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EdTech evidence from Covid-19 response

A thematic review of primary research from Bangladesh, Ghana, Kenya, Pakistan, and Sierra Leone

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About this document

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About EdTech Hub

EdTech Hub is a global non-profit 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 UKAid, Bill & Melinda Gates Foundation, World Bank, and UNICEF. The views in this document do not necessarily reflect the views of these organisations.

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Abbreviations and acronyms

ASAL   Arid and Semi-Arid Lands

ASC   Annual School Census

ASER   Annual Status of Education Report

CHV   Community Health Volunteer

EDT   Education Development Trust

EdTech   Educational technology

EGMA   Early Grade Maths Assessment

EGRA   Early Grade Reading Assessment

ETS   Educational Testing Service

GLRRP   Ghana Learning Radio and Reading Programme

GLTV   Ghana Learning Television

IDELA   International Development and Early Learning Assessment

IPA   Innovations for Policy Action

IRI   Interactive Radio Instruction

IVR   Interactive Voice Response

LMICs   Low- and middle-income countries

OECD   Organisation for Economic Cooperation and Development

PDA   Participatory Development Associates

RCT   Randomised control trial

SeGMA   Senior Grade Mathematics Assessment

SeGRA	Senior Grade Reading Assessment
SDPI	Sustainable Development Policy Institute
SMS	Short Message Service
TaRL	Teaching at the right level
TIMSS	Trends in International Mathematics and Science Study
TSES	Tschannen-Moran's Teacher Sense of Efficacy Scale
T-TEL	Transforming Teaching, Education and Learning
USD	United States Dollar
USSD	Unstructured Supplementary Service Data

Executive summary

From early 2020, all over the world, in-person schooling was closed for extended periods due to the Covid-19 pandemic. Learners were forced to find new ways to learn, teachers new ways to teach, and parents and caregivers took on responsibility for education provision in unprecedented ways. To enable remote learning in large these shifts relied on greater use of educational technology (EdTech). However, in low-resource contexts, many tech-based education efforts reached neither those they were designed for nor those most in need. And where they did reach learners, the EdTech interventions were often not sufficient to support quality or continuity of teaching and learning.

To better understand the use of EdTech interventions as part of the Covid-19 response, in late 2020, EdTech Hub commissioned ten small-scale research studies in five low- and middle-income countries (LMICs). This research, conducted in Bangladesh, Ghana, Kenya, Pakistan, and Sierra Leone throughout 2021, included studies examining the use of three main types of devices: radio, television, and mobiles / smartphones. Education interventions were delivered via a range of different tech-based approaches, including:

- Interactive voice response (IVR) audio lessons

- Audio-visual lessons (e.g., YouTube)

- Text messages / social media / digital applications (e.g., Zoom, WhatsApp)

- Digital platforms for online learning

- Data systems development

This paper presents a summary and review of these studies to explore EdTech use in low-resource contexts during the Covid-19 pandemic and considers implications of its use in these contexts going forward.

Our analysis includes insight into research methodologies on effectiveness, with particularly interesting findings on how it has been measured. The measures of EdTech effectiveness used across these ten studies fell into five main types:

1. Learning outcomes

2. Engagement with content

3. Levers to access and use

4. Group-based variations

5. Perceptions and awareness.

Unsurprisingly, the 'learning outcomes' category appears to have been the most difficult in which to secure reliable data and showed mixed results. The other types of measures generally resulted in rich data sets but served more as proxies for or descriptors of EdTech effectiveness rather than providing evidence of impact. A further category on cost-effectiveness was flagged as important in the studies but received limited investigation due to the studies' limited scope and scale.

Our semi-structured thematic analysis to identify commonalities across findings in the studies further provides insights into EdTech effectiveness in relation to four main user groups of learners, girls, teachers, and parents / caregivers. These insights include:

EdTech and learners

■ EdTech interventions have mixed results in improving learning outcomes.

■ Vulnerable and marginalised learners see the biggest benefit from EdTech when designed with their needs in mind.

■ The design of interventions influences levels of EdTech access and use in resource-poor households.

■ Learners have important insights on improving EdTech effectiveness and see it as a complement to in-person learning.

EdTech and girls

■ Girls lag behind boys in EdTech access and use.

■ EdTech limitations for girls are largely attributed to social norms in cultural, religious, and labour divisions.

■ Girls seem to perform better than or as well as boys when using EdTech.

EdTech and teachers

■ Tech-enabled teacher professional development enhances the ability and confidence to use EdTech in teaching and learning.

■ Availability, access to, and usage of EdTech are all challenging for teachers and teacher trainers.

■ Teachers' use of EdTech to engage students is a critical factor in encouraging structured learning.

EdTech and parents / caregivers

■ Parents' and caregivers' critical role in facilitating learning can be boosted through EdTech alignment with curricula.

■ Messaging is promising but does not have consistent effects on parent and caregiver engagement.

The findings in this report point to a series of cross-cutting factors that are important for the effectiveness of EdTech interventions in low-resource settings.

1. Base resourcing of devices and connectivity is necessary but not sufficient for learning via EdTech.

2. Chains of connections between teachers, parents and caregivers, and communities are critical to realising opportunities in EdTech use.

3. Co-design and personalisation will improve the reach of tech-based interventions.

4. Blended learning through combining technology with in-person teaching and learning is desirable and can amplify impact.

5. Awareness raising of tech-based learning opportunities supports the uptake and norm change.

An overarching takeaway from across the studies centres on the fact that having technology in place is a small part of EdTech effectiveness. Wider EdTech teaching and learning ecosystems deserve more attention. The variety of approaches across our studies further shows that clearer and more common approaches in measuring EdTech effectiveness are needed. Finally, our studies reveal a symbiotic relationship between people and technology, reinforcing that EdTech works best when users are involved across design, iteration, awareness building, and engagement.

Figure 1. *Map of EdTech and Covid-19 research studies*
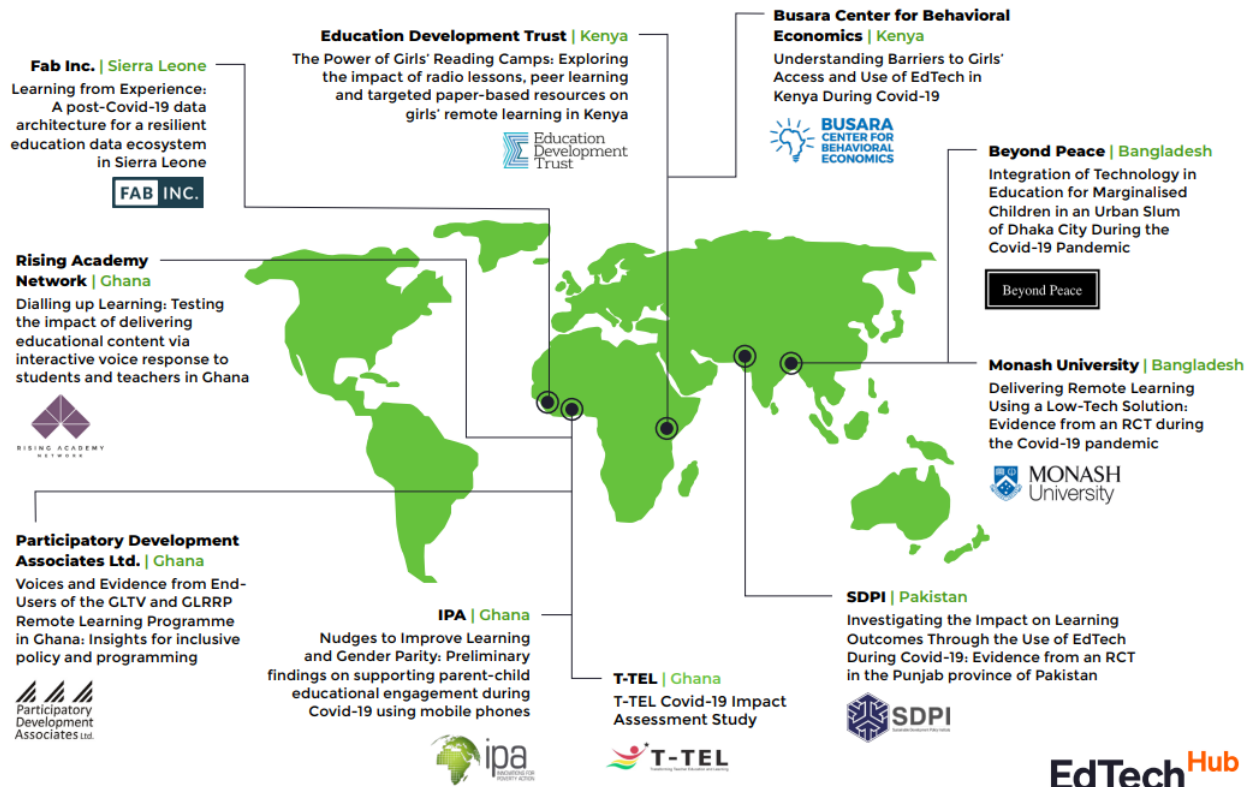
1. Introduction

