EdTech Hub

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Summary

Addressing the global learning crisis requires a fundamental change in how technology is used in education. In this paper, we call for collaboration across the sector to build an evidence-driven future for EdTech in low- and middle-income countries and explain the steps required to achieve it together.

Investment in EdTech in low- and middle-income countries is growing rapidly, but we have not yet realised the potential of technology to improve learning outcomes at scale. This situation is a significant disservice to the millions of children around the world who are not learning — in or out of school. Uncritical optimism or non-specific pessimism tend to dominate discussion of EdTech throughout the global education community. Both sides can draw on practical examples of EdTech usage that support their positions. We need to move beyond this tendency towards binary argument and instead centralise the role of evidence in EdTech — generating and using robust and relevant evidence to drive better decision-making.

We want to encourage and provoke everyone working in EdTech to define themselves as evidence-based decision-makers. It is imperative that specific, strategic action is taken to build a future where the high promise of the input of technology into education is matched by significant improvements in learning outcomes: this paper is our case for how we get there.

EdTech interventions should be designed and implemented on the basis of what works to improve learning in education, and on what we know works in EdTech. They should also embed rigorous experimentation to learn more about 'what works' in each specific context, and then apply the learning and adapt to become more effective. The generation and application of evidence should be undertaken in an integrated way, aligned with government, and using embedded research. Efforts to share evidence should always be responsive to the political and contextual factors and the incentives and constraints that influence evidence use. This all requires commitment from a broad coalition of stakeholders to champion a culture of evidence-based decision-making in EdTech.

Every group of decision-makers working in EdTech — governments, developers, implementers, researchers, funders, and teachers and school leaders — should become obsessed with asking and finding answers to the following five questions.

1. Will this use of technology lead to a sustained impact on learning outcomes?

2. Will this use of technology work for the most marginalised children and enhance equity?

3. Will this use of technology be feasible to scale in a cost-effective manner that is affordable for the context?

4. Will this use of technology be effective in the specific implementation context?

5. Will this use of technology align with government priorities and lead to the strengthening of national education systems?

Each of these questions can sometimes be answered with a clear 'yes' or 'no' but also — and more significantly — each one requires a detailed response and iterative cycles of reflection focused on the **'how'** the **'why'** and **'to what extent'** behind the responses given.

Prioritising these five questions will help every group working in EdTech to embed a culture of evidence within their activities and decision-making. This is not simply a benevolent agenda: by committing to prioritising evidence-based decision-making, everyone working in EdTech will benefit and become better able to address their own challenges, increase their own effectiveness, and achieve their own objectives.

There are also specific things that should be done by each group working in EdTech in order to prioritise evidence and realise its benefits:

■ Prioritising evidence in EdTech will **enable government decision-makers to use EdTech to more fully meet their national education objectives and provide learning at scale for all children.** To realise these benefits, decision-makers should ensure that all EdTech activities in the country are justified on the basis of impact on educational outcomes (whether direct or indirect); required to share transparent and independently verified financial models for interventions and; aligned with the rest of the national education strategy, system, and related national systems.

- Prioritising evidence in EdTech will **enable EdTech developers and vendors to improve their chances of long-term success and scale-up.** To realise these benefits, developers and vendors should ensure that EdTech products are built based on appropriate evidence; aligned with the national curriculum and teaching and learning frameworks of the country of implementation; promoted on the basis of what is cost-effective and affordable and; positioned at the leading edge of the market by tracking and using data to enable teaching and learning at the appropriate level.

- Prioritising evidence in EdTech will **enable organisations implementing EdTech to more effectively reach their strategic objectives and help children to learn.** To realise these benefits, implementers should ensure that EdTech implementation is driven by the best of education evidence; based on iterative design including user research; undertaken in close collaboration with researchers to facilitate effective adaptation and; designed to track and communicate anticipated outcomes with findings shared publicly and regularly.

- Prioritising evidence in EdTech will **enable organisations researching and assessing EdTech to achieve increased impact and buy-in for their work.** To realise these benefits, researchers should ensure that research on EdTech is focused on priority evidence gaps to build critical masses of evidence; conducted as openly as possible with shared datasets, methods, and early-stage findings; undertaken in close collaboration with implementing organisations and users (students, teachers, school leaders, families); structured to centralise the role of EdTech researchers within the country where the research is taking place and focused on pathways to effective uptake.

- Prioritising evidence in EdTech will **enable donors funding EdTech to work in a manner aligned with their own impact criteria and educational goals.** To realise these benefits, funders should ensure that the funding of EdTech interventions is considered as part of a broader education funding portfolio; prioritises implementations that have evidence building embedded throughout and are based on realistic cost models for learning at scale and; used to exert positive influence across all groups working in EdTech to take the steps required of them to champion evidence within their work.

- Prioritising evidence in EdTech will **enable teachers and school leaders to make more effective use of EdTech within their work**

because products and implementations will be better aligned with their needs. To realise these benefits, all other groups involved in EdTech outlined above should centralise the expertise and real-world requirements of teachers and school leaders within their work; evidence should be built based on the experiences and feedback of teachers and school leaders and; evidence products should be made available in formats where they can be used to help shape and improve practices at the school level.

Building a culture of evidence-based decision-making among all those involved in EdTech is the single most significant thing that can be done to ensure that technology is used in ways that help address the global learning crisis. For EdTech to play its role in helping to transform education we need all stakeholders to find unity of purpose through committing to an evidence-driven future. This is a bold but achievable ambition that requires a radical shift from current practices.

1. The peril and promise of EdTech

Technology and the learning crisis

Many children are not learning, and business-as-usual approaches are not increasing learning outcomes fast enough. Before the Covid-19 pandemic, nearly 9 in 10 children (87%) in sub-Saharan Africa could not read and understand a simple sentence at age 10 (⬆World Bank, 2019a), and rates of learning poverty have increased widely following Covid-related school closures (⬆World Bank et al., 2022). As the education sector continues to adapt to potential future school closures, interruptions, and student movement caused by ill health, climate disasters, or conflict, innovations — including the use of technology — are vital in order to provide multiple pathways to enable children to learn key foundational skills.

