequately represented during model training, while correlation analysis supported the identification of relevant predictor variables and reduced the risk of inappropriate feature selection. These measures strengthen model development, but are not in themselves a test of algorithmic fairness across demographic groups.

Governance therefore plays a central role in how predictions are used. SiPKPM does not make automated decisions about individual students. Individual risk predictions are accessible only to authorized school personnel, specifically the principal, school counsellor and student affairs teacher. Personnel are expected to consider the prediction alongside the student's individual circumstances and other contextual information before determining whether and what support is appropriate.

This distinction is particularly important when the model incorporates characteristics associated with disadvantage, such as disability. SiPKPM adopts a human-in-the-loop approach in which AI supports identification, while qualified education personnel retain responsibility for interpretation and action. The prediction is a starting point for support and not a judgement on a student.

"SiPKPM is more than a technological platform; it is an expression of our shared commitment to equity and to ensuring that children at risk of exclusion are seen, supported and given the opportunity to remain engaged in education. Through this work with UNICEF Malaysia, we are strengthening the systems and human capacity needed to ensure that no child is left behind."

– Director, Ministry of Education Malaysia

The 2026 AI dropout intervention module will extend this model across Ministry, school and community stakeholders, using predictive insights to support community-level interventions and connect children and families at risk to wider social services. In doing so, Malaysia is shifting early warning from a data-driven exercise into a coordinated equity practice that takes a whole-of-society approach to school inclusion.

Part 4

Safety and well-being first

"The government should require companies to comply with a set of requirements for digital products used by children."

Child, Spain, 10–13 age group[393]

Evidence review

Context

For children in LMICs, where connectivity and the availability of tools are expanding faster than the institutions meant to oversee them, the prominence of digital and AI-enabled tools in education increases both opportunity and risk simultaneously.[394, 395] This section is concerned with the risk side of that equation, exploring key dimensions reflected in the EdTech for Good Framework 2.0: well-being, online safeguarding, data protection and privacy. The conditions under which digital education can be trusted, sustained and equitable depend on whether the tools through which children learn are safe and aligned with their rights.

The following analysis addresses the central question:

What evidence do we have about how digital technologies can be designed and governed in ways that uphold children's rights, protect them from harm and support their well-being?

Key insights

- Education benefits of digital tools should be weighed against **emotional, developmental and other negative impacts**, which evidence suggests can be substantial.
- The nature of children's digital experiences can open them up to **exploitation**. Sexual abuse, cyberbullying and manipulative engagement can cause measurable developmental, physical and emotional damage.
- The education sector is particularly susceptible to the tacit **neglect of children's data rights**. It is simultaneously a major target for cyberattacks and a major source of children's data being shared without meaningful consent or legal basis.
- Keeping children safe in digital education cannot rely on voluntary commitments. **Safety-by-design frameworks, child rights impact assessments and government safeguarding regulations** are increasingly being discussed and in some cases legislated in LMICs.

What the evidence says to date

A platform that brings learning opportunities to a child in a rural school or a government-run classroom is not delivering on the promise of digital education if it simultaneously exposes that child to abuse, extracts their data without consent or takes them down a problematic developmental path. International organizations such as UNICEF, the OECD and others have for years explored the risks of child engagement in the digital environment,[396, 397, 398] including developing a typology for these risks. This chapter builds on these frameworks to examine three specific impact areas: **psychosocial well-being and cognitive development, online safeguarding failures, and data protection and privacy.**

The evidence across these domains does not describe isolated problems, but a system in which children in digital education environments are systematically exposed to harm, and in which the institutions, markets and regulatory frameworks governing those environments have not kept pace. Each domain examined below, understood together, indicates structural failures in how EdTech is currently governed which must be remedied.

Psychosocial well-being and cognitive development

Reviews connecting screen time to well-being show significant but weak negative effects.[399, 400] One review of broad digital adoption by 15-year-olds (considering the roll-out of 3G coverage across 82 countries) links to statistically significant declines in learners' social relationships and reported sense of belonging.[401, 402] Negative effects are much more significant when it comes specifically to digital exposure to harmful content and online abuse, which are consistently associated with negative mental health effects.[403] Learners' performance has also been shown to suffer due to digital distraction, defined as a loss of academic focus resulting from engagement with non-academic content on digital devices.[404]

However, the term 'digital technology use' is often broadly defined, encompassing social media, gaming, educational apps and general browsing, and effects are likely to differ across these categories. Some studies point in particular to the harmful effects of social media use, including what some refer to as a 'great rewiring' of how young people develop and interact with one another.[405, 406] Various studies link social media use with poor mental health outcomes, including symptoms such as depression, anxiety, loneliness and weakened social relationships and academic performance.[407, 408]

Some EdTech tools increasingly feature the persuasive 'addictive-by-design' features that are common in social media and other commercial technology.[409] These include endless scrolling, auto-playing videos, unpredictable rewards and push notifications that exploit the brain's dopamine system,[410] as well as commercial assumptions about the value of data collection and algorithmic recommendations, which arguably undermine education objectives, reinforce groupthink and remove learner agency.[411]

Generative AI has added new dimensions of concern to child well-being and cognitive development. They include the risk of cognitive offloading, in which children's reliance on AI tools may progressively displace the development of their own reasoning and problem-solving capacities.[412] Analysis of outputs from large language models in LMIC contexts shows inconsistencies in both the accuracy and the relevance of educational output in less-represented contexts, an issue that is exacerbated when using lower-resourced languages. This is unsurprising given that, as of early 2025, less than 0.2 per cent of data used to train AI models came from Africa and South America.[413]

Online safeguarding failures

The scale and cross-national consistency of online harms confronting children is substantial: in OECD countries, one in six 11–15-year-olds reported being cyberbullied, and over one in three reported that they had encountered age-inappropriate and upsetting materials.[414] In Eastern and Southern Africa, over 1 in 10 internet-using children aged 12–17 across six countries had experienced at least one form of online sexual abuse in the prior year; approximately 30 per cent had encountered violent imagery online.[415] These harms tend to be concentrated among certain demographics: children from lower economic backgrounds and girls in particular tend to experience higher rates of cyberbullying and abuse.[416, 417] Reviews that are specific to LMICs identify reduced parental supervision and fewer support resources as compounding factors.[418]

Children who experience online sexual abuse or cyberbullying show significantly elevated levels of anxiety, self-harm and suicidal ideation.[419] Generative AI has further accelerated these vectors of harm. AI models available to children, including for educational purposes, can catalyse the creation of harmful content, manipulation, profiling, exploitation and privacy violations unless they are designed with child rights as a default.[420] AI-generated child sexual abuse material, deepfake abuse imagery and AI-assisted personalized grooming (where predators use AI to analyse a victim's online behaviour, interests and emotional state to customize their grooming strategy) represent an emerging threat that current safeguarding frameworks are not yet equipped to address.[421, 422, 423]

Data protection and privacy

EdTech can pose multifaceted risks to children's rights when platforms are not governed, financed and controlled by public authorities with data sovereignty in national hands,[424] especially as some education platforms gather, process and share personal data in ways that can constrain rights to education, privacy, expression and autonomous development.[425, 426]

Commercially, children's education data are routinely harvested for advertising and monetization. Of 163 EdTech products reviewed by Human Rights Watch, 89 per cent engaged in data practices that risked or infringed children's rights. These practices included secretly monitoring children, harvesting personal and family data, tracking them across the internet beyond the classroom and, in some cases, fingerprinting them in ways that were impossible to avoid or remove.[427] Significantly, these cases have at times included websites from state education actors.[428] Data-driven profiling can constrain children's educational trajectories by locking them into predicted pathways, a process characterized as 'technological redlining', while permanent digital records limit future opportunities.[429] Cybersecurity vulnerabilities leave children's data exposed: a global landscape review by UNICEF, UNESCO and the Global Privacy Assembly (the international coordinating body for data protection authorities) finds that the education sector accounts for 30 per cent of security breaches, and half of surveyed data protection authorities report awareness of EdTech-related data breaches.[430] The consolidation of the EdTech market around a small number of dominant platforms compounds this exposure: the 2026 breach of Instructure's Canvas learning management system affected millions of learners across the globe, exposing personal information and, in some cases, messages between users.

Data security measures and regulatory frameworks are struggling to meet the challenges they are facing. As of 2023, UNESCO found that only 16 per cent of countries had laws specifically protecting children's data privacy in education.[431] A UNICEF review of 40 personalized learning products found data security measures to be patchy, with data ownership typically resting with providers rather than schools, learners or governments – a particularly common pattern in LMIC contexts, where institutional capacity to negotiate or enforce data terms is weakest.[432] A regional study of ethical AI governance in Southeast Asian education systems similarly identified weak operational security, absent transparency disclosures and limited mechanisms for contesting automated outputs as widespread across the region.[433] Learners' data are not easily in their control:

in OECD countries – where data protection regulation is comparatively more mature – 40 per cent of learners have reported having their data shared without their consent.[434] This gap is likely wider still in the many LMICs that lack protections equivalent to the European Union's General Data Protection Regulation and the enforcement capacity to apply them.[435]

Ultimately, commercial incentives will not always align with the best interest of children and caregivers. Companies have at times located themselves in jurisdictions with weaker governance requirements to minimize compliance obligations.[436, 437] Into this inadequately governed ecosystem, AI systems are now being deployed with even less transparency and more potential for cross-national data-sharing. The UNESCO–UNICEF–ITU Charter for Public Digital Learning Platforms[438] represents an international call to action for governments to ensure that digital learning platforms are publicly governed, financed and controlled, with data sovereignty held nationally rather than by commercial actors based elsewhere.

Evidence gaps related to safety and well-being

The evidence base contains gaps that are structural rather than incidental, reflecting the power imbalance between technology developers and education decision makers. There is a clear pattern of inequity: the children and contexts most dependent on digital education are most at risk, and least represented in the research that is supposed to protect them.[439]

The evidence on online risks, psychosocial harms and data governance failures in LMIC educational settings is **disproportionately thin and largely derived from secondary adaptations** of research conducted in high-income contexts.[440] **Mitigation strategies** have not been thoroughly studied either. While frameworks such as safety-by-design, child rights impact assessments and privacy-enhancing technologies are well developed in theory, and their role as an advocacy tool has increased awareness of child rights concerns, there are significant barriers to implementing them.

Industry self-regulation and voluntary certification have never been properly evaluated, and it is unclear whether they produce real improvements or just performative compliance.[441] This is even more challenging for learner-facing tools built on generative AI models, which have little transparency.[442] Finally, **children's own views on privacy, data governance, AI literacy and ethics** are conspicuously absent from all known multi-stakeholder EdTech governance initiatives – a silence that is itself a governance failure.[443] Recent global consultations with children and young people further underscore the importance of incorporating children's own experiences and perspectives into digital education research, policy and practice, including in determining their best interests.[444] Yet recent evidence on AI and children's rights finds that meaningful child participation remains poorly embedded in AI governance in practice, while the wider evidence base remains predominantly short-term and concentrated in the Global North.[445]

Promising practices to protect safety and well-being

The picture described above is not without remedy. We believe it will be crucial, particularly through teacher training and curriculum integration, to ensure that teachers and learners are well equipped with digital and AI literacies that enable them to make day-to-day decisions about leveraging digital and AI-enabled technologies in ways that prioritize their privacy, well-being and development. In addition, across these domains, means of addressing harm at the level of design and governance are becoming more prominent in the evidence. Three of these approaches are outlined below: safety-by-design frameworks, well-being-centred design, and tools and resources for policymakers.

Safety-by-design frameworks

Frameworks which place the onus on averting potential harms on the tech developer have become an important mitigation measure. 'Safety-by-design' principles posit that potential harms should be identified and mitigated proactively at the product design stage, not reactively after launch. In practice, it requires EdTech providers to conduct structured risk assessments before deployment, embed protective defaults (high privacy settings, minimal data collection, no targeted advertising), and provide accessible redress mechanisms for users who experience harm.

The Child Rights by Design framework is among the best known of these frameworks.[446] It sets out core principles which tech tools should be evaluated against at the design phase, to ensure alignment with the United Nations Convention on the Rights of the Child.[447] Child rights impact assessments have been created (including one focused on digital tools, D-CRIA),[448] requiring high privacy settings, minimized data collection and turning off location tracking and profiling for children. While their use is still inconsistent, these tools are increasingly being leveraged for regulation by governments.[449, 450] Child rights impact assessments and audits are also now being applied to AI tools directly. In the United Kingdom, researchers at the London School of Economics Digital Futures for Children centre, working with the 5Rights Foundation, audited five generative AI tools used in schools (including Grammarly, Character.AI and MagicSchool AI) against the country's Age-Appropriate Design Code and found no evidence that any of the five companies had conducted a child rights impact assessment.[451]

Well-being-centred design

The documented risks to psychosocial well-being are, in part, products of design choices. However, design choices can be changed. For example, the RITEC-8 framework,[452] developed through participatory consultation with over 300 children across 13 countries, identifies eight dimensions of child well-being that digital design can positively support in designing gaming experiences.[453] It moves beyond harm avoidance to specify features with documented real-world effects: meaningful choice architectures, skip functions, off-ramps during negative emotional states, and transparent in-game reward systems. Experimental field research found that structured digital play improved well-being scores in South Africa and had positive effects on autonomy and social relations in Chile and the United States, with medium effect sizes.[454] These examples suggest that the manipulative engagement patterns identified as a structural concern are not inevitable features of digital design.

Tools and resources for policymakers

Tools and resources that provide guidance to education decision makers prioritizing learner safety and well-being in procurement decisions are crucial. Recently, many important policy recommendations from international organizations have been published around safety in digital education,[455] data governance[456] and AI use for children.[457] Beyond policy recommendations, guidance to users and families, enabling parents to help children understand advertising and online risks, can also prevent problematic usage of online tools.[458] Benchmarks which assess large language models against specific outputs or criteria relevant to education, such as pedagogy, visual reasoning, gender bias and contextualization, have also recently been developed to help education decision makers better understand which AI models should be used for specific education use cases.[459] The EdTech for Good Framework 2.0[460] applies safety and well-being criteria that can disqualify a tool outright if it fails on child data protection, privacy or safety grounds – regardless of its pedagogical merits.

Think piece

EdTech, AI and the safety of learners: A systems approach to child protection in education

Afrooz Kaviani Johnson, Catherine Flagothier and Auken Tungatarova

Within UNICEF's Global Programme Division, Dr. Afrooz Kaviani Johnson is a Child Protection Specialist, Catherine Flagothier is a Programme Specialist with the Secretariat of the Safe to Learn Initiative and Coalition housed within UNICEF Education, and Auken Tungatarova is an Education Specialist in Digital Transformation. This think piece introduces their five-point pathway for systematically integrating child safety into education in the digital and AI age. It argues that the burden of managing digital risks must shift from teachers, parents and students to the institutions and systems deploying these technologies. It is included in this section to offer policymakers and education leaders a practical, systems-level framework for embedding violence prevention and child protection into the design, procurement and everyday governance of EdTech.