The Covid-19 pandemic has dramatically altered how we teach and learn. School closures around the world, often lasting for long periods, caused more than 1.6 billion children and youth to shift to remote education with dramatic effects (↑World Bank et al., 2021). In efforts to maintain learning continuity through this severe disruption, governments and other education providers quickly embraced and experimented at unprecedented levels with use of educational technology (EdTech). This report synthesises learning from across a set of small-scale primary research studies that looked at the use of EdTech in response to the Covid-19 pandemic in select low-resource contexts. Its principal finding is that having technology in place is a small part of EdTech effectiveness; with wider ecosystem elements surrounding the learner deserving as much, if not more, attention.

1.1. The challenge of remote learning

The stakes are high, with the pandemic having worsened what was already considered a global learning crisis (↑UNESCO et al., 2022). Estimates are that in low- and middle-income countries (LMICs) the share of children unable to read a basic text by the age of ten is likely to rise sharply from 50% to 70% as a result of Covid-19 (↑World Bank et al., 2021). Throughout the pandemic, children and youth from low-income households worldwide bore the brunt of increasing education inequalities (↑Save Our Future, 2020). On average, school closures in LMICs were longer than in high-income countries, students had less technology access for continuing education, and there was less adaptation (↑Global Education Evidence Advisory Panel, 2022). As a result, LMICs experienced greater learning loss during the pandemic than found in higher-income countries part of the Organisation for Economic Cooperation and Development (OECD) (↑Global Education Evidence Advisory Panel, 2022). These setbacks are likely to undo years of progress made in education and compromise generations to come (↑Azevedo, 2020; ↑World Bank et al., 2021).

The variation in remote learning policies and approaches has been widely acknowledged (↑World Bank et al., 2021), with "evidence […] mounting of the low effectiveness of remote learning efforts" (↑Global Education Evidence Advisory Panel, 2022). It is, therefore, critical to reflect on the potential of EdTech interventions and under what conditions they have appeared to be more effective during the pandemic period.

1.2. EdTech Hub response to the Covid-19 pandemic

The EdTech Hub consortium had been in place for only half a year and was just finishing its inception planning period when the Covid-19 pandemic hit in early 2020. With our work focused on evidence for decision-making, efforts quickly pivoted to respond to new needs as remote learning, often via EdTech, emerged as a widespread response. EdTech Hub's work in the first few months of the pandemic included the production of more than 30 knowledge products[1] covering EdTech in relation to issues such as gender, disability, conflict and crisis, getting back to school, blended learning, and policy and planning, as well as country-specific research, evidence, and advice.[2] As a part of this response effort, EdTech Hub provided a helpdesk (↑Chuang & Moss Coflan, 2020), offered technical assistance, including an EdTech Tools Database,[3] and ran a series of sandboxes — small and contained spaces to test and iterate an EdTech intervention (↑Rahman et al., 2021).

During this time, EdTech Hub also began to build research partnerships. Working with Digital Pathways Oxford,[4] it convened the Building EdTech Evidence and Research (BETER)[5] working group involving organisations and individuals undertaking or providing funding for research in Covid-19 response, which resulted in collaborative work around both surveys and mapping.[6] In-country research partnerships were kicked off by

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[1] https://edtechhub.org/covid-19-resources/ Retrieved 30 January 2023

[2] Knowledge products produced by the Hub in the first few months of the Covid-19 pandemic included: rapid evidence reviews (e.g., ↑Ashlee et al., 2020; ↑Damani & Mitchell, 2020; ↑Major & Francis, 2020; ↑Watson & McIntyre, 2020; ↑Webb et al., 202); evidence summaries (e.g., ↑David et al., 2020; ↑Education Endowment Foundation, 2020; ↑Gorgen & McAleavy, 2020; ↑Hallgarten et al., 2020; ↑Hallgarten & Fitzpatrick, 2020; ↑Joynes et al., 2020; ↑McAleavy & Gorgen, 2020b; ↑McAleavy & Gorgen, 2020a; ↑Naylor & Gorgen, 2020; ↑Ndaruhutse et al., 2020; ↑Traxler et al., 2020) and help desk responses (e.g., ↑Adam et al., 2020; ↑Allier-Gagneur & Moss Coflan, 2020; ↑Coflan & Kaye, 2020; ↑Chuang et al., 2020; ↑Haßler et al., 2020i;↑ Kaye et al., 2020; ↑Kimenyi et al., 2020; ↑Koomar et al., 2020; ↑Lynch et al., 2020; ↑McBurnie, 2020;

[3] https://edtechhub.org/edtech-tools/ Retrieved 30 January 2023

[4] https://www.bsg.ox.ac.uk/research/digital-pathways-oxford Retrieved 30 January 2023

[5] https://edtechhub.org/building-edtech-evidence-and-research-beter/#:~:text=Get%20in%20contact-,What%20is%20BETER%3F,as%20a%20global%20public%20goods. Retrieved 30 January 2023

[6] The BETER group met monthly in 2020–2021 to learn about and discuss EdTech and Covid-19 research. Work produced via the group's collaboration included, e.g., a thematic

commissioning a series of ten country case studies on EdTech and Covid-19 response.[7]

This range of EdTech evidence and experience was initially captured in a background paper (↑Haßler et al., 2020kj) to the ↑Save Our Future (2020) white paper, *Averting an Education Catastrophe for the World's Childre*n. In addition, with such an expansive portfolio, there was felt to be a need to consolidate evidence in a more accessible form that could be used by senior decision-makers in the education space. Through a semi-systematic review of EdTech Hub's own products and experience, key lessons were further set out as part of an evidence-based report *EdTech and Covid-19: 10 things to know* (↑Nicolai et al., 2020) that brought together key messages from our EdTech work during the first year of the pandemic. The *10 things to know* included:

1. Use EdTech in ways that reach the most marginalised.

2. One size won't fit all; use a multi-modal approach.

3. Think about the personal connection, well-being, and safety.

4. Enhance teacher professional development.

5. Build learning teams: Involve parents, siblings, and carers.

6. Apply EdTech across system, teacher, and learner needs.

7. Adapt existing content, pedagogies, and hardware.

8. Reimagine education by testing new approaches.

9. Consider political will, planning, and partnerships.

10. Scale and invest where EdTech is most effective, equitable, and appropriate.

While this portfolio represented significant EdTech evidence and experience, none was based on new primary research. As weeks of school closures turned to months, there was both a critical need and window of

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analysis of surveys (↑Fitzpatrick et al., 2020) and a systematic review on how technology has been used for learning continuity remotely during an emergency (↑Crompton et al., 2021).