Access to digital technologies is increasing rapidly — almost three-quarters of the world's poorest households in 2020 had a mobile phone, more than have access to toilets or clean water (⬆Hawkins et al., 2020). At the same time, basic digital literacy is becoming increasingly important for formal employment (⬆World Bank, 2019b), engagement with public services, communication with friends, and a variety of other life practices (e.g., ⬆Kispeter, 2018). Linked to this, a wide range of stakeholders — including governments and the private sector — are investing in educational technologies ('EdTech'). The EdTech sector is growing quickly — the global market is predicted to be worth USD 404 billion by 2025 (⬆HolonIQ, 2022), and government education sector plans increasingly include EdTech as a central tenet (⬆Chuang et al., 2022).

However, to date — and despite the long history of efforts to use technology in education — there has been a conspicuous lack of focus on the detailed, technical questions of how these investments will work, for whom, in what contexts, for how long, and at what cost. The evidence base for individual EdTech interventions is rarely strong enough to enable decision-makers to answer these questions with confidence; instead, they have to deal with competing and contradictory advice about the use of technology.

Despite the lack of a cohesive evidence base, investments in EdTech continue to increase. This presents both an opportunity (for increased funding, innovation, and impact in the sector) and a threat (of huge waste of potential, effort, and financial resources if investments do not lead to learning) (⬆Roddis et al., 2021). It is vital that we capitalise on this growing appetite for EdTech to shape the market and harness the growing use of

technology to help all children learn. Doing this effectively requires an urgent commitment to position evidence at the centre of all decision-making in EdTech. This should replace the current situation where decisions are often made without the benefit of evidence — and so are at risk of being overly shaped by political aspirations or influential private-sector marketing.

Moving beyond polarised debates

The use of technology in education regularly provokes debate: the promise and peril of EdTech have been argued for decades. One reason for this is the broad range of technologies used in education and the varied ways in which they are used (↑Hennessy et al., 2021). This often results in confusing conversations about the merits or otherwise of EdTech, where similar vocabulary is used to describe or compare wildly different interventions and practices — for example, using virtual reality headsets for immersive science experiments and using radio for distance education would both be described as 'EdTech'. Additionally, the conspicuous lack of robust and applied research in the sector enables providers to showcase the purported positives of proposed solutions, without the foundational technical evidence or contextual detail to enable decision-makers to sensibly understand the comparative costs and benefits of the options they are presented with.

To caricature the debate, on the one side are those who advocate for the transformational benefits of technology and the potential to 'leapfrog' the education status quo. This group sees EdTech as an equaliser, that can support learning for disadvantaged students, and reduce the burden on overstretched teachers (↑Omidyar Network, 2019) and cites benefits ranging from more choice and content to better digital skills (↑Lim, 2021). There are plenty of smaller-scale programmes that have led to improved learning outcomes to back up these arguments (e.g., learning gains from OneTab use in ↑Outhwaite et al. (2020), or the impact of Sesame Workshops through television in ↑Van Nostrand et al. (2022)).

On the other side are those who emphasise the dangers of technology use, and cite expensive technology interventions which have not led to anticipated improvements in education (e.g., ↑Facer & Selwyn, 2021). This group often legitimately highlight the well-known failures of the One Laptop Per Child schemes of the early 2000s (e.g., ↑Ames, 2019), the lower learning rates on online courses compared to face-to-face teaching (e.g., ↑J-PAL Evidence Review, 2019), or the widespread learning losses during

Covid-19 despite the unprecedented levels of technology use in education(↑World Bank et al., 2022).

Many within the sector have long advocated for the need to move beyond these entrenched viewpoints, with recognition that EdTech in itself is neither a silver bullet nor a failure, and that effective usage needs to be based on appropriate evidence (↑Wagner et al. (2005), ↑Unwin et al. (2020), ↑Facer & Selwyn (2021), ↑Van Nostrand et al. (2022)). However, this has not yet become the dominant narrative, and we still do not have the critical masses of evidence on priority technical topics within EdTech to provide a foundation for reliable decision-making (↑EdTech Hub, 2022a).

Given the seemingly inevitable increase in the use of EdTech and the urgent ongoing nature of the global learning crisis, we need to accelerate progress towards a more nuanced understanding of the technical and political factors that impact how these investments will work, for whom, in what contexts, for how long, and at what cost. Achieving mainstream change will require a concerted effort and culture shift, away from generalised and polarised debates, towards a sustained commitment to building and using better evidence around technology.

What we mean by evidence in EdTech

Many readers will be familiar with the meanings of 'evidence'. Because we argue that building a culture of evidence is the crucial determining factor in ensuring a high-impact future for the use of EdTech in low-income countries, it is worth clarifying how we understand and use key terms. The three main components to consider in discussions regarding evidence are explained below.

The current evidence in EdTech (also known as the **'evidence base'**) — This is the pre-existing knowledge and understanding regarding how technology can be used effectively in education. It consists of formal sources including academic articles, policy reports and evaluations, and also more tacit knowledge and expertise held within organisations and individuals working in EdTech and the wider education system.

The generation of evidence in EdTech (also known as **'evidence building'**) — These are the activities that take place to improve knowledge and understanding of particular topics regarding how technology can be used effectively in education. Work to generate evidence can be undertaken in many ways including desk research, primary research (including mixed methods and design-based research), various forms of evaluation, plus other informal activities.

The use of evidence in EdTech (also known as **'evidence uptake'**) — This refers to how evidence that has been generated is used to inform decision-making. Evidence uptake activities aim to ensure that policies and programmes align as closely as possible with the best knowledge of what practices positively influence student learning. Proven pathways to evidence uptake include evidence generation in consultation with key decision-makers, translating findings into specific contexts, or providing technical briefings and technical assistance to policymakers to share global evidence.

Finally, when we talk about '**an evidence-driven future for EdTech**' we mean a future where all aspects of decision-making regarding the use of technology in education are informed and directed by the evidence base, new and relevant evidence is built, and there is an uptake of this evidence by decision-makers.