Digital technologies are now embedded in everyday learning experiences for many children, from early childhood through secondary education. The digital revolution in education is often framed in terms of opportunities: expanding access, supporting teachers and enhancing learning outcomes. Yet the same technologies also shape how children experience harm, enabling new forms of harm, including exploitation, peer violence and privacy violations, and creating pathways to familiar risks such as bullying and abuse.[461]

This highlights the need for a more deliberate and considered approach to the use of digital technologies in learning environments. The United Nations Committee on the Rights of the Child provides a clear starting point. In General Comment No. 25, the Committee explains:

"States parties should develop evidence-based policies, standards and guidelines for schools and other relevant bodies responsible for procuring and using educational technologies and materials to enhance the provision of valuable educational benefits. Standards for digital educational technologies should ensure that the use of those technologies is ethical and appropriate for educational purposes and does not expose children to violence, discrimination, misuse of their personal data, commercial exploitation or other infringements of their rights, such as the use of digital technologies to document a child's activity and share it with parents or caregivers without the child's knowledge or consent."[462]

In other words, governments are expected to set standards, assess risks and ensure that technologies used in learning environments are safe, rights-respecting, fit for purpose and subject to oversight. Decisions about the use of EdTech should also always consider first whether they are educationally relevant, pedagogically sound and can contribute to meaningful learning for diverse groups of students.

This matters because schools operate within a public system and must serve the public interest, even as commercial actors play an increasingly prominent role in education.[463] A child using a learning app is a rights-holder in a digital environment where the State, school authorities and technology providers all carry responsibilities.

Too often, however, the burden of managing digital risk falls on those closest to the child – teachers, parents and caregivers, and children themselves – rather than on the systems and institutions that introduce these technologies. A more systematic approach is needed, especially as AI systems become embedded in education. Governments must also consider the long-term implications of technology choices, including how reliance on particular platforms or providers may influence future procurement decisions, data governance arrangements and schools' ability to transition to alternative learning solutions as needs evolve.

This think piece proposes a five-point pathway for systematically integrating safety into all aspects of education in the digital and AI age. It is structured around the five areas of Safe to Learn's Call to Action,[464] which is a global framework for ending violence in and around schools. These areas are further detailed in 'Safe Learners in a Digital World: Adapting the Safe to Learn tools to address technology-facilitated violence in and around schools', a technical brief developed by Safe to Learn and UNICEF.[465]

1 Establish and implement laws, policies and normative standards that treat digital and AI-enabled harm as part of violence prevention in, around and through schools.

AI-based solutions are already in schools and homes, yet laws, policies and standards are lagging behind. Frequently driven by the private sector, the rapid integration of digital and AI solutions before adequate safeguarding and data protection mechanisms are in place can expose children to digital risks, including excessive data collection, profiling, behavioural monitoring, opaque algorithmic decision-making and the commercial use of their personal information. Many governments are grappling with regulation and oversight of rapidly evolving AI technologies, often without frameworks, institutional capacity or clear evidence of emerging risks, opportunities and their overall impact on children.

Laws and education sector policies should therefore establish clear standards for the responsible design, procurement, deployment and governance of EdTech and AI-powered solutions used in education. Ministries of education should develop or update frameworks to evaluate technologies before adoption, including setting clear standards for data protection, platform design and reporting functionalities.

In addition to building responsible governance of EdTech and AI, legal and policy frameworks should acknowledge that children's experiences of violence, exploitation and abuse are increasingly shaped by digital technologies, which often occur in educational settings and have direct consequences for children's safety, well-being and ability to learn. This means that measures to prevent technology-facilitated violence should be explicitly integrated into broader school safety, education sector policies, planning processes and child protection policies.

AI, and specifically generative AI, intensifies these risks. Generative AI has made it possible to produce highly realistic synthetic sexual images, including non-consensual content involving children. Such content can be created without any original image and can quickly circulate within peer networks, including school communities, causing serious harm.[466] At the same time, conversational AI systems are increasingly used as sources of advice, information or emotional support, despite evidence that they may provide unsafe responses or lack basic safeguards for children.[467]

A policy framework that does not account for these forms of harm is not fit for purpose. Laws and policies must be technology-neutral in scope but explicit in standards, ensuring that protections apply across all digital and AI systems, including requirements for safety-by-design, child rights impact assessments and accessible reporting mechanisms.

2 Translate regulatory and standards-setting instruments into prevention and response systems that reflect how harm actually occurs in digital spaces.

Recognition at the policy level must be matched by implementation capacity. Effective implementation requires translating national laws and policies into school-level procedures and guidance, including clear expectations for technology use, data protection, reporting mechanisms, and responses to digital and AI-enabled harms. However, schools are not always equipped to do so. At the school level, as at the policy level, online safety should be embedded within safeguarding systems, including clear prevention, reporting and response mechanisms that span both physical and digital learning environments.

In practice, this means clarifying how digital technologies are used, what boundaries apply to communication among students, teachers and other school staff, how data are handled, and how incidents are reported. It also means ensuring that teachers and school staff have digital and AI literacy, skills and professional judgement to understand how different technologies function, to decide whether, when and how to use them to support teaching, learning and school tasks, and to recognize when technology-facilitated harm may be occurring.

Meeting these needs calls for two kinds of support: safeguarding guidance to help teachers and school staff identify and respond to harms, and broader pedagogical support to integrate technology effectively, critically evaluate digital and AI tools, and understand their benefits, limitations and potential risks. Signs of distress related to cyberbullying, coercion or image-based abuse – such as withdrawal, anxiety, declining academic performance – may mirror those associated with 'offline' violence, yet may require different responses.[468]

AI further complicates response and prevention strategies. Schools must now respond to harms that may involve synthetic media, impersonation or automated interactions such as chatbots. A child may report harm relating to an image that is not 'real' but is nevertheless widely believed to be authentic and shared.[469] Another may disclose that they relied on a chatbot for support and received harmful advice. Current prevention strategies, often focused on advising children not to share images or engage in risky behaviour, are insufficient in this context. Schools need clear protocols that connect reporting to action, including psychosocial support, referral to child protection services, and mechanisms for escalating content removal where appropriate. Teachers and school staff should understand their roles within these processes and have access to guidance, referral pathways and specialist support when concerns arise. If children are to use reporting processes, they must be accessible, trusted and linked to meaningful action.

3 Implement a whole-school approach to addressing violence in digital spaces, building a respectful culture and confronting social and gender norms shaping how technologies are used.

Technology does not operate in a social vacuum. Harmful social and gender norms extend into digital spaces and can be amplified there. This is particularly evident in relation to image-based abuse and AI-generated sexual content, which often reflect and reinforce existing patterns of gender inequality.[470]

Peer-to-peer deepfake sexual content can disproportionately target girls, while norms around masculinity, peer status and sexual entitlement can shape how such tools are used. Focusing only on the technology risks obscuring these underlying social dynamics. Prevention efforts must engage with peer behaviours, consent, respect and accountability, and must do so in ways that resonate with learners' lived experiences.

Shifting harmful norms and minimizing digital risks also require supporting learners to develop the knowledge, skills and critical understanding to navigate increasingly complex digital environments. Digital and AI literacy can play an important role in helping learners recognize manipulation, understand consent and privacy in digital spaces, critically evaluate online content and engage more responsibly with emerging technologies.
Teachers also benefit from ongoing opportunities to develop their digital and AI literacy, pedagogical skills and professional judgement required to use

these technologies safely, effectively and in ways that support learning. Such training cannot be a one-off exercise but should be continuous and integrated into professional development. These skills should be embedded alongside broader efforts to promote respect, inclusion and healthy relationships.

Schools are a critical site for this work, not only through formal curricula and the development of digital and AI literacy skills, but through the culture they create. Whole-school approaches, bringing together teachers, learners, school leaders, parents and caregivers and community members, are essential to shift norms that enable both in-person and technology-facilitated violence.[471]

4 Direct effective investment into both systems and human capacity development so that education systems and schools can manage digital risks rather than absorb them.

Expecting schools to address technology-facilitated violence without corresponding investment is unrealistic. There must be dedicated resources to support training, safe connectivity, vendor compliance and integration of digital safety into safeguarding systems.[472] Too often, digital tools are rapidly introduced into education systems while the resources required to manage their risks have not kept pace.

Procurement can be a particularly important lever. Governments should assess not only how technologies function within the platform, but also what happens when they are linked to external services where protections may not apply. In the case of generative AI, this becomes even more critical, given concerns around data use, transparency and safety safeguards. Research has found that some prominent generative AI tools in education expose children to tracking, inappropriate advertising and unreliable information, reinforcing the need for stronger oversight.[473] Governments can help create safer digital environments for children by requiring companies they contract to implement rights-respecting standards, not only for their EdTech products but also across their wider business practices.

However, procurement alone is not enough. Schools require the resources, guidance and implementation support needed to translate national policies and standards into everyday practice. This includes developing school-level procedures, digital education plans and strategies, data protection practices, acceptable AI use policies, reporting mechanisms and clear guidance on the safe and effective use of digital and AI-enabled technologies. Above all, investment should focus on people. Teachers, counsellors and school leaders require sustained training and support to understand evolving risks, respond to disclosures and navigate complex cases involving digital evidence or AI-generated content.[474]

5 **Generate and use evidence to respond to the realities of technology-facilitated violence, including AI-related harms.**

The capacity to respond effectively depends on understanding the scale and nature of the problem. Education data systems should track how technology contributes to violence in and around schools. At present, cases involving digital technologies, including AI, are either under-reported or not classified as such, limiting policymakers' and practitioners' ability to respond.

UNICEF's work on AI governance highlights the need for child-centred, gender-disaggregated research on how children use these tools, the risks they encounter and the experiences of children in LMICs, where evidence remains limited.[475] Policymakers and educators are increasingly required to make decisions about digital and AI-powered technologies before robust evidence becomes available. As AI tools continue to evolve rapidly, education systems need mechanisms for ongoing monitoring, evaluation and learning that enable policies and practices to adapt as evidence emerges. For education systems, this means ensuring that data systems can safely capture technology-facilitated harm, ensuring the highest standards of privacy and data protection, in ways that inform prevention, response and policy development.

The practical application of the principles

The challenge is both structural and adaptive: many education systems still lack comprehensive violence prevention frameworks, while those that exist have yet to be fully aligned with digital and AI-enabled learning environments. The task is to build and strengthen child protection approaches in, around and through schools where gaps persist, while integrating digital and AI-enabled harms into school safety systems, and embedding safety into the design, procurement and governance of digital technologies in education from the outset. At the same time, safe digital learning also requires investing in the capacity of schools and educators to make informed decisions about how technologies are used, ensuring that digital and AI-powered tools support teaching and learning while upholding children's rights, well-being and safety.

Think piece

Towards a new vision of digital learning and well-being for children

William Doyle and Pasi Sahlberg

William Doyle and Pasi Sahlberg are authors of the green paper for public discussion, 'Towards a new vision of digital learning and well-being for children' (UNICEF, forthcoming). Pasi Sahlberg is a Professor of Educational Leadership at the University of Melbourne, Australia, and William Doyle has served as a Fulbright Scholar and as an advisor to Finland's Ministry of Education. This think piece outlines their child-centred, rights-based vision for navigating the double-edged nature of childhood digitalization. It is included here to help shift the focus of conversation from simply preventing harm to also promoting well-being, grounding current contentious issues such as smartphone bans within the broader context of a child's right to play and thrive.

Introduction

"There can be no keener revelation of a society's soul than the way in which it treats its children." [476]

– Nelson Mandela, 1995

Today, that test is being administered around the world by smartphones, tablets and laptops in the hands of young people – devices given to them by their parents, teachers and policymakers. The digital well-being of children has become a defining question for the world's families and schools. As parents of young and teenage children ourselves, we have grappled with the complexities, risks and benefits of childhood digitalization on a near-daily basis.

For children, digitalization is a double-edged tool. It opens pathways for learning, expression and human connection, but poses real risks to childhood health, safety and development. A tablet in a refugee camp may be the only way to access a maths or science lesson. A smartphone in a classroom may hijack a child's attention. A laptop may offer a teenager life-saving health information or unlock the dangers of sleep loss, sexual exploitation, social media overuse and misinformation.

Nations are wrestling with hot-button issues such as smartphone bans, social media limits and the unknowns of AI in the hands of young people. Yet research on the risks and benefits of digital devices to childhood learning and well-being remains incomplete and preliminary. The digitalization of society, childhood and education are fast-moving subjects undergoing astonishing change. The sudden mass adoption of generative AI platforms in 2022–2026 illustrates the speed of these transformations. Fortunately, the path to childhood learning and well-being in the digital age has already been illuminated, in the form of key United Nations documents.

A rights-based vision

We propose a new child-centred, rights-based vision of digital learning and well-being for children, grounded in the United Nations Convention on the Rights of the Child,[477] the United Nations Committee on the Rights of the Child's General Comment No. 25 on children's rights in relation to the digital environment,[478] and the work of UNICEF, UNESCO, the World Health Organization and the United Nations Human Rights Council's Special Rapporteur on the right to education.

The rights of every child must be honoured in the digital environment. Under the Convention on the Rights of the Child, children have the rights to education, to privacy, to the highest attainable standard of health, to expression of their views and to protection from economic exploitation and all forms of physical or mental violence, abuse, negligent treatment, maltreatment or exploitation. The United Nations Special Rapporteur on the right to education has further identified both the right to safe and equitable internet and AI access, and the right "to opt out and disconnect" as "emerging twenty-first century fundamental human rights".[479] General Comment No. 25 instructs nations to ensure that, in all actions regarding the digital environment, the best interests of every child are a primary consideration.

In high-income countries, conversations increasingly centre on the need to protect well-being and learning by placing health, safety and distraction limits on children's access to technology through classroom smartphone restrictions, social media age limits and a new pushback by some parents against the unchecked roll-out of EdTech products. At the same time, in LMICs, the urgent question is often the opposite: the lack of digital access, especially for children living in poverty and with limited educational opportunity. If a child in very-low-resource conditions can only access education through a smartphone, then a blanket smartphone ban is a bad idea. And if a child of 7 or 17 cannot resist the compulsion to scroll through algorithmically powered feeds on a school-issued laptop through the day and night at the expense of learning and well-being, then such unlimited access is a bad idea too.

Notably, some leaders of Western technology companies have judged the risks of digital misuse and overexposure so severe that they have sent their own children to low-tech schools and restricted their children's use of digital devices.[480] Yet for a child who cannot attend traditional classes because of remote location, community restrictions, conflict, poverty, special needs or disability, an internet-connected tablet, smartphone, television or radio that can deliver essential lessons can be a lifeline. For a child in a marginalized or vulnerable community seeking information on mental health or physical safety, screen time can save a life.