[7] The 10 case study reports on EdTech responses in the first few months of the Covid-19 pandemic included China (↑Liangdi & Groenewegen-Lau, 2020), Indonesia (↑Suriastini et al., 2020), India (↑Doraiswamy et al., 2020), Pakistan (↑Tabassum et al., 2020), Jordan (↑Al-Hindawi & Hashem, 2020), Kenya (↑Ngware & Ochieng, 2020), Rwanda (↑Ngabonzima et al., 2020), Nigeria (↑Isisi et al., 2020), and Ghana (↑Agbe & Sefa-Nyarko, 2020).

opportunity for primary research on responses being used in the pandemic to begin to address multiple evidence gaps on EdTech use and effectiveness in low-resource contexts as part of remote learning.

1.3. Commissioning primary research

To gain further insight on EdTech effectiveness, in late 2020, EdTech Hub issued a call for proposals for research studies on EdTech use in response to the Covid-19 pandemic in low-resource contexts. These were envisaged as rigorous, small-scale studies with budgets of less than GBP 50k to be delivered by partners over the course of 2021. The call required that studies take place in one of six LMICs — Bangladesh, Ghana, Kenya, Pakistan, Sierra Leone, and Tanzania — that EdTech Hub had prioritised as focus countries.[8]

Following receipt of more than 175 proposals, a selection process involving external review led to the commissioning of 10 studies to be carried out by partner organisations in five countries: Bangladesh, Ghana, Kenya, Pakistan, and Sierra Leone. An overview of the selected organisations, their studies, the tech-based intervention studied, and the authors is provided in Table 1 below.

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[8] EdTech Hub focus countries were chosen for the following reasons: "Potential to influence major upcoming investments in EdTech if relevant evidence is applied; High level of government and donor interest in how EdTech can accelerate progress; Varying levels of EdTech maturity… making it possible to draw on and share applicable lessons" (↑EdTech Hub, 2022b).

Table 1. *Overview of commissioned EdTech studies on Covid-19*

Research partner	Study	Tech-based intervention	Authors
Rising Academy Network	*Dialling up Learning: Testing the Impact of Delivering Educational Content via Interactive Voice Response to Students and Teachers in Ghana*	IVR audio lessons	↑Afoakwah et al. (2021)
T-TEL	*T-TEL Covid-19 Impact Assessment Study* [in Ghana]	Online learning via virtual platform	↑Ananga et al. (2021)
PDA	*Voices and Evidence from End-Users of the GLTV and GLRRP Remote Learning Programme in Ghana*	Television and radio lessons	↑Hodor et al. (2021)
IPA	*Nudges to Improve Learning and Gender Parity: Preliminary findings on supporting parent-child educational engagement during Covid-19 using mobile phones*	Text message "nudges"	↑Aurino et al. (2022)
EDT	*The Power of Girls Reading Camps: Exploring the impact of radio lessons, peer learning and targeted paper-based resources on girls' remote learning in Kenya*	Radio and reading camps	↑Amenya et al. (2021)
Busara	*Understanding Barriers to Girls' Access and Use of EdTech in Kenya During Covid-19*	Television, radio, video (e.g., Youtube)	↑Tembey et al. (2021)
Beyond Peace	Integration of Technology in Education for Marginalised Children in an Urban Slum of Dhaka City During the Covid-19 Pandemic [in Bangladesh]	Television, radio, smartphone, computer	↑Islam et al. (2021)
Monash University	Delivering Remote Learning Using a Low-Tech Solution: Evidence from an RCT during the Covid-19 pandemic [in Bangladesh]	IVR audio lessons	↑Islam et al. (2022)
SDPI	Investigating the Impact on Learning Outcomes Through the Use of EdTech During Covid-19: Evidence from an RCT in the Punjab province of Pakistan	Online learning, computer-assisted teaching	↑Adil et al. (2021)
FAB, Inc.	Learning from Experience: A post-Covid-19 data architecture for a resilient education data ecosystem in Sierra Leone	Data system	↑Fab Inc. (2021)

Research focused on how a range of low-tech interventions were used to support learners affected by closures, alongside, in several instances, its use in teacher training or in engaging parents and caregivers, with one study focused on data architecture. By and large, studies examined the use of three main types of devices: radio, television, and mobiles / smartphones. Education interventions were delivered via a range of different tech-based approaches that can be grouped as:

- Interactive Voice Response (IVR) audio lessons

- Audio-visual lessons (e.g., YouTube)

- Text messages / social media/ digital applications (e.g., Zoom, WhatsApp)

- Digital platforms for online learning

- Data systems development

Overall, given their small-scale nature, they reached relatively low numbers, but with implications and findings applicable in many other settings. A set of quick facts on the research portfolio is captured in Box 1, with further detailed information set out in Annex 1.

Box 1. *Quick facts on EdTech and Covid-19 research studies commissioned by EdTech Hub*

- 10 primary research studies with 10 in-country partners

- 5 countries: Pakistan, Bangladesh, Kenya, Ghana, Sierra Leone

- 2,898 learners reached by EdTech within the studies

- 2,101 teachers reached by EdTech within the studies

- 3 main types of device used: Radio, TV, Mobile / Smartphones[9]

- 5 tech-based approaches: Interactive Voice Response (IVR) audio lessons, audio-visual lessons (e.g., YouTube); text messages, social media / digital applications (e.g., Zoom, WhatsApp); digital platforms (for online learning); and data systems development

- 4 emergent themes: Learners, Girls, Teachers, Parents and Caregivers

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[9] While the Pakistan study talks about computer-supported learning (↑Adil et al., 2021) and a Ghana study online / eLearning (↑Ananga et al., 2021), content in both of these was largely accessed through mobile / smartphones.

With these studies now completed and published in their own right, we have gained a better understanding of the range of methods and findings from across the studies as captured in the following sections.

2. Methodology across studies

Conducted during the Covid-19 pandemic, our ten studies varied in terms of focus and approach, including research question framing, data collection methods, and measures used. There were significant challenges in conducting research over and above a typical study due to the pandemic. Looking across these elements provides a number of insights on *how* research on EdTech effectiveness and use has been conducted.

2.1. Varied questions and methods

A variety of research questions were posed as a part of these studies, tied to evaluating the effects of tech-enabled learning interventions alongside identifying supportive conditions and barriers to uptake. Distribution, access and use of technology for learning by students, teachers, parents and caregivers were also examined. Vulnerability and marginalisation, such as income levels, rural vs. urban contexts, and disability, were considered in nearly all studies, and ways in which EdTech could advance gender equality were examined by more than half of them. Examples of select research questions are set out here in Box 2, with the full menu of research questions from the studies set out in Annex 2.

Box 2. *Example research questions from EdTech Covid-19 research studies*

- Does listening to numeracy lessons delivered via interactive voice response (IVR) on mobile phones improve student learning outcomes?

- Can interactive radio instruction-(IRI)-based audio lessons, delivered through feature phones, lead to better learning outcomes for primary graders?

- What were the separate and combined effects of delivering Teaching at the Right Level (TaRL), fortnightly assessments, and digital training sessions online on student learning outcomes when it came to Urdu, English, and maths?

- How do GLTV (Ghana Learning Television) and GLRRP (Ghana Learning Radio and Reading Programme) interventions (educational broadcasts) meet the specific needs of marginalised groups?

- What can we learn about the impact of radio lessons, reading camps, and targeted paper-based resources on girls' learning (when combined or used separately)?

- How do caregivers make decisions about encouraging the use of edutainment, smartphones, and low-tech (radio, IVR, USSD, TV) education solutions for their children? What have they found particularly valuable for encouraging girls?

- Do nudges to parents in the form of SMS messages increase the rate of children returning to school and general engagement with education when schools reopen?

- Are student teachers (especially those from low-income backgrounds and those with visual and hearing impairments) becoming independent and responsible in their learning?

- What lessons can be drawn from school-level changes in enrolment following Ebola, which can be applied to school reopening following Covid-19?