Focus and structure of the paper

There is a growing call from varied actors across the education sector globally for the need for more evidence in EdTech, including the World Economic Forum (⬆Kucirkova, 2022), funders (e.g., ⬆Segura & Sommer (2022), ⬆Jacobs Foundation (2022)), and analysts (e.g., ⬆Tate (2022)). Our focus in this paper is on low- and middle-income countries and particularly how EdTech can be used effectively in the most financially resource-constrained education systems. Many of the same principles apply for the effective use of EdTech in any context, but the priority questions and practical recommendations of this paper are targeted for those working in contexts where the learning crisis is most acute.

Section 1 outlined the need for evidence in EdTech and the problems that result from the dichotomies that dominate the current discourse. Section 2 illustrates a positive possible future for evidence-based EdTech. Section 3 highlights the need to work on the basis of what is already known regarding effective practices in education and EdTech. Section 4 explores the challenges of evidence uptake and articulates the need for an integrated approach. Section 5 provides three illustrative examples of how increased generation and use of evidence can improve EdTech interventions. Section 6 focuses on how to achieve a future defined by evidence — calling for a universal obsession with asking and answering five questions that can build a culture of evidence in EdTech. Section 7 identifies a series of positive and practical changes to be made by different stakeholder groups within the EdTech sector, in order to increase the

speed and extent of progress towards an evidence-driven and high-impact future. Section 8 concludes the paper.

2. An imagined future

The main focus of this paper is on how to achieve the changes required for an evidence-driven future. But first we share a future-focused summary to illustrate the kind of practical shifts that would take place if this future was achieved, ultimately leading to better learning outcomes for all children. We — as impatient optimists — anticipate an evidence-driven future where:

All those involved in EdTech in low- and middle-income countries are focused on how to achieve maximum impact on learning outcomes

No serious education stakeholder seeks to justify an investment in technology on the basis of inputs and outputs. Access to rigorous data helps to form points of technical agreement on how technology can be most effectively integrated in education to have maximum impact on learning outcomes.

There is widespread commitment to ongoing learning and adaptation based on evidence

It has become an expected default that EdTech will be built and scaled in a way that facilitates constant improvement in product development and implementation. Iterative design-based research is the norm and early-stage findings are shared through communities of practice. Ongoing evaluation serves users by informing future iterations, rather than just providing standalone assessments of previous attempts.

Governments are able to make informed assessments when faced with multiple EdTech product options from vendors

Decisions are based on the contribution products make to national education strategies, strengthening national curricula and associated learning and teaching resources, and improving learning outcomes for all children. Decision-makers are confident and equipped to know what type of technology-enhanced intervention should be used in what context, and when it is more appropriate instead to use low-tech or no-tech options. There is no longer such a gap between researchers and decision-makers and strong pathways to uptake have been built — so that the right evidence gets into the hands of decision-makers in a timely manner and in an accessible format.

All those buying, selling, and researching EdTech are aligned on tracking cost-effective impact on learning outcomes

The sector is focused on building generalisable principles *and* detailed context-specific insights to drive effective use of EdTech. Interrogating evidence is the norm — it is critiqued, interpreted, and applied to understand what works for whom, in what contexts, for how long, and at what cost.

Technology interventions are designed, tested, and scaled with the most marginalised at the centre

Technology is used to support children who are not in school or who are not learning, and who have specific barriers to learning such as gender, location, or disabilities that interfere with their access and progress in education. Technology is used to reduce inequality and increase education for the most marginalised, and helps integrate out-of-school, displaced, and refugee learners.

3. Build from the current evidence base — in education and EdTech

Everyone involved in EdTech can be part of the process to build and use evidence to achieve the better future outlined above. To do this, we need to ensure all interventions have the current evidence base — for effective education and effective EdTech — as their starting point for implementation.

EdTech interventions must use the existing education evidence base

From a low base, in recent years, there has been an increased emphasis on the generation and use of rigorous evidence in the education sector (↑Building Evidence in Education, 2015). There is a growing consensus around the type of interventions that improve learning outcomes (e.g., ↑GEEAP, 2020), although many important research gaps remain (particularly on scaling implementation, adapting interventions to new contexts, and serving marginalised learners). The use of technology is just one modality to improve teaching and learning and education management, and EdTech initiatives should be focused on addressing the biggest constraints in any education system.

EdTech investments have the potential to amplify good practices and support high-quality learning. This is particularly true when they are based on existing strong pedagogical theory and evidence (↑Van Nostrand et al., 2022) and align with the existing robust evidence base on effective instructional practices, including, for example, teaching children by their learning levels, not grade (e.g., ↑Angrist et al., 2020b), teacher coaching and reflective practice (e.g., ↑D'Angelo et al., 2022), and structured assessment (e.g., ↑Gray-Lobe et al., 2022). Investments will normally have the most impact when integrated into a coherent and well-aligned education system (↑World Bank, 2018), when there is a credible pathway for how the investment will achieve the desired impact within the system, and when the relevant ongoing support is given to education personnel (see, e.g., ↑Perlman Robinson & Winthrop (2016); ↑Trucano (2013)).

At the same time, digital learning can also facilitate instructional approaches not possible without technology and can improve equity (↑Zubairi et al., 2021). This is particularly the case for the most marginalised learners — for example, the use of assistive devices to support children with disabilities (see ↑Lynch et al., 2021).

EdTech interventions must use the existing EdTech evidence base

The evidence base on how technology can support education is relatively small but growing — and combines the best practices identified in the wider sector with specific principles of technology use, including the Principles for Digital Development (⬆Digital Principles, n.d.). Below we set out some of the key lessons learned and evidence generated so far, concerning the use of technology to improve education. This draws on our research work at EdTech Hub, a global research partnership aiming to empower people by giving them the evidence they need to make decisions about technology in education.