Children in LMICs should be protected from the dangers of digital overuse, misuse, cyberbullying, sexual and criminal exploitation and loss of privacy no less than children in high-income countries.

General Comment No. 25 observes that the digital environment can meaningfully widen children's access to quality, inclusive education – supplying resources for formal, informal, peer-to-peer and self-directed learning, and offering distance or mobile learning to those outside school, in remote regions or facing disadvantage or vulnerability.[481] The Committee also notes that digital technologies can support children's health and well-being, provided that use is balanced against time for rest, physical activity and face-to-face contact with peers, family and community. General Comment No. 25 further recommends:

The use of digital devices should not be harmful, nor should it be a substitute for in-person interactions among children or between children and parents or caregivers. Training and advice on the appropriate use of digital devices should be given to parents, caregivers, educators and other relevant actors, taking into account the research on the effects of digital technologies on children's development, especially during the critical neurological growth spurts of early childhood and adolescence … States parties should ensure that the use of digital technologies does not undermine in-person education and is justified for educational purposes.[482]

The limits of EdTech as currently delivered

In 2023, when UNESCO published a major report on technology in education, it noted that technology "can improve some types of learning in some contexts", but the "learning benefits disappear if technology is used in excess or in the absence of a qualified teacher". The report stated that "there is little robust evidence on digital technology's added value in education" and that "intensive technology use negatively impacts student performance and increases disruption".[483]

Four problems influence the underperformance of EdTech. First, products are too rarely tested independently for effectiveness or risks of harm before being sold to schools. Second, the dominant delivery model isolates each child in front of a screen, in an era when society and the workplace demand collaboration, communication and creativity. Third, digital devices generate enormous distraction, and many children cannot reliably self-regulate against features designed by behavioural scientists to capture attention.[484] Fourth, traditional analogue tools such as paper books, pen and pencil, chalkboards and in-person instruction retain measurable strengths that the rush to digitization has overlooked.

None of this argues against technology in education. It argues for a different design.

UNICEF's Tinkering with Tech and AI[485] initiative – being implemented in schools in Honduras, the Maldives, Montenegro and Viet Nam and expanding to the Lao People's Democratic Republic, Ukraine and Uzbekistan – places small groups of children around shared devices, where they take turns, negotiate roles and build projects together using AI, robotics and coding. Teachers receive training and ongoing mentorship; girls are deliberately centred in spaces where global gender gaps in STEM begin early. The technology is not the focus; it is the medium through which collaboration, problem-solving and digital fluency are practised. This is the form EdTech should increasingly take: human relationships at the centre, and devices as enablers.

The voices most often missing

In a 5Rights Foundation consultation with more than 700 young people across 27 countries, children expressed views that were complex and sometimes contradictory but unmistakably their own. They want to be part of the digital world, not only as users but as creators and decision makers. They want affordable, equitable access to digital opportunities. They want protection from harm but resent restrictions imposed on them without consultation. They want privacy. They are clear-eyed about the commercial machinery beneath the platforms they use. And they want the adults around them to model the behaviour they preach.[486]

A new vision: Three priorities

We propose a vision that moves from technology-driven to more child-centred, evidence-informed approaches to deliver better learning and well-being to children.

First, put children's rights and best interests first. All decisions and recommendations about digital devices in children's lives should be grounded in the Convention on the Rights of the Child and General Comment No. 25: rights to education, health, expression, privacy, protection from exploitation, and participation in decisions that affect them. The precautionary principle should govern. As the UNICEF Innocenti research team noted in May 2025 in a recommendation on AI chatbots that can apply equally to all digital device use by children: "The precautionary and do-no-harm principles should apply: in case of doubt, aspects of the technologies should not be made available to children."[487] Governments should require digital education platforms to be safe by design and by default – with embedded time and content controls, strong age-appropriate privacy protections and the removal of features known to drive compulsive use. Independent evaluation and alignment with good-practice standards, not vendor marketing, should determine what reaches classrooms.

Second, treat digital well-being as an essential school outcome. Schools should equip every child with a comprehensive digital education that teaches not only how to use digital media and technologies but how to live safely, responsibly and wisely with and without them. Digital tools should be deployed in schools only where there is strong independent evidence of pedagogical benefit, and should support rather than replace human teachers and in-person collaboration. Effective analogue tools such as paper, pen, physical books and human conversation should be honoured and strengthened, not phased out. Teachers and parents should be supported to model the digital behaviour they hope to see. Digital well-being should be part of the future metrics for measuring the performance of schools and education systems.

Third, guarantee regular play and physical activity for every child, in and out of school. Article 31 of the Convention on the Rights of the Child guarantees every child "the right of the child to rest and leisure, to engage in play and recreational activities appropriate to the age of the child and to participate freely in cultural life and the arts". The World Health Organization recommends that children and adolescents aged 5–17 "should do at least an average of 60 minutes per day of moderate-to-vigorous intensity, mostly aerobic, physical activity, across the week" and "limit the amount of time spent being sedentary, particularly the amount of recreational screen time". It noted that "evidence indicates that greater time spent in sedentary behaviour, especially recreational screen time, is related to poorer health outcomes". On the positive side, it reported that physical activity reduces the risk of experiencing depression, and has positive effects on cognitive function and academic outcomes such as school performance, memory and executive function in children and adolescents.[488] Regular recess, fun and inclusive physical education, and free play and movement are not luxuries; they are foundations for children's learning and well-being.[489]

Three contested issues

Three critical issues are now being debated in schools, homes, the media and the halls of government: banning smartphones in schools, setting a minimum age for social media, and designing the role of AI in education. We propose that each issue be addressed in light of the priorities outlined above, by the best available evidence and by how to advance the priorities of children's rights, voices, well-being and learning.

1 **Smartphone bans in schools.** As of March 2026, UNESCO's Global Education Monitoring (GEM) Report team counted 114 education systems – 58 per cent of countries worldwide – with a national ban on mobile phones in schools, up from 24 per cent when the policy was first monitored for the 2023 GEM Report.[490] The evidence on the academic and well-being effects of such bans remains mixed. We support context-sensitive policies that reduce distraction without severing learning lifelines – particularly in LMIC settings where a phone may be a child's only path into education.

2 **Social media age limits.** The status quo on social media is failing children, and recent legislation reflects legitimate concerns over the risks of harm. But age limits alone, without

redesigned platforms and meaningful support through the education of children, educators and parents, risk pushing children into less regulated spaces and reducing incentives for companies to build safer products. Early evidence suggests age limits are very difficult to enforce: Australia's online safety regulator found that three months after its under-16 ban took effect, nearly 82 per cent of under-16s were still using at least one restricted social media platform, compared with 86 per cent before the ban.[491] Protection must come through platform accountability, not exclusion alone. Children should be deeply involved in both the process of reviewing the evidence and the design of solutions.

3 **AI.** AI is being marketed to children as a tutor, coach and companion, often without safety testing or age-appropriate design. We support the deployment of AI in education only where there is credible evidence of pedagogical benefit and where risks to children's rights are identified and minimized. Companion chatbots that mimic intimacy raise particular developmental and safety concerns. Children must be meaningfully included in shaping the AI systems that will shape them. AI literacy should be framed not as 'how to use AI well' but as 'how to know when not to use it, and what the risks are'.

Build the digital world in partnership with children

The path forward is not through adult-imposed rules alone. Children and adolescents are not passive users of technology, or problems to be managed. They are creators, learners, citizens and rights-holders. They are also, in many parts of the world, increasingly pulled between school, family, peer pressure and platforms engineered to be inescapable. The most hopeful task ahead is to give them agency in the design of the digital world, real information on risks and benefits, and the skills, support and adult example they need to navigate both. **A better, fairer, safer digital world will not be created for children unless it is also created with them.**

Case study

Viet Nam: Turning digital and AI safeguards into school-level practice

This case study was developed primarily through an interview with a senior official at the Viet Nam National Institute of Educational Sciences, a key state research organization under the Ministry of Education and Training. The interview explored in detail how Viet Nam is addressing data protection, safety and well-being as the use of digital education and AI expands. Assertions made in the case study are based on the information shared by the official and are not cited individually in each instance. The official's insights were supplemented by background research and selected publicly available policy documents to contextualize and verify the key points raised.

Context

Viet Nam has prioritized digital transformation in all aspects of its economy as a key strategic goal of its National Digital Transformation programme to 2025, with orientation to 2030.[492]

Specifically in education, frameworks have been developed to enable digital education management, digital learning resources, online teaching and learning, and the use of data to support governance and service delivery.[493]

This policy direction builds on a relatively strong foundation of access to and use of digital technologies for education in schools across the country. A 2025 United Nations Viet Nam profile reported that 9 out of 10 schools were connected to the internet, bringing Viet Nam closer to its national target of full school connectivity.[494] The 2018 General Education Curriculum made ICT a compulsory subject from Grade 3.[495] Digital transformation efforts have been especially prominent in education management, data collection and monitoring, while Viet Nam is increasingly turning attention to the integration of digital and AI competencies into teaching and learning.[496]

Supporting the ambitions for cross-sector digital transformation are also formalized data protection policies such as the Personal Data Protection Law.[497] This took effect on 1 January 2026 and establishes a comprehensive data protection framework aligned with internationally recognized privacy principles. Within the context of education, the key challenge is ensuring that protections for children's data as mandated in the policy are translated into consistent practice across schools.

Spotlight on practice

Viet Nam's experience illustrates a common challenge for fast-moving education systems: legislation, strategies and competency frameworks regarding the use of digital technologies can develop faster than the capacity required to implement them consistently and effectively. The senior official interviewed identified two issues that are particularly pertinent for ensuring safe digital education across the country: managing the risk of data leakage as education systems become more connected, and building the human capacity needed to translate national safeguards, including by identifying and promoting positive examples of digital and AI transformation into school-level practice.

Data leakage and system integration

Data leakage is identified as a major data security risk for Viet Nam. This risk is partly technical: in earlier phases of digital education development, some systems were built to meet specific programme or reporting needs, rather than as part of a secure and interoperable national data architecture. Over time, this fragmentation made it harder to apply consistent security controls, manage access rights and ensure that data moved safely across the system. Where systems were developed for time-bound projects, they could also lose funding or technical support once the project ended, contributing to repeated cycles of rebuilding. Viet Nam is now moving towards more integrated national data systems, with the government playing a stronger coordinating role.

The risk is also institutional. At the school level, teachers and leaders receive training on privacy, cybersecurity and online safety within the teacher training programme, but this does not always translate into practice. Staff may know these issues are important in principle, yet still lack the procedural knowledge, confidence or support to respond when a real incident occurs. Ensuring standardized compliance across all schools and regions has proven challenging. Schools need stronger escalation pathways, defined roles, incident response protocols, and staff who understand both education and digital risk.

Clear protocols that can be applied in practice

The absence of clear protocols for digital safeguarding and the effective use of digital technologies and AI can leave schools in a difficult position. Without adequate guidance, staff must rely on their own judgement when developing students' digital and transferable skills for future work in a rapidly changing labour market. AI is adding pressure to this implementation gap.

Viet Nam is moving from general digital literacy towards explicit digital and AI competencies. A digital competency framework for students, developed by the Ministry of Education and Training with the support of UNICEF Viet Nam, has been issued, and an AI curriculum framework for Grades 1–12, also supported by UNICEF Viet Nam, is being piloted during the 2025/26 school year.[498] The inclusion of gender responsiveness, security, data protection, privacy, AI application and transferable skills development in the teacher training framework signals that digital competence is increasingly being framed as part of safe, equitable and responsible education governance.

The national conversation and sentiment are also moving rapidly: in 2023, schools and policymakers focused on asking whether AI should be banned; by 2026, the focus was on the practical question of how it should be used most effectively. This observed shift matters because AI brings digital safety questions closer to everyday teaching and learning. Another important consideration in rolling out digital and AI competency frameworks is how to narrow learning gaps for the most marginalized learners, including children with disabilities and from ethnic minority communities. Digital and AI initiatives should serve as enablers rather than barriers, reducing rather than widening inequalities in learning outcomes and skills development.

Financing and budget constraints

Financing and budget limitations reinforce the implementation gap between policy ambition and day-to-day practice in schools. Public education is largely government-funded, but routine school budgets are heavily absorbed by salaries and annual operating costs. It is estimated that around 80 per cent of regular funding goes to recurrent activities, leaving little room for academic improvement, teacher development, specialist support or sustained capacity-building. Technology investments can be funded through separate government projects, but the human capacity needed to use those systems safely is often harder to finance, measure and maintain. Schools are expected to have ICT staff, and Viet Nam has also introduced school-level mental health counsellor positions, reflecting growing attention to student well-being. However, these roles can be difficult to fill. They may be perceived as having a lower status than core subject teaching posts, while salaries may be less competitive than opportunities outside schools, and training pathways are still developing.

Reflections and lessons learned

Viet Nam's experience points to three lessons that may be applicable for other education systems that are also moving quickly to incorporate digital technologies at scale.

1 **The implementation challenge begins at school level,** as Viet Nam already has digital transformation plans, data protection legislation, competency frameworks and AI pilots in place. The next priority is ensuring that teachers and leaders can apply these commitments consistently in daily decisions about privacy, cybersecurity, online safety, transferable skills development and student well-being.

2 **Data leakage requires system-wide attention,** including secure and interoperable data systems, clear access rights and practical incident response procedures. As systems become more integrated, the key governance question is how responsibility is distributed across the education system.

3 **People are central to safe digital transformation,** because infrastructure, platforms and AI tools depend on those using and governing them. Viet Nam's experience highlights the need for prioritizing ongoing investment in school-level ICT support, mental health counselling, teacher training and practical guidance for how ambitious policies should be applied at the school level. Particular attention should be given to identifying and implementing solutions that close the digital divide for the most marginalized groups.

Viet Nam's case is ultimately about investing in the people who make safe digital transformation possible. Data protection, online safety, AI governance and digital well-being require people who can interpret risk, support teachers, advise school leaders and respond when harm occurs.

Part 5

Designed for learning and teaching

Companies should start thinking about the people behind the screen."

Child, United States, 10–13 age group[499]

Evidence review

Context

This section synthesizes evidence from LMICs across five dimensions: pedagogical practices, educator support and autonomy, learner-centred design, participatory processes and human-centred AI. The analysis draws on OECD guidance, UNICEF digital education evidence, EdTech Hub research and other relevant literature.

The following analysis addresses the central question:

What evidence do we have about how digital and AI-enabled technologies can be designed and used in ways that support effective teaching and learning processes for greater educational equity?