Various research methods were employed across the studies (see Table 2 below). Among these, qualitative methods included a literature review, interviews, focus groups, and lesson observations. Quantitative methods included surveys, learning assessments, randomised control trials (RCTs), and secondary data analysis. All studies used a literature review to ground their work. All but two studies used surveys, often administered through structured interviews, to collect baseline, midline, and endline results. Four studies took a mixed-methods approach, combining a survey with a learning assessment and / or RCT with qualitative methods of semi- or non-structured interviews and focus groups. Only one study used lesson observation on a virtual learning platform (↑Ananga et al., 2021). One study used a 'human-centred design thinking process' to collaborate with participants on co-designing technological solutions to problems discovered during data collection (↑Tembey et al., 2021). Another integrated a database that it analysed alongside interviews with stakeholders and secondary sources, producing an interactive dashboard for policymakers (↑Fab Inc., 2021).

Table 2. *Range of methods used to collect data across studies*

Country	Research partner	Qualitative methods				Quantitative methods			
		Literature review	*Interview*	*Focus Groups*	*Lesson observation*	*Survey*	*Learning assessment*	*RCT*	*Secondary data analysis*
Ghana	Rising Academy	X				X	X	X	
Ghana	T-TEL	X	X		X	X			
Ghana	PDA	X	X	X					X
Ghana	IPA	X				X	X	X	
Kenya	EDT	X	X	X		X	X		
Kenya	Busara	X	X			X			
Bangladesh	Beyond Peace	X				X			
Bangladesh	Monash University	X				X	X	X	X
Pakistan	SDPI	X	X	X		X	X	X	
Sierra Leone	Fab Inc.	X	X						X

2.3. Types of measures used

Five main types of measures were used to gauge EdTech effectiveness across the studies. As illustrated in Figure 2 below, these can be categorised as:

1. changes to learning outcomes

2. engagement in content

3. levers to access and use

4. group-based variations

5. perceptions and awareness

Unsurprisingly, the learning outcomes category appears to have been the most difficult in which to secure reliable data. The other types of measures generally resulted in rich data sets but served more as proxies or descriptors of EdTech effectiveness rather than providing evidence of impact. A further category on cost-effectiveness was flagged as important in the studies but received limited investigation due to the studies' limited scope and scale.

Most of our studies involved measuring *changes to learning outcomes,* looking both at students and teachers in relation to the EdTech intervention being studied. Five of our studies captured student learning outcomes using assessments (↑Adil et al., 2021; ↑Afoakwah et al., 2021; ↑Amenya et al., 2021 ↑Aurino et al., 2022; ↑Islam et al., 2022)[10] and an additional two used testimonials of improved performance gathered through focus groups and interviews (↑Hodor et al. 2021); (↑Tembey et al.,

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[10] The student learning assessments used included a numeracy assessment similar to Grade 4 TIMSS (Trends in International Mathematics and Science Study) items (TIMSS, 2013 cited in ↑Afoakwah et al., 2021); student literacy assessments based on the IDELA (International Development and Early Learning Assessment), EGRA (Early Grade Reading Assessment), and the Young Lives surveys and numeracy assessment using tasks from the IDELA, EGMA (Early Grade Math Assessment) and the Young Lives surveys (↑Aurino et al., 2022); SeGRA (Senior Grade Reading Assessment) and SeGMA (Senior Grade Mathematics Assessment) covering girls' literacy and numeracy (↑Amenya et al., 2021); assessment taken from the national curriculum of Bangladesh covering English literacy, Bangla literacy, numeracy, and general knowledge plus Scales for Rating the Behavioural Characteristics of Superior Students to measure noncognitive outcomes (with mothers as respondents) (Renzulli et al., 2002 cited in ↑Islam et al., 2022); language and maths tests administered for the ASER (Annual Status of Education Report) Survey, plus, for older children, grade-appropriate tests based on the Punjab textbook board syllabus for maths, English, and Urdu (↑Adil et al., 2021).

2021).[11] Assessment measures were generally framed in terms of how many students were learning and by how much across subjects (e.g., language literacy, numeracy). For instance, a Pakistan study measured separate and combined impacts of the intervention on Urdu, English, and maths learning outcomes based on TaRL, fortnightly formative assessments and digital training sessions (↑Adil et al., 2021). Several other studies measured if EdTech improved teacher knowledge, for how many teachers (including teacher trainers, aka tutors), and by how much.[12] By and large, the studies showed mixed and potentially promising results in learning outcomes, as discussed further in Section 3.2 below.

The second type of measure used across studies was *engagement in content*. This involved, for instance, students' and teachers' rates of lesson completion, such as in a Ghana study which tracked the rate of completion of IVR audio lessons by students and teachers (↑Afoakwah et al., 2021). In addition, the rate of increase in student engagement (level of effort, attitude) was looked at, with a study in Kenya measuring the impact of radio intervention on girls' attitudes towards learning (↑Amenya et al., 2021). Some studies also measured if EdTech improved parent and caregiver engagement (e.g., beliefs, attitudes, and behaviours towards girls, returns to education, investment, expectations and aspirations for children, and emotional support). For example, a Ghana study looked at the rate of change in parental beliefs about returns to education and expectations and aspirations based on text nudges (↑Aurino et al., 2022).

Thirdly, studies measured *levers to access and use* of EdTech. This typically involved a closer look at barriers and enablers to students accessing and using EdTech (e.g., caregiver decision-making, social norms, devices, and connectivity). For instance, a Kenya study measured the impact of caregiver decision-making on children's use of EdTech (edutainment, smartphones, radio, IVR, USSD, TV), especially girls (↑Tembey et al., 2021).

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[11] In the case of ↑Tembey et al., (2021), this was done rigorously via analysis of data from a first phase involving 58 interviews and 494 phone surveys conducted simultaneously, which framed a second research phase.

[12] Teacher assessments used included the ETS (Educational Testing Service) Praxis assessment Teaching Reading: Elementary and a modified version of TSES (Tschannen-Moran's Teacher Sense of Efficacy Scale) Short Form to capture teacher self-efficacy (ETS Praxis, 2021 and Tschannen-Moran & Hoy, 2001 cited in ↑Afoakwah et al., 2021); also measurement of the number of student teachers and tutors that gained a stronger understanding of online learning and confidence was done through structured interviews (with 356 student teachers and 462 tutors) and lesson observation (with 211 tutors) (↑Ananga et al., 2021); and qualitative data on the positive impact for teachers was also collected via interviews (↑Hodor et al., 2021).

Fourthly, a number of *group-based variations* were measured in the studies. This included efforts to better understand variations in EdTech effects linked to characteristics indicating vulnerability or marginalisation; for example, in a Bangladesh study, learning outcomes from IVR audio lessons for children were measured and grouped by gender, baseline learning level, and caregiver income and education (↑Islam et al., 2022). Also, some studies attempted to measure if EdTech improved impact distribution (learning outcomes and engagement) for girls and boys. A Ghana study looked at the distribution of impacts for girls and boys from text nudges in education messaging, as well as attitudes and behaviours towards girls' use of EdTech, and drivers of this distribution (↑Aurino et al., 2022).

A fifth type of measurement in the studies was that of *perceptions and awareness* of EdTech. This included different users' views of EdTech; for example, feedback from students and teachers on the audio lessons and the IVR method of delivery (↑Afoakwah et al., 2021). Other measurements included student, teacher, parents and caregiver knowledge and social awareness of EdTech. For example, a Ghana study looked at the number (percentage) of respondents in urban and rural settings aware of educational TV offerings and other remote learning programmes (↑Hodor et al., 2021).