Girls often have higher levels of engagement than boys when provided with equal access to technology

For example, significantly greater use of the Worldreader app has been recorded among female readers compared to male readers (West and Chew, as cited in ⬆Dahya, 2016). To reduce the existing gender digital divide (⬆Tyers-Chowdhury & Binder, 2021), a broad range of technology modalities should be leveraged (including mobile phones) (⬆GSMA, 2021), and parents and caregivers (who act as gatekeepers to girls' access to technology) must be engaged in programme development and training (⬆Webb et al., 2020).

Technology can be used to improve participation through messaging for both students and teachers

However, we need to move beyond simplistic approaches to messaging in order to improve equity and impact on long-term outcomes. This can be done by allocating funding to support those most in need (⬆Zubairi et al., 2021), co-creating learning-at-home outreach with the community to enable them to support students learning (⬆Kimathi et al., 2021). Messaging can also be used to support and motivate teachers through providing ideas for lesson plans and other resources (⬆Jordan & Mitchell, 2020).

Technology-supported teacher continuous professional development is most effective when co-created with teachers and linked to tangible impacts on teaching practice and student learning

The appropriate use of technology has been shown to catalyse teacher reflection and peer learning. It can also be a way to provide resources and lesson plans for classroom experimentation and access to coaches and mentors. Blended models are likely to be the optimal way to support critical human relationships. Working with teachers to design professional

development enables content that is relevant, contextualised, and aligned with diverse teacher and student needs (↑Hennessy et al., 2022).

To support learning, technology can be used to provide combined and cohesive data for decision-making

The provision of large volumes of poorly structured data — especially fragmented or duplicated data — can hinder decision-making as much as a lack of education data (↑Crouch, 2019). Education management information systems are most effective when they provide a single source of truth with no repetition of data points (↑Fab Inc., 2021). Dynamic school-level data management can lead to a virtuous cycle of learning and improvement if school leaders accept the short-term costs of a higher administrative workload and governments actively support the decisions of school leaders (↑McBurnie et al., 2021).

There is promising evidence on the use of technology to maximise the effectiveness of personalised learning and teaching at the level of the student

Approaches that adjust the intervention to the level of the learner appear to be more effective than approaches that have learners determine their own path or which rely heavily on assessments (↑Lakhsman, 2019). Digital personalised learning does not have to be long-term to be effective: short-term, low-intensity interventions may have similar positive effects (↑Major et al., 2021). Low-attaining learners may have higher learning gains from digital personalised learning than high-attaining groups, potentially creating opportunities to increase equity (↑Major & Francis, 2020).

4. Evidence uptake for EdTech decision-making

It is difficult to ensure that evidence leads to change across the education sector and then specifically in EdTech. In order to achieve effective evidence uptake, we need an integrated approach to help overcome the challenges.

The challenge of evidence leading to change in education

There is a gap between evidence, policymaking, and implementation across the education sector due to well-documented challenges including validity, accessibility, and applicability of evidence (⇡Hinton et al. (2019); ⇡Bangay & Little (2015); ⇡du Plessis (2016)).

Education has a particular set of political complications (such as a broad stakeholder base, strong teacher unions, and the use of schools and inputs in campaigning). These factors, combined with the fact that it often takes a long time to really understand what change is taking place as a result of a particular education intervention, mean that the pathway between evidence and change is particularly challenging to navigate. Evidence is just one form of information used by policymakers — alongside process and practice knowledge, public opinion, and biases and beliefs. It is clear that beliefs and motivations also impact evidence uptake (⇡Punton, 2016). Much evidence is not used and remains rarely read. When evidence *is* read there can be misunderstandings about what is a general lesson and what is context-specific (⇡Bates & Glennerster, 2017), meaning that findings are at risk of being misinterpreted. And much education evidence simply lacks rigour and has findings which are unreliable, either by design for nefarious purposes or through lack of expertise and unintentional error (⇡Tate, 2022).

Moving from evidence to policy and implementation not only requires the effective supply of evidence but also for that evidence to be accessed, valued, and understood by policymakers (⇡Newman et al., 2012), in a manner that can then translate into effective teaching and learning practices. This is difficult for many reasons. The broad social interest in education leads to pressure on decision-makers to act outside of evidence-based recommendations due to a range of external factors (political, economic, social etc.); decision-makers have a lack of agency or ability to implement long-term strategic change in the midst of urgent competing priorities; evidence is often presented in an overly-complex way

that requires too much time from decision-makers to actually digest and act on it.

In addition, any new intervention or policy in education needs to be widely supported and adopted if it is to have an impact. If local education officials, teachers, and school leaders are not involved in evidence generation — and the application of that evidence in their specific contexts — then they will be less likely to alter their practices on the basis of it (see e.g., ⬆Muralidharan & Singh, 2020). This is applicable in multiple sectors across the nexus of research and policy and practice but is particularly pertinent in education. There is now a broader understanding that achieving positive change in education requires providing the right evidence, in the right format, at the right time, to the right people (e.g., ⬆Tilley et al., 2017).

The challenge of evidence leading to change in EdTech

The gap between evidence, policymaking, and implementation within the education sector is particularly pronounced in relation to the use of technology (⬆Bapna et al., 2021). The increased level of attention on EdTech, particularly following pandemic-related school closures, has led to a plethora of contradictory guidance without a common language to show impact (⬆Pellini et al., 2021). The main specific challenges are summarised below.

First, there is sometimes significant political gain to be made from the optics of investment in EdTech, alongside a default assumption of the positive impact of technology (⬆Unwin et al., 2020). This means that even when evidence is available there is potential for procurement-related decision-making to be more influenced by political considerations than evidence of impact.

Second, the nature of much of the EdTech market means that there is significant pressure on product developers to rapidly increase their user base, and this means that evidence can sometimes be sidelined in the pursuit of short-term growth objectives and associated commercial imperatives (⬆Kucirkova, 2022).

Third, because the capabilities of technologies are constantly evolving and contexts surrounding EdTech are fluid, the effective use of evidence also changes and requires up-to-date technical and contextual knowledge to apply it well. Regulatory environments alter, infrastructure develops, devices spread, and new norms become quickly established with

technology — all of these things are opportunities but are also challenges in relation to the uptake of EdTech evidence (↑Unwin et al., 2020).