Key insights

- Commercial EdTech products often prioritize technologically novel features over meaningful learning opportunities, driving **adoption based on shallow-form engagement metrics** rather than pedagogically grounded learning progression.

- Learner-facing EdTech can sideline teachers into support roles while platforms deliver core instruction, **undermining teachers' relational, creative, empathetic and ethical qualities** within the pedagogical process.

- EdTech that fails to account for learners' diverse cognitive, sociocultural and contextual realities risks widening existing inequities; **learner-centred design must address techno-ableism and treat learner variability as the norm** through differentiated, supported instruction.

- Participatory, iterative approaches to designing EdTech solutions with educators and students that **consider the interconnection between humans and technology** will be more effective in the long term.

- While most current evidence investigates the impact of AI adoption on a narrow set of educational outcomes, this often **overlooks social, emotional, cultural and ethical dimensions** that are critical to the development of the whole child.

What the evidence says to date on designing for learning and teaching

The learning sciences – incorporating cognitive science, psychology, anthropology and linguistics – show that learning is an active, supported process contingent on learners' prior knowledge and cultural contexts.[500] Effective EdTech should therefore be adaptable – allowing teachers to deliver guided, differentiated instruction tailored to students' learning levels.[501] 'Designed for learning and teaching' therefore requires EdTech to be informed by evidence from the learning sciences. This evidence base informs the underpinning pedagogies, and associated practical teaching and learning approaches[502] which shape the impact of digital and AI technologies on teaching and learning. While evidence has consistently shown that infrastructure and device investments, when decoupled from targeted pedagogical interventions, yield limited impact,[503] more nuanced challenges remain regarding ineffective uses of EdTech, many of which are amplified by the increasing use of AI in education.

Pedagogical grounding is often missing by design

EdTech and AI developers do not automatically bring a deep understanding of the learning sciences to their work. This can result in products that do not follow evidence-based teaching and learning practices.[504] Learning theories, including social constructivism (learning through interaction), dialogic approaches (learning through dialogue) and liberationist perspectives (emphasizing power and learner agency), are often neglected during design and development.[505] Engagement with such theories is important to ensure they can ground EdTech in one – or a blend – of these ideas, depending on the pedagogical purposes of the intervention.[506] These theories give rise to a range of teaching and learning processes, such as retrieval practice, scaffolding, debate and metacognitive reflection, and which of them is appropriate depends on the intended learning goals, who leads (teacher, learner or EdTech), and who participates.[507, 508]

Beyond pedagogical grounding, EdTech in LMICs requires contextual alignment with infrastructure, teacher capacity, language, curricula, data governance and wider political economies.[509] Strong examples combine such alignment with pedagogically grounded implementation. In Andhra Pradesh, India, a government-run, curriculum-integrated digital personalized learning programme used diagnosis, targeted instruction and feedback through shared tablets and teacher-supported classroom sessions, producing learning gains 2.3 times those of controls.[510] In rural Bangladesh, curriculum-linked literacy and numeracy lessons delivered in Bengali through basic phones and supported by caregivers improved learning by 0.60 standard deviations, with particularly strong benefits for disadvantaged learners.[511]

Despite these examples of good practice, when EdTech tools apply teaching and learning practices in limited and superficial ways, it can lead to a 'crutch effect' – accelerating task completion while weakening retention and transfer – unless teachers intentionally embed pedagogical structure and context.[512] Offloading cognitive work – for example, to chatbots – risks fostering 'metacognitive laziness'[513] and can remove desirable difficulty, productive failure and the cognitive effort required for deep learning.[514]

There is a particular propensity for some commercial EdTech tools to prioritize technological sophistication, engagement and completion over pedagogy.[515] This 'feature fallacy' drives adoption based on novelty rather than pedagogical effectiveness, assuming sophisticated features or polished interfaces improve learning. The fallacy shifts developers' focus from how students learn to what the software can do.[516] There is also a tendency for some EdTech providers to overly depend on a single pedagogical approach, without acknowledging its limitations or conditions for appropriate use. An example of this is the way that some digital personalized learning systems are rooted in critiqued behaviourist models – casting students as passive and teachers as information givers – while still being championed as solutions to the learning crisis.[517]

Digital and AI-powered tools can sideline teachers when their agency is not prioritized

Within centrally managed and organized education systems in LMICs there are questions around the space left for teachers to lead, take decisions and effect changes within their respective contexts.[518] Teacher autonomy can be further constrained by structural realities accompanying the expansion of digital and AI environments. In contrast, where digital and AI tools are integrated into a rhythm of teacher-led usage that preserves their agency – allowing teachers to override technology-derived recommendations when they choose to – there is evidence that this is likely to result in significant learning gains.[519] This balancing of agency with technological adoption is complex. While technological tools may free up time for teachers by automating routine tasks, they can also introduce hidden labour, as teachers must verify and correct outputs.[520] Some tools reduce lesson planning and grading demands.[521] Yet others encroach on the instructional core, reducing pedagogical autonomy[522] and in effect relegating teachers to supportive roles while platforms lead instruction.[523] This sidelines teachers' relational, creative, empathetic and ethical qualities within pedagogical processes, which can diminish learning experiences.[524]

Learning analytics dashboards aim to help teachers intervene when necessary, but their effectiveness is often limited due to a lack of actionable insights, limited flexibility and little focus on learning outcomes.[525] Without clear interpretation of dashboard data, they can constrain rather than support teachers, especially as 'automation bias' often leads teachers to defer to system recommendations.[526] Overemphasis on easily measurable indicators further risks diverting teachers' attention away from learners making meaningful progress.[527]

Ultimately, when teacher agency is diminished, education risks becoming dehumanized.[528] For teachers to effectively and agentically integrate technology into their practice, their professional development must go beyond basic digital skills and platform usage, and also include training on critical digital and AI literacy.[529]

Inclusive design for learners must consider individual variability

When EdTech fails to account for learners' cognitive, motivational, socioeconomic, linguistic, cultural, technological, accessibility and agentic needs, it risks widening inequalities between those who can access EdTech and those who can use it meaningfully. These barriers operate at multiple levels, from whether learners can access and understand a tool to whether it supports their ways of learning, identities, agency and participation. Children themselves highlight these challenges, pointing to restrictive security filters, financial barriers and paywalls, discrimination and cyberbullying, and English-centric platforms that limit access, self-expression and participation.[530]

Recent studies underscore the importance of learner-centred design. In Ethiopia, educational television and digital libraries widened gaps by primarily benefiting urban, economically privileged learners.[531] Similarly, some generative AI models have been shown to reproduce aspects of pre-existing global power hierarchies through Western-centric content, cultural stereotyping and weak support for local languages.[532] However, generative AI models have rapidly improved in this regard. For example, one benchmark of how well large language models support the teaching of pedagogical concepts in African languages found Kiswahili to be within 1–3 percentage points of English.[533] Yet the gap is far greater for more marginalized languages, which is a concern for minority language teachers and learners.[534]

Inclusive design, supporting learners' diverse needs, has been shown to produce positive outcomes. EdTech initiatives such as Google's Read Along have shown statistically significant gains by supporting learners' reading and pronunciation in languages such as Hindi, Tamil, English and Swahili.[535] In Kenya, researchers are leveraging AI to support deaf learners by translating spoken English into Kenyan Sign Language via virtual avatars.[536] These cases highlight that learner-centred digital and AI technologies must go beyond user-friendly interfaces and offline access to address learner variability.[537]

Structured, participatory co-creation can lead to substantive improvements

Participatory co-creation offers a way to identify and fix design weaknesses before deployment, but there are limited in-depth examples of this. Where human-centred design is substantive, iterative, structured and genuinely incorporates educator and learner voices from idea through evaluation, it yields tangible benefits.[538] For example, continuous co-design of the Akelius digital language tool with refugee students, teachers and engineers improved attendance, peer support and self-esteem while reducing dropout.[539] However, extractive co-creation can also shift unpaid design labour onto teachers while benefits accrue to developers, and participation does not always lead to adoption.[540]

Participatory approaches can also ensure learner variability is considered at the outset. This can include designing **with** learners with disabilities to address issues such as techno-ableism. For example, in Brazil, deaf primary-school learners were design partners, alongside teachers and developers, to build a bilingual educational game; their ideas and lived experiences directly shaped the game's characters, rules, setting and more.[541] However, if the design of such products is not participatory, the risks of techno-ableism – i.e., enforcing ableist tropes and ideas on persons with disabilities – are heightened.[542]

Structured approaches, such as EdTech Hub's teacher-in-the-lead sandboxes and WISE EdTech Testbeds, and public sector-led hubs such as Helsinki Education Hub and Ceibal bring teachers, researchers, developers and policymakers together to co-create and test context-sensitive solutions.[543] Similarly, Design-Based Implementation Research for Digitally Enabled Education Reform (DBIR4DEER) in the United Republic of Tanzania demonstrates how collaboration between researchers, policymakers and practitioners can embed iterative co-creation into system-level reform.[544] Together, these varied approaches link co-design with evidence generation and governance, helping quality-assure EdTech through alignment with national standards, ethics and data policies.

Evidence gaps related to design for teaching and learning

Despite a growing evidence base, critical gaps constrain both policy confidence and product accountability regarding teaching and learning design.

1 **Safeguarding, accountability and ethics:** As AI enables more autonomous, agentic content generation and pedagogical decision-making authority, the consequences of design flaws such as inappropriate content, inaccurate recommendations, excessive scaffolding, misaligned feedback, cultural bias and emotional manipulation become more severe and harder to detect.[545] EdTech companies often absolve themselves of responsibility in terms and conditions of use.[546] Research should examine the guardrails present to ensure high-quality, safe teaching and learning, and accountability lines for data protection compliance, ethical adherence, student safeguarding and learning outcomes, especially when responsibility is distributed across human and AI actors.

2 **Holistic learning:** With EdTech increasingly focused on improving measurable cognitive test scores,[547] the holistic aims of education from philosophical, political, ethical and social framings are often neglected.[548] Additionally, the increase in technology-mediated learning can lead to a reduction in physical and embodied learning. Research should explore the impacts of various types of digital and AI-powered technology on children's whole long-term development.

3 **Teachers' role:** AI in education is reshaping teachers' roles, requiring them to continually adapt to new technologies, revise assessment practices (as AI blurs distinctions between learning and performance) and verify AI outputs. This role shift can contribute to digital burnout, particularly among novice teachers.[549] Research should investigate the long-term implications of EdTech and AI integration for teachers' professional development needs and overall well-being.

Promising approaches when designing for learning and teaching

A set of approaches is emerging that tend to put pedagogy ahead of technology. They show how digital tools can extend what teachers and learners can do, rather than substitute for them, and challenge assumptions about what effective EdTech requires.

Shared and collaborative digital learning

Emerging approaches challenge the assumption that effective EdTech requires one device per learner. UNICEF is testing shared-device models that combine digital technology with collaborative, playful and peer-to-peer learning, potentially offering both pedagogical and cost advantages in resource-constrained settings.[550]

Models of human–AI collaboration

Emerging concepts such as 'synergistic teaming' or 'multi-intelligence learning ecology' describe AI and humans working collaboratively to extend each other's cognition, producing outcomes greater than either alone, while also addressing concerns about declining teacher judgement.[551] These approaches can support holistic, pedagogically purposeful and context-responsive learning in the age of AI by safeguarding human connection.

Benchmarking AI's teaching capability

Effective integration of digital and AI-powered technologies depends on whether large language models can meaningfully support teaching. Pedagogy benchmarks have emerged that assess models against teacher certification standards. Leading systems now exceed 90 per cent performance, offering a proxy for teaching capability.[552]

Tools for learner agency and self-regulation

Alongside this, new genres of AI tools aim to enhance learner agency and self-regulation rather than task completion alone,[553] including conversational tutors supporting emotional and cognitive development such as Socratic Playground and systems such as FLoRA that provide personalized scaffolding targeting self-regulated learning strategies.[554] While these developments expand learner agency, they may also raise concerns about displacing rather than complementing educators' roles.

Technology-supported learning through making

Physical computing can shift learners from consumers to creators of technology, supporting project-based learning, creativity, collaboration and problem-solving.[555] Emerging system-level applications include Colombia Codes, which integrates hands-on physical computing into the national computing curriculum while adapting activities for schools with limited connectivity and devices.[556]

Think piece

How AI can support teachers – and why teachers must shape it

Daniel Plaut and Brenda Haiplik

Daniel Plaut is AI Observatory and Action Lab Learning Lead at EdTech Hub. Brenda Haiplik is Senior Education Advisor and Global Lead for Teacher Development and Workforce at UNICEF. Their think piece explores the available evidence on the following question: what do we know about where AI can meaningfully help with the work of teaching and catalyse more effective instruction and improved outcomes for every learner? Framed by EdTech Hub's Three Horizons framework, the piece illustrates what meaningful, teacher-centred AI integration looks like in practice. Building on the previous piece about teaching at the right level, it is included here to underscore the vital strategic, technical and operational roles that teachers should play in influencing AI adoption.

How can AI best support teachers?

Millions of teachers across the world work in extremely demanding contexts and conditions. Many face overpopulated classrooms, inadequate resources and uncertain environments, increasingly shaped by climate and conflict crises. Teachers are also in short supply: an estimated 50 million additional teachers are needed by 2030 (covering preschool to upper secondary), including 15 million in sub-Saharan Africa alone, where pupil–teacher ratios average around 37:1.[557] Additionally, heavy workloads, time-consuming administrative tasks, major gaps in subject knowledge and fragmented professional development (pre- and in-service) contribute to low motivation and retention, high absenteeism and constrain the quality of instruction learners receive.[558]

The use of AI (spanning the full spectrum from established machine learning and predictive analytics to newer generative AI) is increasingly being promoted to help ease these difficulties by streamlining teachers' routine tasks (e.g., classroom administration), strengthening pedagogy, and extending professional support (e.g., on-demand coaching, continuous professional development resources) to teachers. To understand where AI is effectively aiding teachers' work, UNICEF and EdTech Hub have each been mapping the field through country-programme analysis, market scans and a series of learning briefs that examine how AI tools might be affecting teachers' roles.