While the importance of cost-effectiveness is touched on in a few studies, cost capture was generally not conducted across the studies due to their limited scope, timeframe, and resourcing. A few studies do flag the differences between fixed and recurring costs and highlight the potential for the cost-effectiveness of an intervention by keeping recurring costs low. [13] Others emphasise the challenges of user costs that must be addressed to make interventions more feasible (e.g., the high cost of data for student teachers to access virtual learning in ↑Ananga et al., 2021; high internet costs for students in ↑Amenya et al., 2021 and ↑Adil et al., 2021). This is clearly a gap, with work only recently starting to emerge in consolidating evidence and providing guidance on how to approach measuring EdTech

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[13] The Bangladesh study on IVR audio lessons provides an example of forecasting cost-effectiveness at scale (↑Islam et al., 2022). At USD 27.5 per student over 15 weeks for 1,182 students in two districts, fixed costs were found to be relatively high compared to variable costs. However, it was also noted that, scaling up would drive cost down with estimates showing that if the intervention was scaled to reach 100,000 students over one year, it would cost USD 45 per student (↑Islam et al., 2022). Another study on IVR audio lessons in Ghana notes that while there was significant investment of time and resources in the setup phase, recurring costs were minimal once the intervention was underway, again suggesting potential for cost-effectiveness in the longer term (↑Afoakwah et al., 2021).

cost-effectiveness (↑Chuang et al., 2021; ↑Mitchell & D'Rozario, 2022a;↑Mitchell & D'Rozario, 2022b; ↑Mitchell & D'Rozario, Forthcoming).

Figure 2. *Measures used for EdTech effectiveness in studies*
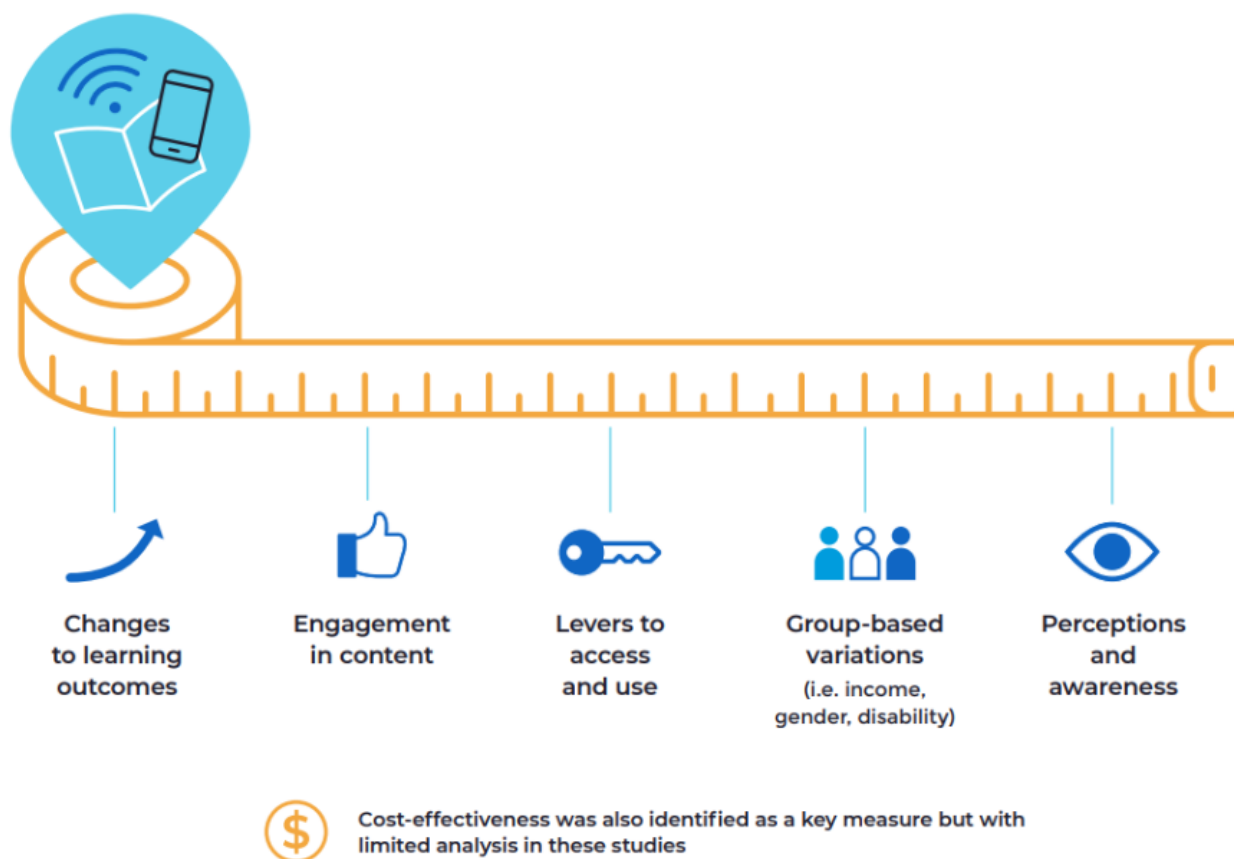
2.3. Research challenges and mitigation

All studies reported challenges and limitations in conducting the research. Carrying out research during the pandemic was a fundamental design feature but also made coordination unpredictable and data collection challenging. For many studies, government lockdowns and caution about spreading the virus reduced the possibility of field visits; instead, participants were contacted by phone for interviews and learning assessments. Concerns in terms of research-at-a-distance included

- network issues for participants in hard-to-reach locations (requiring tracing — ↑Aurino et al., 2022);

- a lack of trust established by phone (↑Aurino et al., 2022);

- questions about the suitability of participants' environments to speak and concentrate (↑Tembey et al., 2021);

- the survey being too long to conduct over the phone and an inability to read body language (↑Tembey et al., 2021), among other things.

A further challenge for many studies was sample attrition (e.g., due to phones not working or switching off or numbers changing; people leaving WhatsApp groups; internet connectivity issues; literacy issues; a lack of financial incentives; seasonal migration and religious customs). In one Kenya study, for example, the research team was unable to measure learning losses and gains from the radio intervention as a result of attrition (↑Amenya et al., 2021).

The timing, level of effort and involvement required to launch EdTech interventions and prepare data collection instruments, which sometimes required adjustments after field testing, were further common challenges. For instance, substantial contracting delays in a Ghana study caused the focus to shift from supporting caregiver educational engagement during Covid-19 school closures to doing so as schools reopened (↑Aurino et al., 2022). It took time for another study in Ghana to partner and prepare content with an IVR platform, with limitations in delivery timing as the research team in question did not directly manage the intervention (↑Afoakwah et al., 2021).

Some research teams found creative ways to navigate these challenges. In dealing with Covid-19 lockdowns and health and safety protocols, one coping mechanism involved identifying small windows when lockdowns were lifted and having small field teams focus on quick data collection (↑Islam et al., 2021) or do data collection back-to-back in different communities, with accelerated analysis, reflection, and identification of further areas to investigate (↑Amenya et al., 2021). Where it was not possible to conduct learning assessments in students' homes, children were assessed at a distance while sitting on stones, the ground, and in trees (↑Aurino et al., 2022). A study that was planning to use a sign language interpreter for in-person interviews with hearing-impaired students and teachers capitalised on smartphones, communicating instead through Whatsapp (↑Ananga et al., 2021). Overall, there was definitely a sense across studies that researchers had gone above and beyond in difficult circumstances to gather more rigorous evidence on what works.

3. Thematic review by user groups

This section presents results from a semi-structured thematic analysis coding across nine of the ten EdTech and Covid-19 research studies in relation to four main user groups: learners, girls, teachers, and parents and caregivers. Within these, a set of emergent lessons were identified and are shared.[14]

3.1. Process of thematic review

To synthesise findings across the studies, given their variety in focus and methods, we opted for a semi-structured thematic analysis process using open coding, initially cross-referenced with EdTech Hub's five focal topic areas.[15] This resulted in an analytical framework where four of the five themes essentially were linked to user groups, with the fifth as an outlier.[16] Details on which studies have contributory evidence for each theme shown are in Table 3.

Our adopted frame helps elucidate evidence on the use of EdTech in relation to learners, girls, teachers, parents and caregivers, and within these, more detailed sub-themes emerged. For example, within the theme of learners, sub-themes on EdTech's impact on learning outcomes, access and engagement, and perceptions of remote education were found across the study findings. The teacher theme includes sub-themes on teacher training and tech-enabled connection with learners, parents and caregivers. Analysis of these provides a sense of what can be inferred as evidence across the studies.