Lastly, there is an inevitably diverse stakeholder group that is involved in the development, implementation, and uptake of technology in education, often with different incentives. Stakeholders have varied abilities to access different sources and preferences on evidence presentation. There is often competing, ambiguous, or misunderstood terminology around EdTech, with different norms and assumptions regarding evidence, which can lead to confusion and conflict (↑Pellini et al., 2021). The effective use of evidence is dependent on the difficult requirement for all parties to understand and agree on the usefulness, meaning, and credibility of the evidence.

Building evidence in EdTech requires an integrated approach

The challenges in ensuring evidence leads to uptake are significant and cannot be avoided completely. However, they can be reduced by championing the building and use of robust evidence in EdTech.

EdTech evidence building and uptake is best achieved through an integrated approach, which deepens understanding among stakeholders, connects theory with practice, and shapes decision-making. When we talk about integrating these activities we mean an approach of working hand-in-hand with governments and other key stakeholders to generate and use relevant, high-quality evidence that is multi-disciplinary and built through rigorous research on high-priority evidence gaps. EdTech implementations should have cycles of real-world experimentation embedded within them to generate real-time evidence that can improve practices,, accompanied by technical assistance provided directly to implementation teams and decision-makers to enable effective uptake (↑EdTech Hub, 2022b).

EdTech evidence is most likely to lead to change where it responds to a specific education need, is aligned with the government's strategic goals, and fits with a funding or reform cycle (↑Pellini et al., 2021). This is not a short-term effort, rather, the process of effective evidence uptake takes place in cycles and over time. It requires detailed understanding of multiple facets of the education system, including technical, political, cultural, and socio-economic factors. This provides the greatest opportunity to build pathways to ensure EdTech evidence uptake. For it to be of maximum use for decision-makers to inform and improve policies and practices, researchers and advisers must be able to translate evidence and adapt it for real-world opportunities and constraints.

(Section 6 and Section 7 provide more detail of how practical progress can be made to use this integrated approach to reach the required evidence-driven future.)

5. Three examples of the benefits of evidence in EdTech

We have summarised the need to move towards an evidence-driven future and highlighted challenges in doing so. Now we offer three real-world examples of specific ways in which evidence can be used more effectively to shape practices in EdTech. Each one illustrates the challenges resulting from gaps in the evidence and a lack of evidence uptake, and demonstrates how addressing these should lead to improved decision-making and an increased impact on learning outcomes.

Example 1: Outcomes over outputs — an evidence-driven future for connectivity in education

Providing internet connectivity for schools in low-income countries is often championed as a way to achieve significant positive change in education. There are associated calls for increased funding to connect schools in order to facilitate digital learning (e.g., ⬆Yao et al., 2021; ⬆Roddis et al., 2021). Publicised targets and results for connectivity are often predominantly framed around output indicators rather than outcome indicators (i.e., how many schools are connected), rather than what happens to learning as a result of connecting the schools. Centralising the use of evidence in school connectivity interventions is vital to ensure that they actually have the anticipated positive long-term impact on learning outcomes.

It is well recognised that the provision of infrastructure alone rarely has a long-term impact on learning outcomes, and there is currently limited evidence regarding the link between the provision of the internet and improved learning outcomes. Studies have shown varied impacts on learning in low- and middle-income countries (no impact in provision of internet to homes in Peru — ⬆Malamud et al., (2019); some small gains in school connectivity in Malawi — ⬆Derksen et al., (2022); and increased use of technology but no impact on school attendance in Kenya — ⬆Okyere (2022)). The lack of evidence does not necessarily mean efforts to connect schools should be reduced. However, it does mean that there should be a substantial change in the way connectivity for schools is promoted, funded, and implemented.

The educational impact of providing connectivity to schools in low-income countries will be increased if implementation decisions are based on evidence. This requires reframing priorities so that success is no longer assessed on the basis of the number of schools connected, but rather on

what happens to learning outcomes as a result of that connectivity, which would not have been possible previously (i.e., the lack of connectivity was the constraining factor). This also requires aligning with the best of current evidence, with connectivity only provided as part of an integrated programme — at the school level — to make effective use of technologies for teaching, learning, and school management (↑Unwin et al., 2020).

While advocating for increased connectivity in schools, the sector must recognise the urgency of addressing the evidence gap regarding how connectivity can be provided in ways that do enhance learning outcomes for the long term. This requires embedding research and independent evaluation within all connectivity initiatives to understand the technical detail of what works, for whom, in what contexts, for how long, and at what cost — and sharing the learning openly to shape the wider sector. Further, it is particularly important to understand the bandwidth and cost implications of different forms of EdTech (e.g., real-time video streaming can require hundreds of times more bandwidth than ebooks and use of local networks can dramatically reduce bandwidth requirements). Sharing full cost data regarding connectivity for schools should be the new normal, so that it is possible to assess the cost-effectiveness of connectivity in contrast to other potential education interventions.

Example 2: How addressing specific evidence gaps can improve decision-making in digital personalised learning

In recent years, there has been a proliferation in options for the use of digital personalised learning (DPL) in low-income countries and significant improvements have been made in their level of pedagogical sophistication and variety of application (see ↑Alam & Castillo, 2022). There is a well-established body of evidence that demonstrates the potential for impact on learning outcomes by adopting technology-enhanced approaches centred on the level of the individual learner (↑Major et al., 2021).

However, there are three specific evidence gaps in relation to DPL in low-income countries that make it complicated to move forward with effective at-scale implementation. First, there is a lack of evidence regarding the specific modes of implementation of DPL that may maximise learning gains, specifically relating to level of personalisation, level of integration, and required time on task. Second, there is a lack of evidence regarding how best to integrate DPL with other components of education (e.g., teacher professional development). Third, there is a lack of

evidence regarding the cost-effectiveness and affordability of DPL, meaning it is difficult to know what constitutes an appropriate use of financial resources in different contexts.