Three findings stand out:

1 **The evidence is still early and limited.** While teacher-facing generative AI tools are emerging quickly, most research focuses on use cases in which students directly interact with AI.[559] Most teacher-facing tools are designed for teachers working in the Global North, with a small but growing evidence base in LMIC contexts. Much more research is needed (qualitative and quantitative) to better understand how teachers (new to very experienced) are actually using these tools, and which use cases deliver the greatest benefit – in time saved, instructional quality or teacher confidence and student learning, especially for teachers working in marginalized, crisis, low-resource, low-connectivity and multilingual settings that are often excluded from research and product design.[560]

2 **Despite these gaps, a handful of use cases already show promising early evidence.** To date, AI is most helpful where it enables teachers to perform routine tasks (e.g., administration and planning) more efficiently (potentially freeing more time for direct student engagement), and where it can enhance or strengthen teacher instruction – for instance, helping generate curriculum-aligned lesson plans and teaching materials; assessing and providing feedback on foundational skills such as oral reading fluency; offering on-demand personalized, confidential coaching; and enabling more personalized instruction through adaptive materials and activities which teachers actively steer. **In each case, the value comes from helping teachers perform tasks more efficiently and sharpening their delivery, not from doing the job for them.**

3 **Teachers are not passive recipients of these tools; many are already adopting them on their own and making judgements about where they help.** EdTech Hub's Teacher-in-the-Loop survey,[561] focused on educators in LMICs, found that 82 per cent of teachers were currently using AI in their teaching or within school environments. That agency should be built on: these tools are far more likely to add value when they solve a real problem teachers actually have, and when teachers are brought to the table as use cases are co-designed, tested and refined.[562]

The current teacher and AI landscape

EdTech Hub's AI Observatory and Action Lab[563] offers a helpful way to organize this landscape through three horizons: Upgrade, where AI helps teachers complete existing tasks more efficiently; Disrupt, where it changes the underlying practices of teaching and redistributes how teachers spend their time; and Transform, where the very nature of the teacher's role is rethought to account for AI's presence in education.

Table 2. Summary of AI use cases for teachers across three horizons

Horizons	What does this mean for empowering teachers?	Use cases
Horizon 1: Current dominant system where change happens incrementally within existing structures	**UPGRADE:** Early integration of AI into teachers' roles, where some existing tasks and processes become streamlined or enhanced, while new demands emerge around oversight, adaptation and judgement.	• AI for content creation and lesson planning • AI for saving time on administrative tasks • AI for assessments, grading and feedback • AI for professional development
Horizon 2: Turbulent space of innovation and experimentation as society shifts from the status quo to a new paradigm	**DISRUPT:** AI use becomes more formally evaluated and embedded in teaching, addressing some early identified issues and disrupting aspects of teachers' roles in ways that shift their practice or time allocation.	• AI-powered digital personalized learning • AI tutor chatbots • AI teaching assistants • AI-powered inclusive education and language accessibility
Horizon 3: Radical new visions of the future that exist on the fringes today compete to be the future dominant system	**TRANSFORM**: The role of teachers is fundamentally changed, with AI being a core facet of the teaching and learning experience in novel ways.	• 'Teacherless' classrooms • Teacher–AI complementarity and hybrid intelligence • Multi-intelligence learning in unbound learning environments

Source: Adam and Lester (2025).[564]

Most current activity and evidence sits in the **Upgrade** horizon, where AI streamlines existing tasks. The use cases with the strongest evidence are:

1 **Content creation and lesson planning:** AI is being leveraged by teachers to more quickly and easily generate curriculum-aligned lesson plans and learning materials. Early evidence shows this can be done effectively: for example, a study in England found that ChatGPT cut teachers' planning time by 31 per cent with no loss of quality.[565] Taleemabad's WhatsApp-enabled lesson planning tool Lesson Genie, tested in Pakistan, has also demonstrated significant time savings for teachers.[566] While promising, the impact of this use case on teacher and learner outcomes is not all positive: one recent study has suggested that AI-generated material development by teachers can lead to cognitive offloading and worse outcomes for learners.[567]

2 **Learning assessment and feedback:** AI can offer efficient and insightful use cases for assessing student understanding and providing feedback. AI oral reading tools such as Pratham's PadhAI and South Africa's EGRA-AI show promise, with the latter reaching roughly 95 per cent accuracy in local languages.[568]

3 **Professional development and coaching:** Tools which provide content and pedagogical guidance to teachers through low-bandwidth platforms are being deployed in many LMIC contexts – for instance, in Sierra Leone the WhatsApp-based chatbot TheTeacher.AI was preferred over web search and proved around 98 per cent less expensive.[569]

In the **Disrupt** horizon, AI begins to shift how teachers spend their time and support more directly in instruction. The clearest gains come from:

1 **AI-enhanced digital personalized learning:** Randomized trials of EIDU in Kenya, Ei Mindspark in India and ConveGenius's adaptive programme have recorded gains of roughly 0.35–0.5 standard deviations, meaning learners reached outcomes well beyond their standard pace, with the ConveGenius programme's impact being equivalent to almost two additional years of learning at around US$20 per student.[570, 571] Importantly, these tools still rely on the human-centred relationship between teachers and students, and for teachers to be actively involved in deployment: assigning tasks, reading dashboards and adjusting instruction, rather than leaving the work fully to the algorithm.[572]

2 **AI tutor chatbots** such as Rori in Ghana have demonstrated positive impact on learning outcomes – in this case finding that two 30-minute sessions with the tool per week for eight months led to gains of 0.37 standard deviations, the equivalent of moving the average student from the middle of the class to the top third.[573] But beyond this example, results on effectiveness from similar tools vary, and are highly dependent on the tool and the context.[574]

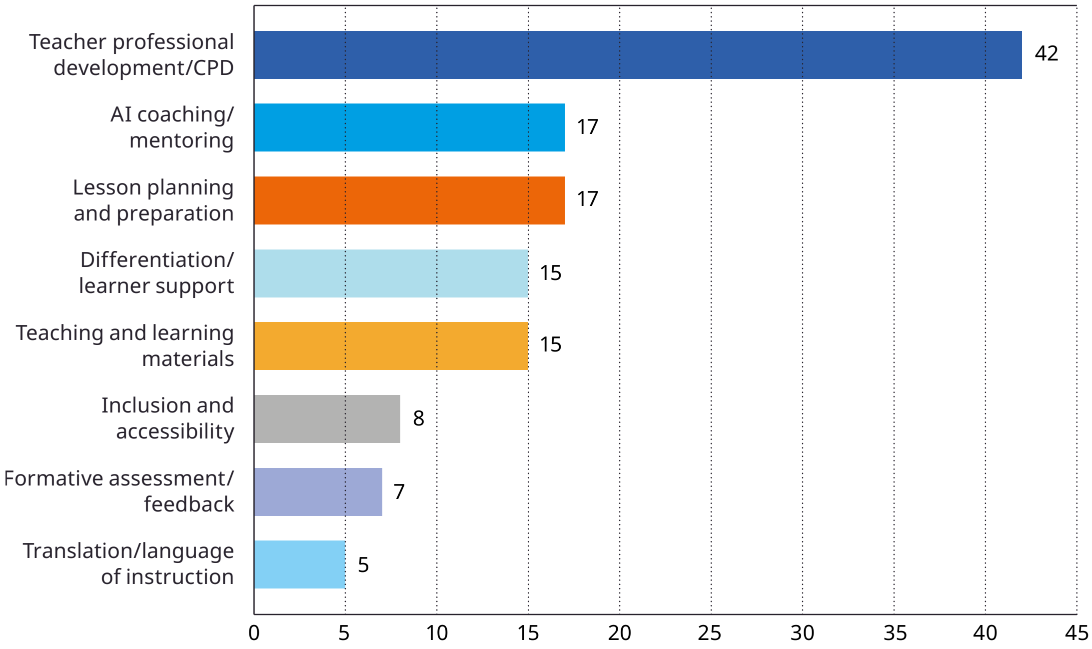
3 **AI inclusive-education tools** (including those providing sign-language translation, or catering to neurodivergent students with intelligent tutoring systems) are spreading quickly, and show promising results, in one case improving learning outcomes across learners with diverse learning needs,[575] but rigorous evidence on learning outcomes is still scarce.

The **Transform** horizon, in which teachers' roles are fundamentally reshaped, remains the most speculative. Concepts such as **teacher–AI complementarity** (or 'hybrid intelligence') where teacher and AI combine to extend the skillset of the other in an ongoing exchange, and **AI-led learning environments** where AI is set up to provide the core of instruction in an adaptive and personalized manner, are emerging but thinly evidenced.[576] There is significant uncertainty about the impact of these types of arrangements, but some positive results have been identified: the Tutor CoPilot model, which feeds real-time suggestions to human tutors who stay in control, led to modest but meaningful gains, with the largest occurring for the least experienced tutors, suggesting a potential to narrow gaps in instructional quality.[577]

Limitations and open questions

The evidence base is maturing, but important questions remain. UNICEF employees representing 70 UNICEF country offices working directly with ministries of education responded to a survey in July 2026. As shown in Figure 5, an analysis of their responses indicates a common perception of the importance of interrogating affordability, sustainability and child safeguarding concerns for teacher-facing AI tools, and the need to integrate AI into national teacher development systems rather than create standalone projects.

Figure 5. Survey to UNICEF country offices: Number of mentions of priority areas for highest-value support to teachers with AI (n=75)



Source: Survey for UNICEF country offices – teachers and AI, Q6/Q7, July 2026. Counts are mentions, including open-text additions.

Note: The form did not always allow multiple selections, so the ranking should be treated as directional rather than exhaustive. CPD, continuous professional development.

These responses indicate that participating UNICEF country offices perceive the highest-value AI support for teacher professional development and continuous professional development. Emerging examples from Benin, China, Ghana, India, Senegal, Sierra Leone and the United Republic of Tanzania demonstrate growing interest in integrating AI into national teacher development systems and digital learning platforms. However, most initiatives remain at the concept, pilot or testing stage.

The balance between automating tasks and supporting teachers is still poorly understood and needs deliberate attention, so that AI enhances rather than erodes teachers' professional roles and identities.[578, 579] There are real risks of de-skilling, automation bias and cognitive offloading as teachers come to progressively lean on AI for planning, marking and feedback.[580] The rise of more autonomous 'agentic' AI raises fresh questions about accountability, data governance, child safeguarding and who holds decision-making authority in the classroom.[581] And the evidence itself remains skewed, overwhelmingly Anglophone, with indigenous and non-English knowledge systems largely absent.[582]

Recommendations

The following four recommendations are made for ensuring that we build on effective use cases while maintaining teachers at the forefront of teaching and learning:

1 **Keep teachers at the centre and co-design with and for teachers starting with the problems they actually face.** Effective tools start with teacher pain points rather than technology itself, meet teachers on platforms they already use, build in time to test and iterate, and ground AI outputs in proven pedagogy.[583] This also means inverting the familiar 'human-in-the-loop' logic: rather than asking how teachers can supervise AI systems, we should start from pedagogy and ask when, where and how – if at all – a tool genuinely supports teachers to enhance learning.[584] As Hau (2025) argues, educators should not simply inherit and implement AI; they should be actively engaged in leading in defining its purpose, use and ethical boundaries, with learning always at the centre.[585]

2 **Empower teachers by investing in evidence generation and needs-based professional development.** Reaffirm the irreplaceable, relational role of teachers with their students and protect teacher agency by mandating that AI augments rather than substitutes for teachers, embedding AI competencies in teacher education (pre- and in-service), and funding and supporting teacher-led communities of practice.[586] Investment should prioritize evidence generation, localization and low-resource, offline-first tools (and a focus on humanitarian and fragile contexts where teachers and learners may be on the move), with strategic bets on underserved but promising areas such as individualized AI coaching for continuous professional development and classroom observation support.

3 **Test before you integrate tools into education systems.** AI tools entering classrooms should face the same standard of evidence and ethical scrutiny as any other educational input, reporting not only on learning gains but on how risks to teachers and learners are identified and mitigated.[587, 588] Implementation research methods, testbeds and sandboxes – structured, lower-stakes environments where new AI tools can be piloted with teachers and refined before wider roll-out – are instrumental here to generate evidence at a speed that can compare with the technology.

4 **Measuring success will also require moving beyond adoption metrics.** While uptake of AI tools by teachers is a sign of proactive engagement, it does not necessarily point to impact. Findings from the July 2026 UNICEF survey to country offices indicate an emerging understanding that success should include consideration of teacher capacity and confidence; teaching practice (lesson planning, assessment, differentiated instruction); teacher efficiency and well-being (reduced workload); equity and inclusion (benefits for rural, female and vulnerable teachers); and system-level integration into national continuous professional development policy and financing. Teachers themselves should help design and validate any such framework.

"The promise of AI for teachers is real, but it is conditional. It will be realized only if teachers are treated as codesigners and decision makers of this next wave, not as AI's passive end users. Solving the problems teachers actually have in real classrooms across varying contexts, with and for teachers themselves, is the surest way to develop AI that leads to more effective and equitable teaching and learning outcomes."

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Think piece

Curated EdTech repositories: Towards a global mapping

Julian Sefton-Green, Xinyu Zhao, Chris Zomer and Melissa De La Cruz

The authors are researchers at the Australian Research Council Centre of Excellence for the Digital Child at Deakin University, specializing in critical studies of EdTech, children's digital literacy and the app economy. This think piece reports the key findings of a non-exhaustive global review of repositories created to categorize EdTech tools along different design, evaluation, certification, analytical or promotional purposes. It provides a typology of these mechanisms and an analysis of who devises and funds them, and to what ends. It is included in this chapter because the quality of digital and AI-enabled tools for learning and teaching depends not only on how they are designed, but also on the criteria education systems use to identify, evaluate and choose them.

Introduction

The increase of EdTech use within education environments globally has resulted in related challenges of how best to assess what can and should be introduced into learning and teaching settings. Based typically on consumer-type 'best buy' tools, we have witnessed the growth of a wide range of mechanisms that attempt to provide systematic comparisons and/or evaluations for decision makers in education, at home and for investment. These can vary from corporate purchasers buying equipment for a school district to individual teachers who may have control over what technologies go into their classrooms.

This think piece surveys and maps a range of these comparison sites produced by international brokers, philanthropists or global development agencies and even some national or local governments that have attempted to design and offer forms of comparison and evaluation of EdTech. We call these mechanisms 'curated EdTech repositories' (CERs).

This mapping of CERs is not meant to be exhaustive, but it sketches a picture of how the global landscape of CERs relies on a variety of stakeholders, standards and approaches.

Defining curated EdTech repositories

CERs are knowledge repositories aiding the selection of EdTech products or companies (as often companies offer a single solution) for end users, institutions or investors. EdTech products are defined as digital products to be used in education institutions or designed broadly for the purposes of education. These definitions exclude repositories of:

- Funds (investment, grants, incubators)
- Policies
- Data privacy agreements
- Efficacy studies
- Educational resources other than EdTech.

CERs involve a systemic selection and categorization of EdTech solutions for the purpose of comparison, evaluation, certification or promotion. As such, they also exclude online marketplaces, review websites, reports, blog posts and uncategorized lists. Also excluded are evidence frameworks and certification or award programmes without any curation of EdTech solutions.

This think piece offers a mapping and meta-analysis of publicly accessible CERs and asks what types of CERs are available, how these CERs are developed and in whose interests. We discuss what kinds of categories and objective descriptions of EdTech CERs claim they can meaningfully compare and thus also discuss which selection criteria are considered important. We aim to show what different markets think is important for decision makers, purchasers or investors within different jurisdictions.