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[14] The study in Sierra Leone was exceptional in its focus on data architecture and policymakers as users, and so was not coded.

[15] Following the initial year of the Covid-19 pandemic, as part of EdTech Hub strategy development in 2021, five focus areas were identified: digital personalised learning, girls' education, teacher professional development, participation and messaging, and data for decisions (↑EdTech Hub, 2022a). As these were identified after commissioning our primary research studies, they were not used in study selection but laterly did inform our coding. Here, our resulting themes are aligned with user groups and are broader than those adopted by the Hub, but with close overlaps to all of the Hub's five topic areas: learners = digital personalised learning (8 studies), girls = girls' education (8 studies), teachers = teacher professional development (4 studies), parents and caregivers = participation and messaging (8 studies), and data ecosystems = data for decisions (1 study).

[16] With the study in Sierra Leone being the only one to have a focus on data architecture and policymakers as a user group, there were no multiple studies to draw on for findings and implications in this theme and we have thus not included it in our thematic analysis but rather shared headlines in Box 3.

Coding in this way enables discussion of patterns, insights, and interlinkages while at the same time acknowledging limitations in comparison given the design and focus of the different studies. It should be reiterated that in this paper, our analysis does not extend to include external evidence on the different subjects examined, as content was largely drawn from the studies themselves. Instead, this synthesis consolidates what we have learnt and sees what is echoed between studies, as well as highlighting points of departure for further research.

Once the analytic framework was developed and sub-themes initially identified, a learning event was held with study partners to sense-check and iterate on related findings, with their input incorporated alongside the coding analysis in developing common findings as set out below in Table 3.

Table 3. *Thematic frame used in analysis of research studies*

Country	Research partner	Main themes as emerging from open coding				
		Learners	Girls	Teachers	Parents & caregivers	Policymakers
Ghana	Rising Academy	X		X	X	
Ghana	T-TEL		X	X		
Ghana	PDA	X	X	X	X	
Ghana	IPA	X	X		X	
Kenya	EDT	X	X		X	
Kenya	Busara	X	X		X	
Bangladesh	Beyond Peace	X	X		X	
Bangladesh	Monash University	X	X		X	
Pakistan	SDPI	X	X	X	X	
Sierra Leone	Fab Inc.					X

3.2. EdTech and learners

Covid-19 school closures significantly disrupted learning, which was already in crisis in countries where research took place before the pandemic hit. For instance, in Bangladesh and Ghana, despite improvements in access to

schooling prior to the pandemic, large numbers of students were not achieving minimum proficiencies in Grades 4, 5 and 6 (Rahman & Ahmed, 2021, cited in ↑Islam et al., 2021; Ministry of Education at al., 2018 cited in ↑Afoakwah et al., 2021). High levels of poverty are a common issue, with parents' limited financial resources and abilities to assist with schoolwork contributing to higher rates of absenteeism and dropout (in Bangladesh — Sabates et al., 2013, cited in ↑Islam et al., 2021). Compounding this was education systems lacking the necessary resilience to shift quickly to remote education (in Ghana —↑Hodor et al., 2021), with the pandemic reducing contact hours and learning support with teachers (↑Hodor et al., 2021). This left many children engaging in little to no structured learning in our study contexts (Caballero et al., 2021, cited in ↑Afoakwah et al., 2021), resulting in severe learning gaps and poor academic performance (Crawfurd et al., 2021, cited in ↑Adil et al., 2021; ↑Hodor et al., 2021).

Eight studies explored how tech-based approaches could be used to support learning continuity, involving various subjects (e.g., maths and language) and testing a range of interventions. Most looked at learner access and engagement in EdTech, with others capturing learner perceptions of interventions. Sub-themes that emerged through coding were EdTech evidence of gains in learning outcomes, intervention design for marginalised learners, diversity of EdTech access, and learner insight on effectiveness.

EdTech interventions have mixed results in improving learning outcomes

Assessments of learning outcomes, as detailed above in Section 2.3, had mixed results, and no clear common patterns were found across our studies. A Bangladesh study found IVR had positive effects on English literacy and numeracy for primary school children, along with showing an increase in students' interest, attention span, and time investment in education (↑Islam et al., 2022). However, in Ghana, another study using IVR found that positive effects were less pronounced, only impacting one aspect of numeracy: place value knowledge (↑Afoakwah et al., 2021). Across three studies (one in Ghana and two in Kenya), television and video had positive effects in different subjects for different age groups (↑Amenya et al., 2021; ↑Hodor et al., 2021; ↑Tembey et al., 2021), while radio worked well in one study (↑Hodor et al., 2021) but showed no effect in another for a similar age group (↑Amenya et al., 2021). There was variability across subject matter as well; in Pakistan, an online TaRL intervention resulted in Grade 8 students' language scores going up but did not have the same effect on math scores (↑Adil et al., 2021). While these studies were not designed to be

comparable in terms of learning outcomes, the difficulty of measuring gains points to concerns around the reliability and validity of tools, particularly across contexts. While the studies that did include learning outcomes revealed tentative positive effects, more rigorous research is needed to understand how best to measure gains in particular interventions.

Vulnerable and marginalised learners see the biggest benefit from EdTech when designed with their needs in mind

In a Ghana study, television and radio programmes for basic and senior high schoolers were shown to make a difference for students with disabilities; for instance, promoting participation of those with hearing impairment, sign language was used in telecasts (↑Hodor et al., 2021). Yet learning engagement depended on having full access to devices, along with adequate supervision depending on the type and severity of disability (↑Hodor et al., 2021). A Bangladesh study on IVR found that the biggest gains were made for primary grades, especially for girls with poor baseline academic results, from low-income households, and with less-educated parents (↑Islam et al., 2022). This impact is attributed to the study design (i.e., sample recruitment of motivated caregiver-child dyads, cash incentives) and regularly reminding caregivers — mostly mothers — to engage with their children's learning (through text 'nudges' and short calls from village representatives) (↑Islam et al., 2022). Another study in Kenya found that vulnerable girls, due to poverty, rurality, and safeguarding risks, more often listened to radio lessons as a group outside their homes rather than doing so individually in their homes (↑Amenya et al., 2021). Reasons included pooling resources (i.e., low-cost, solar-powered radios), being freed up from domestic chores, having caregivers' trust based on community involvement, and collaborative effects on girls' attitudes towards learning (e.g., more self-confidence and self-efficacy ↑Amenya et al., 2021). In line with efforts toward TaRL, studies suggested that collecting, analysing and acting on data regarding group and individual learning experiences can support timely adjustments and additional support needed to match ability and learning levels (↑Afoakwah et al., 2021), rather than age or grade (↑Adil et al., 2021).

The design of interventions influences levels of EdTech access and use in resource-poor households

Having access[17] to devices, data, electricity, and in many cases, internet connectivity was a bottom-line determinant in all studies. Yet non-technical factors were often key in promoting or inhibiting this process. These included socio-economic demographic elements such as learner age, gender, availability, level of focus, digital literacy, household income, caregiver and teacher engagement, social awareness and norms about EdTech and more inclusive educational practices, also language, intervention scheduling, permission to use devices and sibling rivalry, and group learning and community support. On learner availability, for example, a Ghana study found 78% of learners in rural areas (compared to 29% in urban areas) had to help their parents work and raise income, limiting their time for education (↑Hodor et al., 2021). However, another Ghana study found the highest rate of IVR lesson completion took place in rural and more challenging communities (↑Afoakwah et al., 2021). This difference in access and engagement appears predicated on elements that can be influenced, such as having strong school leaders who embrace the intervention and regularly encourage students and parents to participate (↑Afoakwah et al., 2021). Another study in Kenya found that sharing and setting a schedule is important (↑Tembey et al., 2021).