The priority for evidence in relation to DPL is not to show whether it has the potential to have a positive impact on learning outcomes in low-income contexts — that has already been demonstrated. Rather, if investments in DPL are to make a significant contribution to addressing the global learning crisis — particularly for the most marginalised — building evidence regarding the specific characteristics of DPL that make it most effective in different settings should be prioritised. This includes how and why they are effective, for which children, and the cost-effectiveness and affordability of different options. In relation to the latter, and of particular importance in low-income contexts, it is crucial to understand how DPL interventions can be structured in ways that make them affordable at scale. In other words, it is crucial to understand what is realistic in terms of spend per child within the operating context of the national education system in question.

Having access to these forms of specific evidence is what will enable those building DPL products to ensure the appropriateness of their cost model and to maximise their context-specific effectiveness. It will also enable those making decisions regarding investing in DPL products to sensibly differentiate between them and discern what is likely to have the most significant impact on student learning outcomes.

Example 3: Learning from recent experiences of evidence gaps in EdTech implementation during Covid-19

From early 2020, in response to the Covid-19 pandemic, in-person schooling was closed in many countries for extended periods. Learners were required to find new ways to learn, teachers to find new ways to teach, and parents and caregivers often participated in education provision in unprecedented ways. Often, these shifts relied on the use of technology to enable remote learning (⬆Nicolai et al., 2022). However, this option was not available to many students in low- and middle-income countries and was not as effective as in-person learning even for those who could access it (GEEAP, 2022).

This huge shift in education provision could be described as an enforced EdTech experiment — and some commentators point to the huge learning losses seen over the pandemic as evidence of EdTech's ineffectiveness. The

quality and reach of different remote learning policies and approaches varied greatly (↑World Bank et al., 2021), and "evidence is mounting of the low effectiveness of remote learning efforts" (↑GEEAP, 2022 p. 6). In many cases where learning was lost, students spent less time on education than they would have at school, and they were exposed to pedagogies and curricula that had been hurriedly adapted to remote learning, often by teachers without adequate training in remote instruction (↑World Bank et al., 2022).

However, there were cases of successful remote learning in low- and middle-income countries during the course of the pandemic and these were grounded in pedagogical good practices. For example, the use of mobile phones to teach students in Botswana (↑Angrist et al., 2020a), relied on teaching at the level of the student, and successful learning from radio lessons in Kenya required community buy-in and engagement (↑Amenya et al., 2021).

The success or otherwise of technology-based education interventions during the Covid-19-related school closures was largely dependent on the extent to which they were implemented in alignment with pre-existing evidence on effective EdTech. This includes the need for resources that are aligned with curricula and target the appropriate learning levels, teachers who are equipped and confident to teach remotely, and student access to devices for home learning (↑Nicolai et al., 2022). The experience of the pandemic provides a noteworthy example of the need for an evidence-driven approach if EdTech is to effectively sustain student learning in the context of any future education disruption and school closures.

6. How we can all build a culture of evidence in EdTech

Achieving a fundamental change in evidence use in EdTech requires a concerted sector-wide effort (↑Jacobs Foundation, 2022). Everyone involved in EdTech can contribute to this day by day, through becoming obsessed with asking and answering five important questions. In this section, we explain the questions and why they matter, and identify practical steps they should lead to.

Be obsessed with asking and finding answers to five questions

The five questions below are equally relevant for those working in government and making decisions on EdTech, those building and selling EdTech, implementing EdTech, researching and assessing EdTech, funding EdTech, and directly using EdTech in schools. If everyone involved in EdTech committed to asking these five questions as a default — and made the decision to proceed with implementation on the basis of positive answers — the sector would move towards an evidence-based future where the use of technology would have a bigger positive impact on the global learning crisis. None of the questions works in isolation, but when considered in combination, the answers provide a strong foundation for evidence-based decision-making:

1. Will this use of technology lead to a sustained impact on learning outcomes?

2. Will this use of technology work for the most marginalised children and enhance equity?

3. Will this use of technology be able to scale in a cost-effective manner that is affordable for the context?

4. Will this use of technology be effective in the specific implementation context?

5. Will this use of technology align with government priorities and lead to the strengthening of national education systems?

Each of these questions can sometimes be answered with a clear 'yes' or 'no' but also — and more significantly — each one requires a detailed response and iterative cycles of reflection focused on the 'how' the 'why' and 'to what extent' behind the responses given. This is dependent upon

implementations embedding cycles of rigorous experimentation so that the questions can be answered with increasing confidence and nuance.

This section explains why each question is important and outlines practical steps that can be taken to embrace the opportunity that each question provides to move towards an evidence-driven future.

Q1: Will this use of technology lead to a sustained impact on learning outcomes?

It is not inevitable, nor currently probable, that introducing technology into education will lead to a positive impact on student learning outcomes (see e.g., ↑Meyer et al., 2021). If it does lead to such an impact, this may be short-lived and the extent of the impact may vary widely (↑Major et al., 2021). The effectiveness of a specific implementation depends on whether it is still having a positive impact on learning outcomes — for all children targeted — 1, 3, or 5 years after the initial inputs. A recognition of this needs to be incorporated from the outset of any intervention, and justification for investment should never be based on the demonstration of solely short-term learning gains for the easiest-to-reach learners.

Asking this question cuts through hype and aspiration and increases focus on educational outcomes rather than technology inputs and outputs. If it is not clear that a proposed intervention will have a sustained impact on learning outcomes, decision-makers should question whether it is the most appropriate use of financial resources. If there is some promise but limited evidence regarding a specific approach, the initial implementation should be structured to enable rapid cycles of embedded learning and feedback to assess realistic potential for impact.

Practical steps relating to evidence that can be taken to help build an evidence-driven future for EdTech that increases learning outcomes include:

A. Commit to measuring success based on specific medium- and long-term outcome indicators, not input or output indicators (and avoid nonspecific terms like 'students reached'); define this at the outset and track it independently throughout.