The process behind the global mapping

During the first quarter of 2026, we searched, identified and compiled a list of 46 CERs. **Our sample is not exhaustive,** but our aim was to cover a wide variety of different types of CERs across geographies and jurisdictions.

We used keywords as search terms in English, French, German, Dutch, Spanish, Portuguese and Chinese. These included (in English):

EdTech OR educational tech*

AND

database OR repository OR index OR comparison

AND

[geographic location]

For the geographic location we used the following countries representing substantial EdTech markets: France, Netherlands, Germany, Switzerland, Spain, United States, Canada, Brazil, Mexico, China, India and Australia. We also used the geographic regions as defined by UNICEF. Additionally, we used a snowball strategy by looking up repositories referenced by those in our sample.

Besides the actual repositories, we analysed the 'About us' sections on relevant websites, and (if applicable) the submission instructions for EdTech developers, as well as evaluation criteria. We then produced a table in which we included the categories used by the CERs to describe and classify EdTech products and companies.[589] We also included the nature of the organizations behind the CERs (for profit or not), their countries of operation, the languages used and the geographic focus (if relevant). It is also important to note that not all evaluation mechanisms follow a CER approach, such as the many evaluative reports produced by EdTech Hub. This chapter focuses only on CERs.

Findings: Geography, language, actors and classifications

Globally, we identified and analysed 46 CERs developed by 42 organizations and 1 individual. We organized our key findings into three main areas:

- Geographic and linguistic focus
- Key actors in the field
- Classifying the field.

Geographic and linguistic focus

The majority of the CERs in our sample have either a Western European or a global focus. Fifteen of the CERs focus on regions with countries that comprise the Global South, primarily sub-Saharan Africa and Latin America. While there is a geographical representation of all inhabited continents, only around one third of the organizations were headquartered in countries outside Europe or North America. Despite the multiple languages we used to search, the majority (25) of the CERs are in English only. Other languages available include French, German, Portuguese and Spanish. Despite the fast-growing EdTech industry in China, we did not identify any CERs developed in Chinese. Cultural, regulatory and other issues may instrumentally affect this, so no conclusions can be drawn from this finding.

Key actors in the field

We were intrigued to note that 32 of the 46 CERs we identified were developed by not-for-profit organizations, while only 6 were for profit. It must be noted that some of the CERs are set up by local EdTech industry bodies, which are often not-for-profit institutions. Some other notable organizations behind CERs are set up by educators, such as ISTE+ASCD and the EdTech Marketplace Asia. One CER was developed by a private individual. Equally interesting is the minimal role played by national governments in this global attempt to evaluate EdTech. We found only five CERs initiated by national or state education jurisdictions that were publicly accessible. Not-for-profit organizations, especially supranational organizations such as UNICEF and UNESCO, play an important role filling this gap.

Table 3. Number of CERs in relation to geographic and linguistic focus

Regional focus	Language	Organization type
Western Europe (14)	English (33)	For profit (6)
Global (12)	German (3)	Not for profit (32)
Latin America and the Caribbean (6)	Spanish (3)	Unclear (8)
Sub-Saharan Africa (5)	Portuguese (2)	
East Asia and the Pacific (5)	French (2)	
North America (2)	Indonesian (2)	
South Asia (1)	Korean (2)	
	Thai (2)	
	Dutch (1)	
	Swedish (1)	
	Polish (1)	
	Danish (1)	
	Italian (1)	

Source: ARC Centre of Excellence for the Digital Child, Deakin University.

Classifying the field

We divided the CERs in our sample into three different types based on their explicit or implied purposes: market intelligence, consumer choice and governance *(see Table 4)*. For market intelligence CERs, we distinguished two subtypes: rolodex and analytics.

For consumer choice CERs, we created the following subtypes: evaluation, comparison and certification. Our sample includes 24 market intelligence CERs, 20 consumer choice and 4 governance CERs, with some CERs falling within multiple categories.

Table 4. Typology of CERs and subtypes

Type	Subtype	Common categories	Indicative examples
Market intelligence (24)	Rolodex (20)	Contact information, location, founding year, website, social media, company description	• Cartographies des Edtechs • African EdTech Ecosystem • European EdTech Map • The Australian EdTech Directory
	Analytics (4)	Clients, competitors, number of subscriptions, estimated revenue	• ListEdTech • HolonIQ
Consumer choice (20)	Evaluation (13)	Ratings, (expert) reviews	• Educa Navigator • Learning Cabinet • EdTech Impact
	Comparison (15)	Technical specifications, year levels, age, subject	• EdTech Marketplace Asia • Edtechkartan
	Certification (4)	Seals, labels, standards, awards	• TrustEd Apps Directory • EduEvidence • EdTech Index (ISTE seal)
Governance (4)	n/a	Approval, vetting	• ARC Software Catalogue • Gütesiegel Lern-Apps

Source: ARC Centre of Excellence for the Digital Child, Deakin University.

Market intelligence CERs

Market intelligence CERs can range from basic information about EdTech companies to more extensive data analytics about products or companies. The former subtype of CERs is often set up by national EdTech organizations and alliances aimed at promoting a local industry, such as the Australian EdTech Directory (EduGrowth). Often these initiatives receive government funding, and only members of the national or supranational organizations are included. Interestingly, some of these CERs take the form of a map so that companies can be located visually, such as in the Mapeamento EdTech and the European EdTech Map. The types of entries or information displayed in these CERs often include the company's location, the type of products or services offered, and their contact details. Because this subtype functions as a business directory, we call them 'Rolodex' CERs.

Analytics-oriented CERs provide more fine-grained information on products and companies than Rolodex CERs. The Canadian firm ListEdTech, for instance, offers a subscription service, giving access to detailed market information about EdTech solutions, including the uptake of EdTech solutions among institutions. HolonIQ is another example of a CER that offers business analytics, publishing yearly top 50s of the 'most promising' EdTech start-ups for a range of geographic locations, based on an evaluation of the market. While these CERs may be used to select EdTech products, they predominantly sketch or 'snapshot' the EdTech market. A notable find is Edtech de la Semana, which was set up as a private initiative to study trends in the EdTech industry.

Consumer choice CERs

The second type of CER is based on consumer choice. These CERs provide information to facilitate purchasing decisions. Compared with market intelligence CERs, they focus more on the products than the companies behind them. The target audience of consumer choice CERs varies. CERs such as Children and Media Australia are predominantly catering to end users, such as parents or individual educators. Other CERs, such as EduEvidence and EdTech Index, focus on decision makers and institutional purchasers such as schools, school districts and higher education institutions. There are some CERs which can be categorized as both market intelligence and consumer choice, such as Injini and ListEdTech. The latter also offers a portal for educational institutions that allows them to 'peer benchmark', which entails changing their technological infrastructure based on what other institutions are doing.

Consumer choice CERs have three different subtypes based on purposes: evaluation, comparison and certification. Multiple subtypes might be present within a single CER, but often there tends to be a focus on one of these dimensions. Evaluation involves judgement by either an independent expert or other users in the form of a rating or a ranking. Comparison provides a number of categories by which EdTech solutions can be compared, such as subject, year level, system compatibility and languages used, but this does not involve any explicit judgement. Lastly, certification involves endowing a product with a (usually trademarked) seal, label or award.[590] Most CERs have a comparative element, but not all have an evaluation or certification function. In our sample we identified 13 CERs with an evaluation function and only 4 with a certification function.

Evaluation is most explicit in CERs targeting hypothetical end users, such as parents and children. Common Sense Media, for instance, used to offer expert reviews on the pedagogical dimensions or age-appropriateness of EdTech solutions until it stopped evaluating EdTech in February 2026.

Learning Cabinet and EdTech Hub predominantly provided evaluation for institutions and national governments. They all have a number of dimensions against which EdTech products are rated, such as safety, equity and impact. Most evaluation CERs use independent experts to evaluate products (which often involves EdTech providers submitting their product for review). Examples include Edtech Tulna and UNICEF's Learning Cabinet. Other CERs review evidence provided by third parties. An example of the latter is EduEvidence, which uses validators to assess pre-existing evidence. A small number of CERs rely on ratings from users (i.e., teachers) rather than selected reviewers, such as the Swiss Educa Navigator and the United Kingdom-based EdTech Impact.

Certification CERs include EdTech Index, EduEvidence and the TrustEd Apps Directory (1EdTech). The parent organization of EdTech Index, ISTE+ASCD, offers developers the opportunity to apply for an ISTE seal and have their products assessed on indicators such as learning design, interface design and digital pedagogy. EduEvidence also offers certification in the form of gold, silver and bronze standards, based on a comparative framework ranking pre-existing certifications awarded by a range of commercial and non-commercial actors such as the abovementioned ISTE+ASCD. 1EdTech uses a combination of provider self-assessment and expert evaluation to certify products on data safety and compatibility. Common Sense Media now offers privacy certification for EdTech solutions, but also for other apps for children. Certification often involves an administrative fee (EduEvidence) or a licensing agreement with additional marketing benefits for the developer (ISTE seal). Certification CERs have a dual customer base: EdTech providers looking to promote their product, and their clients looking for EdTech solutions.

Governance CERs

The last type of CER we identified is set up for the purpose of governance. The purpose of these CERs is to vet, approve or recommend apps for use in specific jurisdictions. This is different from the general certification programmes described above, where products are awarded a seal or rating. We could only find four CERs of this type that were publicly accessible: the Arc software catalogue, set up by the Department of Education in the Australian state of Victoria, and the Gütesiegel from the Austrian Ministry of Education. We also found two CERS set up by school districts in the United States. There may be more of these local initiatives, but they are either not publicly accessible or did not show up in our search results.

What this mapping tells us

Scale

The sizes of CERs vary widely. For example, the TrustEd Apps Directory features more than 14,000 products, while Edtech Radar only featured 33 at the time of our analysis. Initiatives such as the Mapeamento EdTech 2020, which has mapped over 500 local companies, underscore the significance of representing developing markets. Importantly, the biggest CERs with a large number of entries tend to be focused more on the Global North, perhaps suggesting unequal investment or support.

Reliability

The reliability of CERs is a matter of concern, especially for those that mostly rely on information provided by EdTech companies, such as EdTech Index. Furthermore, when it comes to evaluation CERs, we do not always know whether those involved in the assessment have relevant qualifications or experience. Our own research found that terms such as 'education' and 'evidence' are regularly used arbitrarily in the marketing of EdTech products.[591] Business intelligence firms such as ListEdTech rely on a form of data collection that is promoted as reliable but is not entirely transparent because the data are not publicly available.

Impartiality

Fees are often required for evaluation or certification processes, which can be a considerable cost to smaller EdTech companies. While most CERs identified were not for profit, we note that they also operate within an industry of qualification and evidence production.[592] Some CERs rely (partly) on information provided by EdTech companies themselves (such as product descriptions) and thereby risk becoming a conduit for these very companies. There is a potential conflict of interest when CERs are either directly or indirectly funded by EdTech companies through fees, (premium) memberships or marketing arrangements.

Standards

The relative absence of CERs created by national or local governments is notable, but as this was not an exhaustive study, we are unable to draw any conclusions from this finding. However, this absence suggests an important role for international organizations such as UNICEF and UNESCO to develop, test and implement common standards and frameworks that can both inform national and local governments in policymaking and align global efforts to scrutinize the different dimensions of EdTech products and companies.

Sustainability

We have observed the challenge of updating CERs, both in terms of keeping information up to date and persistent effort to improve evaluation criteria. At the time of writing this chapter, Common Sense Media announced that it is 'taking a break' from its EdTech reviews. While the organization did not explain the reasons behind this decision, it does indicate the massive time and financial investment behind these evaluation mechanisms. We also see how evidence of ongoing self-evaluation of these evaluation mechanisms is largely invisible or unclear. An exception is the Learning Cabinet, developed by UNICEF and its partners, which is informed by an evaluation framework called EdTech for Good, free of charge for EdTech providers. In 2026, UNICEF updated its framework by considering feedback from different stakeholders with the aim of establishing a baseline of transparency. This updated framework also considers company evaluation along with assessment of EdTech products.

Impact

What remains unclear after this mapping exercise is the actual use and impact of CERs in practice on the global scale. There is a paucity of evidence to support a global understanding of trends in the use of CERs around the world, including which types of stakeholders may engage with them and the extent to which they may or may not influence decisions about procuring EdTech at local or national scale. For some CERs, such as those developed by EdTech Hub[593], the answer is clearer due to the employment of a 'helpdesk' model, showing who the requesters are and whom the CERs benefit. For others, there are gaps in data sources to indicate how CERs work in practice and the extent to which they influence EdTech decision-making by individuals or organizations.

We advocate for a way forward on global standards and metrics for evaluating EdTech, perhaps led by international organizations such as UNICEF that are transparent, sensitive to local contexts and open to scrutiny and feedback. This is crucial given the messiness of the EdTech landscape and the increasing challenges for users and institutions to make informed decisions.

Case study

Uzbekistan: From pilot evidence to scale-up decisions

This case study explores how Uzbekistan has progressed through a staged research pathway to build an evidence-backed investment case for scaling an AI-powered platform designed for maths learning. Beginning with a pilot project with 17 schools in 2023–2024, then accelerating to 50 schools in 2025 with plans to later reach a total of 170 schools in 2026, the Ministry of Preschool and School Education (MoPSE) and its partners are co-constructing a comprehensive portfolio of evidence on teaching, learning, implementation and costing to transform maths teaching and learning at national scale. This case was developed through interviews with the UNICEF Uzbekistan Country Office and adapted from findings from a case study by IDEO.org.

Context

Since 2016, Uzbekistan has pursued wide-ranging education reforms, including more than 100 decrees, resolutions and orders covering curriculum reform, school governance and teacher pay.[594] In just five years, the country has progressed from limited school connectivity to near-universal coverage across its public-school system.

This nationwide reach is now complemented by the UNICEF–ITU Giga initiative's real-time monitoring through GigaMaps.

The country is moving from individual digital learning initiatives towards a coherent, system-wide transformation, with support from the UNICEF Country Office across the entire digital education ecosystem: connectivity and infrastructure, digital devices, localized learning solutions, teacher digital pedagogy, AI and policy frameworks, financing partnerships, and data and evidence.

These investments sit alongside an ambitious learning agenda: Uzbekistan has set a target to rank among the top 30 countries in PISA by 2030, but its first participation in 2022 showed significant gaps in foundational skills, with only 14 per cent of students achieving minimum proficiency in reading and similarly large gaps in mathematics and science.[595] The current priority is therefore to integrate proven approaches to improving learning outcomes through digitally enabled interventions sustainably into the national education system.