Learners have important insights on improving EdTech effectiveness and see it as a complement to in-person learning

Across the studies, the main points of learner feedback included the desire to see increased opportunities for EdTech interactivity and tailoring interventions to the right level for the individual. For example, in a Ghana study, learners felt radio and television programmes should be taught at a slower pace, be more interactive and repeated ↑Hodor et al., 2021). They also suggested phone-ins be introduced to accommodate slower learners and ensure that lessons were understood ↑Hodor et al., 2021). In another Ghana study, while IVR was disliked by most students (only 13% liked it), the most popular feature was the quiz, and a large majority (75%) wanted phone lessons to continue (↑Afoakwah et al., 2021). While there is evidence of learners liking aspects of EdTech, a significant amount felt differently, and some emphasised it was no replacement for in-person learning (↑Adil et al.,

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[17] For instance, evidence in a Bangladesh study associates access with higher rates of attendance to online education (↑Islam et al., 2021), though this also depends on suitable EdTech to match with specific group needs (↑Islam et al., 2021).

2021; ↑Islam et al., 2021). In a Bangladesh study, some respondents said they would not continue their education if they could not participate in person (↑Islam et al., 2021). Conversely, others said they would like a hybrid approach in which classes through EdTech are supplemented by in-person learning (↑Islam et al., 2021).

3.3. EdTech and girls

Girls education and gender inequality in education is a major challenge globally, with the Covid-19 pandemic exacerbating concerns. For example, emerging evidence shows girls disproportionately assumed increased caring duties during the Covid-19 crisis (Nesbid-Ahmed & Subrahmanian, 2020, cited in ↑Aurino et al., 2022), risking progress towards gender parity and chances of returning to school (↑Aurino et al., 2022). Studies in Ghana and Kenya attribute this issue to gender-biased investment decisions (Bjorkman-Notqvist, 2013, cited in ↑Aurino et al., 2022) and structural inequalities that operate against girls' access to learning solutions (↑Amenya et al., 2021), which for EdTech especially reflect a gendered digital divide (Crompton et al., 2021 cited in ↑Tembey et al., 2021). This is counterproductive since there is evidence that girls engage more than boys when given the same level of access to technology and benefit beyond formal learning outcomes in terms of economic opportunities and decision-making about their own health (Webb et al., 2020, cited in ↑Tembey et al., 2021). Parental and teacher engagement can also vary between girls and boys, influencing gender bias in the use of EdTech; according to a Kenya study, there is evidence of teachers having lower expectations for girls' technology competence (Zelezny-Green, 2014, cited in ↑Tembey et al., 2021).

Eight studies explored EdTech effectiveness through a gender lens. These studies looked at different angles, from gender-based differences in learning outcomes to questions of gender-inclusive access and engagement in households and communities. Gender differences in relation to teachers and caregiver support of EdTech were also studied against a backdrop of social norms. In coding these studies, the main sub-themes that emerged centred on the role of social norms in limiting EdTech use, differing perceptions of EdTech and gender differences in realising the benefits of EdTech use.

Girls lag behind boys in EdTech access and use

Gender inequity was found in the study in Pakistan, where nearly a third (29%) of caregivers did not permit girls to access EdTech during school closures for various reasons (cultural, religious, financial — ↑Adil et al., 2021).

Further, 80% gave preference to boys over girls for using mobile phones (↑Adil et al., 2021). Gender-based differences in tech-device usage and overall internet access were also evidenced in a Bangladesh study on students in Grades 6–10 (↑Islam et al., 2021).

However, there were mixed findings in a Kenya study that unanimously found caregivers prioritised both genders and reported no difference in their households, yet in seeming contrast, the study also found that the community view is to prioritise educating males over females, suggesting a tension between the two (i.e., norm dissonance)(↑Tembey et al., 2021). Moreover, a question about EdTech decision-making in these same resource-scarce households had significant agreement that boys should be prioritised (↑Tembey et al., 2021).

EdTech limitations for girls are largely attributed to social norms in cultural, religious, and labour divisions

In our studies, gender-specific reasons that limited EdTech use included a lack of trust in girls using devices, data and the internet, security concerns, and a lower availability for EdTech interventions due to household chores and caring duties (↑Amenya et al., 2021; ↑Aurino et al., 2022). According to a Kenya study, the way children are raised is different based on gender, with boys spending more time with their fathers, while girls spend more time with their mothers doing household chores (↑Tembey et al., 2021). In this context, girls' education is considered less important (↑Tembey et al., 2021). Indicative of a gender-specific life course, a Ghana study on pre-service teacher training found women students had less time to virtually attend lessons at home because of their many domestic roles (including mother, wife, and household manager) (↑Ananga et al., 2021). While communities reinforce a gendered perspective, under the right conditions, they do support girls and EdTech. For example, in a Kenya study, caregivers allowed their girls to participate in reading clubs using radio when facilitators were trusted members of the community and the intervention was hosted nearby in a communal space (↑Amenya et al., 2021). Being able to participate also meant that girls were freed up from household chores, or these chores were rescheduled and even reduced to accommodate the intervention (↑Amenya et al., 2021), demonstrating buy-in from parents and caregivers.

Girls seem to perform better than or as well as boys when using EdTech

In a Bangladesh study, IVR audio lessons are shown to have helped to overcome girls' learning gaps (↑Islam et al., 2022). Another Bangladesh study notes that girls far outperform boys in attending and completing

primary and secondary education, and greater reliance on EdTech should not reverse this progress (↑Islam et al., 2021). Indicative of a gender-specific mindset, a Ghana study on teacher training shows that while female tutors were harder on themselves in assessing their understanding of virtual teaching, lesson observations suggested they actually did better at encouraging student–teacher participation and critical thinking than male peers (↑Ananga et al., 2021). However, a study in Kenya saw no significant differences between genders when it comes to the usefulness of common EdTech resources (↑Tembey et al., 2021), and gender did not seem to be a factor in learning outcomes generated by the Pakistan study (↑Adil et al., 2021).

3.4. EdTech and teachers

Teachers, in addition to learners, were negatively impacted by the disruption caused by school closures. The Covid-19 pandemic further constrained existing teacher workforce challenges. In Ghana, for example, which already had less than two-thirds of primary school teachers trained and qualified to teach (World Bank, 2021a cited ↑Afoakwah et al., 2021), a study found 67% of teachers (56% in urban areas and 79% in rural areas) were unfamiliar with using tools for virtual teaching, leaving many unable to stay connected with their students during the pandemic (↑Hodor et al., 2021). While there is limited research in LMICs on EdTech effectiveness to support teacher professional development linked to student learning outcomes, our studies suggest a link (Perry et al., 2020, cited in ↑Afoakwah et al., 2021). For instance, a Pakistan study posits that providing technology to teachers over students may be more cost-effective with higher learning gains (Beg et al., 2019, cited in ↑Adil et al., 2021).

Four studies examined ways that EdTech could support teacher professional development through different interventions, whether for pre-service or in-service training, including training teacher trainers (↑Ananga et al., 2021). Sub-theme findings in this area included a better understanding of how EdTech best enhances teacher professional development, access challenges, and creative use of tech in teacher–student interactions.

Tech-enabled teacher professional development enhances ability and confidence to use EdTech in teaching and learning

Our studies found that using EdTech to support teachers includes benefits ranging from improving the ability to teach different subjects, engaging

students and caregivers, virtual classroom management, and having more learning resources at their disposal. Teachers are generally positive about receiving training through EdTech (↑Afoakwah et al., 2021). In a Ghana study on pre-service teacher training in public colleges of education, the majority (66%) of student teachers said that the intervention increased their confidence to undertake online learning during future school closures, and 70% said they were more independent and responsible in their learning (↑Ananga et al., 2021). In the same study, online learning improved the participation of most student teachers with disabilities by making lessons more inclusive, for example, by creating autonomy (i.e., through voice initialisation) for those previously dependent on colleagues to read lesson materials (↑Ananga et al., 2021). Moreover, student teachers with disabilities became more versatile at using smart devices and creating and sharing audio content (↑Ananga et al., 2021). A further element in these studies was linking teacher training to improving student learning outcomes. A Ghana study found that while teachers' beliefs in their ability to improve student learning in reading and engagement had improved, this direct effect on learning outcomes was not measured (↑Afoakwah et al., 2021). When causality was followed, as in the Pakistan study, impact was partial on learning outcomes and subject-dependent (↑Adil et al., 2021).