B. Align as much as possible with government learning assessments and comparable global measurements (such as learning-adjusted years of schooling (LAYS) (↑Filmer et al., 2018)) so that evidence can be integrated into the broader context of educational reform while also providing a basis for international comparison.

C. Use the functionality built into the technology to enable regular and detailed tracking of learning gains and incorporate ongoing improvements to the product or implementation in question on the basis of the evidence generated.

Q2: Will this use of technology work for the most marginalised children and enhance equity?

Technology can be used in education in ways that increase or reduce inequality and inequity. However, without proactive design to the contrary, the spread of technology within an education system will usually serve to exacerbate pre-existing inequalities within education systems (⬈Zubairi et al., 2021). The impact of the so-called 'digital divide' affects the most marginalised children most keenly — that is, all those within the population who face particular barriers in accessing and making progress in education. This often includes those in particularly remote and rural regions, children with disabilities, girls, refugees, and forcibly displaced students.

It is often considered simplest to 'pilot' technology-related interventions in schools in urban or peri-urban areas, or among less marginalised groups within the population (⬈Trucano 2013; ⬈Unwin et al., 2020), due to factors such as ease of location and pre-existing investment in infrastructure. As a result, EdTech interventions are often disproportionately focused in less-marginalised areas, leading to increased inequity, and are not based on good practices for how to serve the most marginalised (e.g.,⬈Wagner et al., 2018). In addition, cost models based on pilots conducted in urban areas are likely to provide unreliable data to inform scaling because of the higher costs per child of working with the most marginalised in remote areas.

Practical steps relating to evidence that can be taken to help build an evidence-driven future for EdTech that prioritises the most marginalised and improves equity include:

A. Test the viability of an EdTech intervention with marginalised populations from the outset rather than trialling under optimal conditions and assuming it can later be adapted to help the most marginalised.

B. Base EdTech interventions on the best of the evidence available from the wider education sector for reaching the most marginalised, and factor into all scaling models the often higher cost-per-child figures this entails.

C. Embed the ability to track marginalised groups effectively with disaggregated data into all interventions, so that specific evidence can be generated to target a reduction in inequity.

Q3: Will this use of technology be feasible to scale in a cost-effective manner that is affordable for the context?

Having a positive impact on learning outcomes is not sufficient to justify an investment if the cost-per-child is prohibitively expensive for the context. Understanding the true cost (including both Capital Expenditure and Operational Expenditure) of an EdTech intervention makes it easier to determine whether it will ever be financially viable to scale effectively, i.e., whether it will be possible to ensure the learning benefits are experienced by a large group of students. Similarly, while something may be theoretically cost-effective, it may not be affordable for the context. Evidence on both these factors is crucial for effective decision-making (⬆Mitchell & D'Rozario, 2022). This kind of evidence is vital if EdTech is to help address the global learning crisis in a financially resource-constrained environment with an annual education funding gap of USD 148 billion (⬆GEM Report Team, 2020): where money is spent on one thing it is, inevitably, not spent on something else (⬆Beeharry, 2021).

There are many reasons why it is difficult to gain a realistic assessment of the cost of an EdTech intervention, including market incentives to obscure costs and practical difficulties of coming to reliable figures and determining 'total cost of implementation' (or 'total cost of ownership') in a consistent manner and over a multi-year cycle. However, prioritising this question will focus attention on the need to make progress on tackling these challenges. Once it is viable to more fully assess cost-effectiveness reliably and transparently prior to implementing at scale, then it is possible to make better informed, data-driven decisions regarding what EdTech to invest in, and what to reject.

Practical steps relating to evidence that can be taken to help build an evidence-driven future for EdTech that is increasingly cost-effective include:

A. Only decide whether to undertake an EdTech intervention once all suppliers have provided transparent and independently verified cost calculations including cost-per-child figures.

B. Use calculations of national spending per child per year (with a focus on discretionary spend and capitation grants where applicable) as a

basis for decision-making regarding the affordability of a proposed intervention within a specific national education context.

C. Contribute to building sector-wide evidence regarding cost-effectiveness by making cost data openly available and aligning with the nascent minimum standards on EdTech cost-effectiveness.

Q4: Will this use of technology be effective in the specific implementation context?

An EdTech intervention that works effectively in one context will not necessarily work effectively in another: there is no such thing as universal 'best practice'. This truth is particularly applicable when seeking to replicate a programme in a low-income setting that has been effective in a high-income setting, but it is also equally pertinent when seeking to replicate programmes across low-income contexts (see e.g., ⬆Andrews et al., 2017). Operating environments are highly diverse, and many EdTech programmes have struggled to repeat initial success when transferring their specific implementation model to a new context.

The intelligent use of evidence in EdTech requires determining what findings are generalisable, meaning they can be anticipated to also work in another context, and what findings are context-specific, meaning that they are valuable but unlikely to transfer (⬆Bates & Glennerster, 2017), and why this is the case. Building evidence regarding context is helped through research that is focused on systems and political economy, plus mixed-methods approaches that question not just 'what works' but also invest the time required to understand the factors behind this, determining the why, how, for whom, at what cost, and for how long within the specific context.

Practical steps relating to evidence that can be taken to help build an evidence-driven future for EdTech that is effective in specific implementation contexts include:

A. Ensure that EdTech programmes are based on a detailed understanding of the technical evidence base, plus the local context-specific evidence base, and the differences between them, prior to implementation.

B. Prioritise embedding research within implementation to learn and adapt to contextual realities, with a focus on generating 'hyper-specific' findings that will be sufficiently detailed and practical to actually improve practices.

C. When sharing evidence across the sector, help the user by being explicit within what is written regarding which findings are generalisable and which are likely to be context-specific.

Q5: Will this use of technology align with government priorities and lead to the strengthening of national education systems?

EdTech is most likely to be effective at scale when aligned from the outset with government education systems, sector plans, and priorities. This is the same logic as for any education intervention — governments, on the whole, are best positioned to understand and implement the needs of their citizens at scale, and external actors seeking to enhance these efforts should work within their structures wherever possible.