Spotlight on practice

Amid a landscape of low-quality digital learning tools, the first step was identifying a tool that demonstrated the promise to address the specific needs of Uzbekistan: to improve maths teaching and learning. UNICEF's Global Learning Innovation Hub provided a structured opportunity to thoroughly vet safe and evidence-backed EdTech tools that could help address this challenge and then to model them for scale through a focused study.

The work before the pilot

The Finnish EdTech company Eduten Ltd. provides an AI-powered, gamified maths learning platform developed at the University of Turku with users across more than 50 countries. The Eduten platform was evaluated by UNICEF using the EdTech for Good Framework and selected as a 'Blue Unicorn' – a tool with the potential to rapidly improve learning outcomes at scale. In collaboration with the government and the UNICEF Uzbekistan Country Office, the tool was matched with Uzbekistan for a targeted feasibility study in the Tashkent region in 2023 to explore whether an AI-powered learning platform could support learning in Uzbek classrooms, generate evidence on student outcomes, and inform decisions about wider scale-up.

The platform was localized before implementation: learning content was mapped to the national curriculum and translated into the three languages used in Uzbek classrooms: Uzbek, Russian and Karakalpak. Through structured training workshops, teachers developed their capacity not only to use the platform, but also to integrate digital tools into their teaching practice, read learning analytics and identify where students were progressing or struggling.

What made the evidence from the pilot meaningful

The pilot was designed as an evidence generation exercise, not only a technology roll-out. Just over 1,000 students participated in a mixed-methods study in which students in the treatment and comparison groups across 17 public schools in Tashkent received the same amount of mathematics instruction over a 12-week period, but half of them received Eduten and the other half did not. Pre- and post-tests measured changes in mathematics skills and arithmetic fluency across both groups, and the study found that treatment groups significantly outperformed control groups in foundational numeracy and conceptual understanding.596 These promising gains led the Minister of Preschool and School Education to sign a Memorandum of Understanding with Eduten as part of the official state visit of the President of Finland, Alexander Stubb, to Uzbekistan in October 2025.[597]

Encouraged by these initial findings, the next question was more demanding: could the conditions that supported early learning gains be sustained across a more diverse national system, including in rural and remote areas?

Expanding and strengthening the evidence portfolio during the acceleration phase

The acceleration of Eduten began in October 2025 for the duration of a full school year. Fifty schools across all 14 regions were selected to participate, representing a broader and more diverse cohort than the pilot and reaching approximately 10,000 students, nearly 10 times the scale of the original intervention. To explore equity analyses, both rural and remote schools were included in the sample, supported by a new digital school readiness programme that delivered innovative, portable digital devices and connectivity within the classroom to enable technology use. This system-wide approach was enabled by co-funding from UNICEF's Learning Pioneers Programme and a US$23.5 million partnership funded by ISHONCH 2030 Trust Fund and implemented by UNICEF in partnership with UNESCO.

This phase reflects how the Eduten intervention can catalyse a transition from a project-based approach into a broader transformation of the education system. The expanded scope and investment also changed the nature of the evidence needed. Moving from 17 schools in one region to 50 schools across all regions introduced variation that the pilot could not fully test. Stakeholders needed rigorous evidence on the effect of the EdTech tool on learning and instruction alongside details on how the implementation was taking place in diverse classrooms around the country.

UNICEF partnered with an independent research team, the Economic Policy Research Institute, to conduct a quasi-experimental, mixed-methods study to investigate not only the effect of the intervention on students' numeracy outcomes and how these outcomes differed across population groups, but also the extent to which the platform influenced teachers' professional practice and the learning environment. The ongoing study embeds a cost effectiveness analysis, complemented by rich qualitative insights, to illuminate the critical success factors for transitioning the intervention to full scale in a sustainable way.

The pressing question then becomes twofold: First, could a future experimental study surface scientific proof of positive impact across all learner groups as Eduten scales to more classrooms? Second, could domestic education budgets sustain the costs of a national roll-out over time?

Preparing for an actionable scaling pathway integrated in the national education system

Building on existing evidence and strong political commitment, UNICEF leveraged the Local Education Group coordination platform to connect digital learning innovation with broader education reform and partner investments. This has helped strengthen collaboration with the World Bank, translating emerging evidence into opportunities for scale and system integration. As part of this partnership, the World Bank is financing the first-ever randomized controlled trial (RCT) on digital learning in the country using Eduten as a promising digital education intervention, generating further evidence to inform national policy and investment decisions.

The results from this RCT are expected to help provide "non-questionable answers on the return on investment on learning of Eduten," says Alberto Biancoli, UNICEF Uzbekistan's Chief of Education, emphasizing that "finding the sustainability of this solution into the national system depends on reimagining how digital learning is fully integrated as part of national curriculum delivery and making it part of the national education budget."

Reflections and lessons learned

Two key lessons emerge from the Uzbekistan case:

1. How a tool designed for a specific learning purpose can itself contribute to the broader transformation of teaching and learning through reimagining how technology is integrated into classrooms and domestic education budgets.

2. Why the impact of technologies on educational outcomes should be understood as an evidence generation pathway, not a single research result.

The initial pilot produced promising learning evidence, the acceleration phase tested whether the system could sustain the conditions that made those gains possible, and finally, the forthcoming RCT, supported by the World Bank, will be the first of its kind in Uzbekistan: a scientifically rigorous test of large-scale impact on numeracy.

This phased approach is critical: evidence that a tool can work in selected schools is not the same as evidence that it can be implemented nationally with consistent quality, and the research questions and methods need to adapt to these changing contexts and policy-relevant needs. Uzbekistan has reached the point where national roll-out scenarios are being reviewed with budget implications, requiring attention not only to software costs, but also to teacher training, devices, connectivity, technical support, monitoring, maintenance and the staff time needed to coordinate implementation.

Uzbekistan is no longer asking only whether a digital tool can improve numeracy, but whether differentiated, AI-supported and curriculum-aligned digital content can be financed, governed and sustained across the national education system to truly transform teaching and learning.

Think piece

Technology for learning equity

By Daniel A. Wagner and Pia Rebello Britto

Dr. Daniel A. Wagner is a Professor of Education at the University of Pennsylvania and the UNESCO Chair in Learning and Literacy. Dr. Pia Rebello Britto is Global Director of Education at UNICEF. Their think piece calls for a broader view of innovation that encompasses designing digital ecosystems centred on learning equity, pedagogy, teacher agency and responsible governance. Positioned as the final contribution, it reminds readers that no technology matters on its own terms unless it addresses real barriers to learning. It closes the report on this note to draw the preceding parts together, framing them as interdependent conditions on which learning equity ultimately depends.

Learning equity: The central challenge

Education has entered a new phase of reform. Over the past half-century, remarkable progress has been made in expanding access to schooling, followed by growing international attention to improving learning. Together, these two developments have transformed educational policy and practice around the world. Increasingly, however, a third challenge is emerging: achieving greater learning equity by ensuring that every child has a genuine opportunity to learn.

Advances in technology enter education at an important moment in this evolution. AI, adaptive learning systems, multilingual digital resources, learning analytics and expanding connectivity offer possibilities that would have been difficult to imagine only a decade ago. At the same time, experience reminds us that technological innovation alone has rarely been sufficient to improve learning equity or learning at scale.[598] The educational value of technology depends largely on how well it responds to the realities of learners, teachers and schools.

Seen from this perspective, learning equity is concerned not simply with educational outcomes, but with the conditions that make those outcomes possible. Children cannot learn what they have never had a meaningful opportunity to learn. The concept of **opportunity to learn** offers one useful way of understanding these differences by drawing attention to the educational experiences that precede achievement itself.[599]

The next generation of educational technology

As educational priorities have evolved, so too have expectations for educational technology. Earlier generations focused primarily on expanding access to educational resources. More recent innovations sought to improve learning itself. Today, advances in AI invite us to consider a broader question: how can technology contribute to more equitable opportunities for learning?

During the first generation of educational reform after the Second World War, considerable effort was devoted to expanding access to schooling and educational resources. Radio, television, computers and eventually the internet were often seen as ways to reach larger numbers of learners, particularly where teachers, textbooks or schools were in short supply. Increasing access was itself an important achievement.

As evidence accumulated that millions of children were completing primary school without acquiring foundational skills, attention gradually shifted from schooling to learning, the second generation of reform built on the United Nations Sustainable Development Goals.[600] Educational technology increasingly supported this transition through digital assessments, adaptive learning software, teacher support tools and new forms of instructional content. These innovations reflected a growing recognition that participation in school alone could not guarantee meaningful learning.[601]

AI represents a third generation of this continuing evolution rather than a break from it. Its significance lies less in the novelty of the technology than in the educational possibilities it creates. AI has the potential to support teachers, personalize instruction, provide timely formative assessment, generate learning materials, translate resources across languages and help education systems respond more effectively to learner diversity. These possibilities are particularly important in contexts where shortages of qualified teachers, limited instructional materials or linguistic diversity have constrained educational opportunities.

Experience with earlier generations of educational technology, however, also offers useful perspective. Some highly visible initiatives substantially increased access to digital devices yet produced relatively modest improvements in learning because technology was insufficiently connected to the curriculum, classroom practice, teacher preparation or local context. At the same time, less sophisticated technologies – including interactive radio instruction and carefully designed structured pedagogical programmes – often demonstrated strong educational results because they addressed clearly defined learning challenges within broader instructional systems.[602]

Learning depends not only on motivation or ability, but also on whether learners encounter the conditions necessary for learning to occur. These conditions include capable teachers, adequate instructional time, appropriate language of instruction, a relevant curriculum, meaningful assessment, supportive learning environments and access to high-quality learning resources. Digital technologies can strengthen each of these conditions, but they cannot substitute for them. Rather, evidence increasingly suggests that technology contributes most when it is designed to address **barriers to learning**.

This broader perspective also connects educational technology with a longer tradition of thinking about human development. It has been argued that development is ultimately concerned with expanding people's capabilities and the choices available to them throughout their lives.[603] Such capabilities begin to take shape long before children enter school. Early childhood experiences shape language, cognitive development, health and social-emotional learning in ways that influence later educational trajectories.[604] Education importantly contributes to this process by enlarging what children are able to know, do and become. Learning equity is therefore concerned not only with fairness in educational provision, but also with ensuring that children from different backgrounds have meaningful opportunities to develop their capabilities.

Designing technology around learners

If learning equity is increasingly viewed as a central objective of education, it follows that technology should be designed with that objective in mind. This represents less a departure from earlier approaches than a refinement of them. The question is no longer simply whether technology can improve education. Increasingly, the question is how technology can help create better learning opportunities for children whose educational circumstances differ widely.

Evidence to date has demonstrated both the promise and the limits of educational technology. Many initiatives have broadened access to learning resources and strengthened classroom practice, while others have produced more modest results, suggesting that technology is most effective when it becomes part of a broader educational strategy rather than standing apart from it.[605]

AI illustrates both the opportunities and the responsibilities that accompany this next phase of educational development.[606] Like earlier innovations, however, AI should not be viewed as a solution independent of educational context. AI systems learn from existing data, and those data may reflect long-standing differences associated with language, gender, disability, geography or socioeconomic context. Careful governance, transparent evaluation and thoughtful implementation will therefore remain as important as technological sophistication. The central question is not whether AI should be adopted, but how it can best contribute to stronger and more equitable learning opportunities.

Thinking in this way naturally directs attention towards the barriers that continue to shape children's educational experiences. These barriers seldom occur in isolation. More often, they interact, reinforcing one another throughout a child's school years. Technology cannot eliminate such challenges by itself, but it can become part of a broader effort to address them.

Language remains one of the most persistent and least recognized barriers to learning. Increasingly, owing to internal and external migration, millions of children begin school in a language different from the one spoken at home, making the acquisition of foundational literacy substantially more difficult.[607] Recent advances in multilingual AI, speech recognition, translation and locally developed digital content create new possibilities for supporting children in their first languages while also helping them acquire national or international languages. These developments may prove especially valuable in multilingual societies where language has long limited educational participation.[608]

Similar attention must be given to disability and inclusion. Many educational technologies were originally designed for learners with relatively few barriers to participation. Increasingly, principles such as Universal Design for Learning encourage developers to create flexible learning environments that accommodate a wider range of learners from the outset rather than through later adaptation.[609] Features such as captioning, speech-to-text, text-to-speech, adjustable interfaces and alternative modes of interaction demonstrate how inclusive design can strengthen learning opportunities for many learners, and not only those with identified disabilities.

Gender provides another illustration of how educational opportunities continue to evolve. Considerable progress has been made in expanding girls' participation in schooling, yet differences remain in access to digital technologies, confidence in using them, subject choices and later employment pathways. These divides are widest in low-income countries, where around 90 per cent of adolescent girls and young women aged 15–24 are offline, and their male peers are about twice as likely to be online.[610] Educational technologies can contribute positively by broadening participation, supporting diverse learners and helping ensure that digital opportunities are available to all children.

Geography, displacement and conflict present additional challenges. Rural communities, refugee populations and children affected by emergencies frequently have the greatest need for educational continuity while facing the weakest infrastructure. Well-designed digital resources, including offline applications and low-bandwidth platforms, have demonstrated that technology can help sustain learning under difficult circumstances.

Across each of these domains, one finding has remained remarkably consistent. Educational technology achieves its greatest impact when it strengthens teachers rather than attempting to replace them. Teachers continue to interpret the curriculum, motivate learners, adapt instruction, engage families and build supportive classroom environments. Digital tools can increasingly help them perform these responsibilities more effectively through improved lesson preparation, formative assessment, professional learning and access to instructional resources. Technology extends teachers' capabilities, but it does not diminish their importance.

Emerging priorities

Educational technology is likely to become less defined by individual devices or software platforms and more by the educational purposes it serves. This shift encourages a broader view of innovation – one that places equal emphasis on learning equity, pedagogy, teachers, governance, measurement and inclusion alongside technological development.

One implication is that educational systems should increasingly focus on **designing rather than distributing technology**. Decisions about digital tools are most likely to produce lasting educational benefits when they begin with clearly identified learning challenges and then consider how technology can help address them.

A second implication concerns measurement. For many years, digital initiatives have been evaluated through indicators such as numbers of devices distributed, schools connected or users enrolled. Such measures remain useful for monitoring implementation. Increasingly, however, governments are asking whether technology is contributing to stronger learning, more equitable participation, improved teaching and broader opportunity to learn. Measures such as the Gini Learning Index illustrate one approach to examining not only average performance but also the distribution of learning across populations.[611]

Teachers will remain central to this future. Digital technologies and AI offer new opportunities to support instructional planning, assessment, professional development and collaboration among educators. These developments are likely to be most effective when they reinforce teachers' professional judgement and analytical skills rather than seeking to automate them.

The growing importance of multilingual learning also suggests promising directions for future innovation.

AI increasingly enables educational resources to be translated, adapted and generated in languages that previously received too little technological attention in the classroom.[612] Such advances have the potential to strengthen both learning and cultural inclusion, particularly for historically underserved populations.

These developments also underscore the importance of responsible governance. As education systems make greater use of learner data and AI, questions concerning transparency, privacy, accountability and public trust will grow in importance. Building institutional capacity in these areas is likely to become as significant as investing in technology itself.

Conclusion

Educational reform over the past half-century has achieved remarkable progress by expanding access to schooling for millions of children around the world. We argue here that the next stage of this journey is likely to place much greater emphasis on learning equity. This does not replace earlier goals. Rather, it builds on them by recognizing that children begin their educational journeys in different circumstances, with different resources and different opportunities to learn. Addressing these differences will become an increasingly important part of strengthening education systems.

Digital technologies, including AI, offer new opportunities to support this essential ambition. Their greatest contribution, however, is unlikely to lie in technical sophistication alone. It will depend on how thoughtfully they are integrated into teaching, learning, assessment and educational governance, and on the extent to which they broaden opportunities for children whose educational pathways have too often been constrained.

Educational technologies are ultimately designed for someone. One of the most important questions for the years ahead is whether they increasingly reflect the circumstances of all learners, including those whose opportunities to learn have been the most limited. Keeping that question in view encourages education systems to look beyond technology itself and towards the children whose futures technology is intended to support.

The first generation of educational reform sought to expand access to schooling. The second sought to improve learning. This third generation has the opportunity to build on both by placing learning equity more fully at the centre of educational design. Viewed in that way, technology becomes a means of expanding children's opportunities to learn – and, ultimately, of helping more children realize the capabilities, choices and futures that education can make possible.

"Educational systems should increasingly focus on designing rather than distributing technology."

Conclusion

"I wish our voices can be heard on digital environments, and we can succeed to show ourselves."

Child, Uganda, 10–13 age group[613]

Around the world, education systems are struggling to meet the needs of children, teachers and societies in rapidly changing contexts. Hundreds of millions of learners are progressing through schooling without building the foundational skills they need to exercise individual agency, access the labour market or contribute fully to their societies. Hundreds of millions more are not in school at all. Growing teacher shortages across grade levels, regions and economies strain school management and limit critical student support. These challenges are compounded by poverty, gender inequality, language barriers, disability, conflict and climate change.

Many are turning to digital and AI-enabled technologies as a source of hope – a potential solution to break through stagnation towards quick and visible progress. The evidence and practical examples in this report show that this hope can be realized, but can also be easily misplaced.

The effective practices are clear: technology in education offers a powerful lever for change when applied with approaches that are human-centred, equity-driven, cost-effective and safe-by-design. However, EdTech does not improve teaching and learning or strengthen education systems by virtue of being digital or AI-powered alone. Many digital education activities have shown little to no added value for learning and teaching, with some even exacerbating inequalities or causing harm. To make digital education safe, inclusive and impactful requires a sustained commitment to evidence generation and contextual fit, deep integration into the teaching practice and existing digital systems, government oversight and ownership, and an unwavering focus on the children who are most marginalized.

From Jamaica to Kenya and the Philippines, the case studies in this report illustrate how digital technology can be a lifeline at multiple levels – for the education system disrupted by climate-related school closures, for the child who finally feels included in classroom activities because their digital learning platform has accessibility features, or for the teacher who uses AI to help differentiate curricular activities to accommodate a range of instructional levels in an overcrowded secondary maths classroom.

EdTech sits within a rapidly evolving political economy. Advances in AI, changing investment patterns, platform ecosystems and market incentives dramatically shape the present and future digital education landscape. Against this backdrop, it is imperative that governments are in the driving seat, focusing on long-term sustainability and placing public value at the centre of their strategic planning and procurement processes. The think pieces in this report shed light on the complex capacity and financing considerations that determine whether EdTech tools can be sustainably and safely integrated into a system – or merely piloted fleetingly before disappearing when funding runs out.

Going 'beyond digital as usual' means not viewing success as the deployment of devices and products and focusing instead on human capacity, safeguards and governance, curriculum integration, learning outcomes, evidence generation and sustainable financing. In short, it means building and sustaining the system readiness on which success is dependent in both the short and the long term.

'Good' EdTech is not a question of identifying the tools that work for some people some of the time. It is about how we can advance EdTech for Good: leveraging digital and AI-enabled transformation to address the most persistent challenges, reaching those previously left behind, and advancing a paradigm shift that centres on quality learning opportunities for all children, protects their rights and well-being and builds on meaningful human connection.

Recommendations

Across these five chapters, it is clear that what counts as ‘what works’ in digital education is always conditional: on governance, infrastructure, pedagogy and local capacity. Translating evidence into good decision-making requires deliberate structures that help different stakeholders, including policy-makers, educators, development partners and providers align on expectations and commit to connecting evidence to practice.

Call to Action

As a top priority for the whole education sector, there needs to be a concerted effort to establish the norms and standards that will guide effective practice for how digital and AI technologies inform education. The public sector must govern technologies in education by setting strong and transparent rules that put the public good ahead of short-term market incentives and prevent long-term vendor dependence. In turn, technology partners must respect public authority by working together within clear accountability frameworks and standards for equity, safety, pedagogy, sustainability and evidence.

Achieving long-term positive impact through digital education requires being aware of underlying market agendas. It should be recognized that much of the focus from large technology companies on education is propelled by the commercial imperative to increase market share and increase dependence on particular products. Education interventions, plus the subsidized provision of tokens to access them, are part of a wider cross-sector strategy to increase market share and embed product dependence by temporarily providing loss-leading products – and education is a fertile 'market' in which to do this. Long-term impact requires an upfront focus on the implications of vendor lock-in, future cost models, licensing agreements and the terms on which a provider can be replaced – the detailed work of protecting education investments in a context of unknown futures – and making it central to the global conversation. This is not anti-AI; it is pro-education. Protecting future learners, teachers and systems requires taking seriously the long-term comprehensive costs of today's decisions and designing for financial sustainability from the outset.

Throughout the report, the different contributors have provided a wide range of practical and provocative recommendations. To guide all those leading digital education efforts, big or small, towards making EdTech for Good, this report offers five cross-cutting recommendations which should be priorities for the global education community.

1 Equity

Make learning equity the defining driver of investment in digital technology and AI in education.

Digital education interventions should be designed for equity from the outset. Investments should prioritize areas where technology can address persistent barriers to learning, targeting the most marginalized children first and closing learning and digital divides shaped by poverty, disability, gender and language for children in and out of school. This means co-creating needs-based interventions with communities through the meaningful participation of children, teachers and caregivers, including by ensuring that children's own experiences and priorities inform research, design, procurement and governance; investing in mother-tongue-based multilingual learning and culturally relevant and accessible digital content; and offering continuous and integrated teacher development, **prioritizing those children** at the greatest disadvantage. Designing for equity from the outset also requires checking whether it has been achieved, since no procurement or implementation model delivers equity by default. Investments should be assessed on who is reached, who continues to be excluded and whether outcomes are improving for the groups furthest behind.

2 Safety

Enforce safeguarding and privacy requirements *before* digital and AI-powered tools reach schools, and continue monitoring safety and well-being throughout use.

Education systems should make safety and privacy enforceable requirements before digital and AI-enabled tools are procured, approved or scaled for children. This means requiring safety-by-design, child rights impact assessments, high privacy defaults, minimized data collection, no targeted advertising, accessible redress mechanisms and clear accountability for learner-facing tools. It also means requiring the companies that governments contract to meet rights-respecting standards across their wider business practices, to demonstrate that child rights impact assessments have been conducted, and to build open, documented standards so that content and credentials transfer to government when a contract ends. The rigorous vetting of the safeguarding and privacy policies and practices of technology companies active in education spaces should not be a single event. Strong governance should require the production of regular evidence that tracks how technologies are affecting the safety and well-being of children and school communities over time. Education systems should define who has oversight at national, district and school level, and provide schools with escalation pathways, defined roles and incident-response protocols so that staff know how to act when harm occurs.

3 Pedagogy

Engage teachers as decision makers and co-designers of digital and AI-enabled tools and programmes to ensure that technology serves pedagogy.

Technology must serve pedagogy. Teachers should be supported as co-designers and decision makers in choosing and using digital and AI-enabled tools, rather than being displaced or reduced to technical support roles. This means prioritizing inclusive, culturally appropriate solutions and expanding and sustaining investment in digital and AI technologies for pre-service and in-service teacher professional development, financed through core education budgets, tailored to local contexts and aligned with evidence-informed approaches such as structured pedagogy and Teaching at the Right Level.

4 Sustainability

Ensure that contextual fit, interoperability and cost-effectiveness are prerequisites for scaling education technologies and are reflected in deliberate design choices for procurement, distribution and implementation models.

Sustainable digital education systems should be grounded in public-interest principles, interoperable standards and reusable public goods, with collective action and collaboration helping to build, align and improve them over time. The design of digital education interventions should focus on what works, for whom and under what conditions – and just as importantly, what does not – in order to scale and sustain effective practice in specific contexts. This means that the primary focus does not need to be on use cases of the latest frontier models of AI. For those working in resource-constrained or crisis-affected contexts, the priority should be to develop a collective understanding of which technology-enabled approaches are the most appropriate for addressing local challenges, and then co-design approaches for those realities from the start. Procurement choices should embed equity, safety, contextual fit, sustainability and long-term costs from the outset. Likewise, implementation models should reflect contextual realities, including device access and connectivity. One device per child should not always be the objective: teacher-only use, shared-device models and collaborative use may be more effective and sustainable for teaching and learning. While increased funding is vital to close the digital divide, programmes must account realistically for long-term operating costs: hardware is only a fraction of the total cost of ownership, and recurring costs need a home in domestic budgets before donor financing ends.

5 Evidence

Invest in human and institutional capacity to use robust evidence to guide the effective use of digital and AI technologies in education systems, and to continuously adapt and improve how these technologies are implemented.

There is increased recognition that decisions about digital technologies in education should be based on strong and contextually relevant evidence and aligned with accountability for outcomes and costs. The education sector, and those working within it on the role of digital technologies, now has access to clearer evidence regarding 'what works' and what does not, and, more significantly, how it can be adapted and applied effectively in different contexts. Evidence that a tool works in selected schools is not evidence that it can be delivered nationally with the same quality, so scaling should be staged by evidence-informed decisions to adapt, expand or stop the implementation. Work to build evidence should focus on learning outcomes, align with government priorities, be cognizant of political economy and consider cost across the full life of an intervention. Capacity to build and use evidence is strongest when it is structured into government systems for education delivery.

Enacting these five recommendations and establishing sector-wide standards, with UNICEF's EdTech for Good Framework 2.0 as a reference point, will help governments, technology providers, multilaterals, teachers, young people, researchers and civil society align around responsible and evidence-based use of digital and AI technologies for learning. UNICEF is committed to helping governments take more ownership over all phases of digital and AI use in education: from strategy development and the development of clear evaluation criteria to informed and transparent decision-making on procurement and partnerships.

One finding is consistent across all contexts where evidence exists: on their own, technologies cannot resolve the systemic challenges faced in education and, if poorly designed or implemented, they will cause damage and deepen existing inequalities. However, at a time when many children risk falling further behind, the evidence-based use of digital and AI technologies offers a measure of hope. This comes with a clear responsibility for the education community: to ensure that technologies are used in a way that serves education and the common good, widening the possibilities for every child to learn, participate and thrive.

"There needs to be a concerted effort to establish the norms and standards that will guide effective practice for how digital and AI technologies inform education."

Annex 1

Background paper methodology

The five background papers that open each chapter were produced using a structured, human-led and AI-assisted approach to evidence synthesis. This methodology was designed to extend coverage and accelerate evidence synthesis, while also testing how generative AI can be used responsibly in research. Given the growing use of AI in knowledge production, this report aims to be transparent about the process and to contribute to emerging discussions on good practice.

Each paper followed a consistent three-stage process: human-led targeted literature scoping and evidence curation, AI-assisted extraction, synthesis and drafting, and multi-stage human validation.

In the first stage, the team translated the indicators and questions within the EdTech for Good Framework into four to six 'common descriptors' per pillar, generating corresponding search terms. Targeted searches were then carried out across EdTech Hub, UNICEF and OECD evidence libraries, filtered for education and digital education content and restricted to publications from 2020 to 2026 to capture post-pandemic shifts. This stage was human-led, with researchers determining the scope, search strategy and descriptors that would frame each paper.

In the second stage, selected AI tools were used to support evidence processing and drafting under controlled conditions. Tools were chosen following comparative testing to assess their performance on specific tasks. NotebookLM was used to generate structured evidence summaries from the curated list of sources identified in the first stage. Elicit's Research Agent was then used to search peer-reviewed academic literature for any gaps left by the institutional evidence base. Finally, Claude was used to weave the evidence from NotebookLM and Elicit into a structured draft zero. Prompts were iteratively developed and refined by a small team, and outputs were reviewed across multiple rounds to ensure consistency and relevance.

The third stage underwent extensive human validation and authorship. Researchers first reviewed the AI-assisted draft line by line for narrative consistency, coherency and clarity. Next, they conducted a second review focused on citation accuracy and to identify unsupported claims. This draft was then handed to the paper's lead author, who redrafted it, incorporating their own expertise and additional evidence. The revised paper then passed through internal and external technical review. Final responsibility for the content remained with the human authors throughout.

This approach demonstrates that AI can support parts of the research process when applied within a well-defined and carefully managed workflow, but does not replace expert judgement. Its reliability depended on the quality of inputs, the clarity of the analytical framework, and the thoroughness of human validation at each stage.

Lessons learned from the process

- **Active human involvement, rather than passive oversight, makes AI-assisted research trustworthy.** Having a human 'in the loop' is not enough. The quality of the output depended on researchers actively shaping the process throughout, including defining the questions, developing the prompt language, setting caveats and judging whether each output was trustworthy and aligned with the original sources.
- **The final output is only as good as the prompt behind it.** Time spent iterating and testing prompts before the main work began paid off later. Well-developed prompts produced outputs that were less biased and more consistently relevant to the task.
- **Choose your tool well.** No single tool performed well across all tasks, so effectiveness depended on matching each one to a specific function, such as search, extraction, summarization or drafting.
- **Small, interdisciplinary teams are effective.** Bringing together different levels of subject expertise, research skill and familiarity with AI tools meant team members could cross-check each other's work. This mix, more than team size, was what made quality control effective.
- **The AI-assisted route is not always the more efficient one.** It meaningfully extended the coverage of literature reviewed, but did not accelerate the overall workflow. Time saved on evidence processing was offset by the checking, correction and refinement it required. The trade-off was not more speed for the same output, but broader coverage for a comparable amount of time.

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