When EdTech is implemented in a way that is outside the priorities of the Ministry of Education — not aligned with the curriculum or teacher practices, collecting different data, based on different assessments and so on — it is less likely to have the desired impact in the long term (⬆Unwin et al., 2020). Unfortunately, within the EdTech sector, there are many examples of initiatives that have been built in such a way that they could never be integrated into the national education system within which they sought to operate.

Practical steps relating to evidence that can be taken to help build an evidence-driven future for EdTech that is aligned with government priorities include:

A. Ensure that new EdTech initiatives take time to understand current evidence regarding the detail of the education context within which they are operating, and align with the priorities of the national education system..

B. Conduct future-focused feasibility studies at the outset to assess whether the EdTech being considered could realistically integrate with and contribute to the success of the national education sector plan.

C. Governments can make available all national curricula and associated learning and teaching resources online and open-access so that EdTech developers and implementing organisations can build on the best of what is already available.

7. Priority actions for each stakeholder

Asking and working to answer the five questions will inevitably look somewhat different for each EdTech stakeholder group and in each context. However, there are priority actions that each stakeholder group can take to champion a culture of evidence, be situated at the leading edge of good practice, and build a new normal in the use of evidence for decision-making in EdTech.

Priorities for government decision-makers on EdTech

Governments can use EdTech to more fully meet their national education objectives and provide learning at scale for all children by championing an evidence-driven future, and ensuring that EdTech activities in the country are:

1. Justified on the basis of the extent of impact there will be on equitable educational outcomes, rather than educational outputs (i.e., not prioritising measures such as devices distributed, schools connected, etc.).

2. Required to share transparent and independently verified financial models for all interventions, including cost per child, proportion of discretionary spend, contributions in kind from partners, and anticipated impact on learning outcomes including for the most marginalised.

3. Aligned with the national curriculum, assessment, and associated learning and teaching resources (which is helped by governments making these available online and open-access so that EdTech developers and implementers can work from them).

Priorities for EdTech developers and vendors

Developers and vendors can improve their chances of long-term success and scale-up of their products by championing an evidence-driven future, ensuring that their EdTech products are:

1. Built based on rigorous education evidence, aligned with the national curriculum, assessments, and associated learning and teaching resources, and able to integrate with national sector plans.

2. Promoted on the basis of being cost-effective and affordable ways to have a sustainable impact on learning outcomes, with this

information openly shared in a way that demonstrates credibility and contributes to the sector-wide evidence base.

3. At the leading edge of the market by capturing, tracking, and using learning data to test and improve, particularly to enable teaching and learning at the appropriate level.

Priorities for organisations implementing EdTech

Implementing organisations can use EdTech in a way that fulfils their strategic objectives and helps children learn by championing an evidence-driven future, ensuring that all EdTech implementation is:

1. Delivered based on rigorous education evidence, aligned with the national curriculum, assessments, and associated learning and teaching resources, and able to integrate with national sector plans.

2. Based on a phased and adaptive design, informed by user research, undertaken in close collaboration with researchers to facilitate on-going improvements based on emerging evidence.

3. Designed to track and communicate anticipated outcomes, with emerging findings shared early and often, including those relating to failures, ensuring that all implementations contribute to building better evidence for the sector.

Priorities for organisations researching and assessing EdTech

Researchers can see increased impact and buy-in for their work, by championing an evidence-driven future, ensuring that EdTech research is:

1. Focused on targeting priority evidence gaps, and based on the best of current knowledge, to build critical masses of evidence that can inform decision-making.

2. Conducted as openly as possible, sharing datasets, methods, and early-stage findings in accessible formats in order to contribute to the development of the EdTech research community.

3. Undertaken in close collaboration with implementing organisations to understand real-world application, using the evidence generated to help make ongoing improvements.

4. Structured to centralise the research role of EdTech researchers within the country where the research is taking place, contributing

to the long-term strengthening of national EdTech research agendas.

5. Focused on tailored pathways to uptake, working actively to maximise the use-value of the research, aligning it with national priorities and curating findings to be accessible to different groups of education decision-makers.

Priorities for organisations funding EdTech

Donors can fund EdTech in an effective way that aligns with their own impact criteria by championing an evidence-driven future, ensuring that EdTech funding is:

1. Normally considered as part of a broader education strategy and funding portfolio, with investment decisions based on rigorous evidence across the education sector as well as EdTech-specific evidence, where there is clear commitment to focus on cost-effective learning outcomes.

2. Prioritised for implementations that have evidence building embedded as a default, and where the implementers demonstrate a desire to learn and adapt their approach on the basis of emerging evidence, with intelligent functionality for capturing learning data built into products.

3. Used to exert positive pressure across all groups working in EdTech to take the steps required of them to champion evidence within their work, apply the digital principles, and work from the best of the current evidence.

Priorities for teachers and school leaders working with EdTech

Teachers and school leaders can make more effective use of EdTech products and engage in implementations that are better aligned with their needs and priorities by championing an evidence-driven future, ensuring that:

1. All other groups involved in EdTech outlined above centralise the expertise and real-world requirements of teachers and school leaders within their work.

2. Evidence is built based on the experiences and feedback of teachers and school leaders, with decisions informed by real representation rather than isolated anecdotes.

3. Evidence products relating to EdTech are published and distributed in formats accessible to teachers and school leaders, where they can be used to help shape and improve practices at the school level.

8. A new normal of evidence-driven EdTech

Building a culture of evidence-based decision-making among all those involved in EdTech is the single most significant thing that can be done to ensure that technology is used in ways that help address the global learning crisis and strengthen education systems. Achieving this is a bold but achievable ambition that requires a radical shift from current practices. Now is the time to raise our expectations of the standards the sector should attain.

Every person and organisation involved in EdTech can and should contribute to the change by becoming obsessed with asking and answering the five key questions set out here — and ensuring that these determine decisions. And every stakeholder can position themselves at the leading edge of evidence-driven EdTech by aligning with the priorities outlined above. We hope that the vision and practical steps laid out in this paper can catalyse the global education community to establish a new normal of demanding and providing evidence for better decision-making in EdTech.

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