Availability, access to and usage of EdTech are all challenging for teachers and teacher trainers

Issues ranged from access to devices, data, and electricity and internet connectivity to teachers' limited digital skills and supports, a lack of flexibility and cooperation between trainer and trainee, lower trainee participation compared to in-person learning, and not having enough training materials. In a study in Ghana, the vast majority (91%) of student teachers had poor internet access, one key reason that kept many (40%) from attending lessons synchronously (↑Ananga et al., 2021). Many participants in remote areas were forced to move to other communities to access online learning (↑Ananga et al., 2021). Another Ghana study noted the teacher turnover rate in this study was high, and some participants changed their phone numbers, limiting training effects from IVR audio lessons (↑Afoakwah et al., 2021). A lack of awareness of and norms in the use of EdTech also created barriers to teacher uptake. According to a Ghana study, four out of every ten participants, including teachers, were not aware of radio and television interventions for learning (↑Hodor et al., 2021). A Pakistan study found using technology was more commonly associated with entertainment rather than educational purposes, affecting teacher participation in digital training sessions (↑Adil et al., 2021).

Teachers' use of EdTech to engage students is a critical factor in encouraging structured learning

Teacher–student engagement through EdTech was covered in some studies, along with teacher relationships with caregivers to co-promote learning. In a study in Ghana, 20% of teachers provided lessons to basic and senior high school students via WhatsApp, though this initiative was ad hoc and not organised by schools or the government (↑Hodor et al., 2021). These teachers checked in on students, helped guide and motivate them in their learning and shared information, also with caregivers to increase their access to radio and television interventions (↑Hodor et al., 2021). Due to this support, some parents reported they no longer had to hire private teachers for learning continuation during school closures (↑Hodor et al., 2021). However, indicative of the importance of teacher–student interactions to EdTech effectiveness, a study in Pakistan cited the absence of such interactions as limiting the impact of computer-assisted learning at the right level on maths outcomes for Grade 8 students (↑Adil et al., 2021).

3.5. EdTech for parents and caregivers

During Covid-19-related school closures, parents and caregivers took on more responsibility for their children's learning, essentially taking on the role of teacher on top of other life commitments (i.e., income-generating activities, household management, caring duties). This shift created an opportunity to use more EdTech for remote learning but also presented new challenges for households in addition to increased financial constraints (Caballero et al., 2021, cited in ↑Afoakwah et al., 2021). In a Kenya study, there were indications that caregivers felt unable to guide children and needed more professional advice on lesson planning and knowing what materials to use, in addition to a reliable source, preferably teachers, for answering their children's questions (↑Tembey et al., 2021). In Kenya, respondents expressed a sincere sense of relief whenever teachers or tutors sent them materials and other information, e.g., via WhatsApp groups (↑Tembey et al., 2021). However, according to the Pakistan study, parents perceived technology not as a resource for their children's learning but as a way of wasting time surfing the internet (↑Adil et al., 2021).

Eight studies touched on different aspects of parent and caregiver engagement in promoting children's learning through EdTech, highlighting, in particular, the barriers, limitations, and information gaps in this area. Common sub-themes in findings involve factors that encourage parent and caregiver engagement and the role and impacts of messaging.

Parents' and caregivers' critical role in facilitating learning can be boosted through EdTech alignment with curricula

Caregivers played a crucial role in tech-based learning by giving children permission to use devices and the internet, scheduling and guiding lessons, and supporting learning comprehension (↑Islam et al., 2022). In some studies, parents actively engaged themselves to revise things they had learnt, acquaint themselves with new content and teaching approaches, and identify appropriate learning materials for children (↑Afoakwah et al., 2021;↑Hodor et al., 2021; ↑Islam et al., 2021; ↑Tembey et al., 2021). One Kenya study indicated caregivers helped their children to focus on lessons and not get distracted, as well as providing them with emotional encouragement (↑Hodor et al., 2021). Another study in Kenya showed that mapping EdTech supplementary resources for remote learning to national curricula, based on learning objectives and skills needed to pass national exams — and making these links clear for caregivers — was a key way to increase awareness and buy-in (↑Tembey et al., 2021).

Messaging is promising but does not have consistent effects on parent and caregiver engagement

Many of our studies showed that in addition to not having devices and connectivity, parent and caregivers' limited digital skills, language literacy, teaching capacity, confidence, and lack of motivation to educate their children reduced the effectiveness of using EdTech (↑Adil et al., 2021;↑Amenya et al., 2021; ↑Aurino et al., 2022;↑Hodor et al., 2021; ↑Islam et al., 2021; ↑Tembey et al., 2021). Several studies tried to address these challenges by providing guidance and support to parents and caregivers, but with mixed results. A study in Ghana found that behavioural nudges through text messages increased parent and caregiver engagement in their children's learning when they had some schooling, but for caregivers who had never attended school, treatment effects were negative (↑Aurino et al., 2022). The messaging also inadvertently caused caregiver stress by increasing aspirations about their children's learning without having the necessary resources to act (e.g., devices, data and Internet connectivity, electricity — ↑Aurino et al., 2022). In contrast, a Bangladesh study found that IVR audio lessons reinforced by text message 'nudges' and follow-up calls from village representatives increased the time parents and caregivers spent on children's learning, especially in poorer households and with less-educated caregivers (↑Islam et al., 2022). This points to a need to understand parent and caregiver motivations and capacities better.

Box 3. *Sierra Leone Covid-19 research study on building resilient data architecture*

With its focus on consolidating an education data system that could be used reliably during public health emergencies, drawing on past experience of the Ebola outbreak, the study in Sierra Leone sits apart from others thematically. The study used EdTech platforms and tools to combine census data at the school level for 2015–2019 with data at the district level for 2011–2013 into one longitudinal database. A main finding from analysing enrolment data cross-referenced with Ebola case data was the ongoing significance of non-virus factors in determining education access, mainly geographic and economic factors, over and above short-term public health impacts (⇡Fab Inc., 2021). The implication is that a tech-enabled database can be used to understand and communicate localised trends of how crises interact with household income and education levels (⇡Fab Inc., 2021).

In addition to reviewing Sierra Leone's national education data architecture, a main product of this study has been an interactive digital dashboard, demonstrating the benefits of improved data structures for analysing and visualising possible scenarios to inform education planning and decision-making in a timely and reliable way. The interactive dashboard is intended to anticipate inadvertent side-effects of well-intentioned policy, such as pressure-cooker effects of free schooling on other schools (i.e., fee-based) and the system as a whole, especially alongside crises such as the Covid-19 pandemic (⇡Fab Inc., 2021). This dashboard illustrates the role that technology can play in making education data more accessible and user-friendly.

4. Cross-cutting factors for effectiveness

As part of EdTech Hub's work, five areas have been identified as important in terms of EdTech effectiveness: learning outcomes, equity, context, cost, and scale and sustainability. In Hollow, D., & Jefferies, K. (2022, p. 4), these are framed in terms of the following 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?*

While these studies conducted during the Covid-19 pandemic were not necessarily designed to respond to these questions, many did touch on them in some way. As illustrated in Figure 3, looking across findings through an effectiveness lens helps to point to a series of cross-cutting requisite and design factors that appear particularly important for EdTech interventions in low-resource contexts.

Figure 3. *Cross-cutting factors for EdTech effectiveness as found in ten primary research studies on EdTech and Covid-19 response commissioned by EdTech Hub*
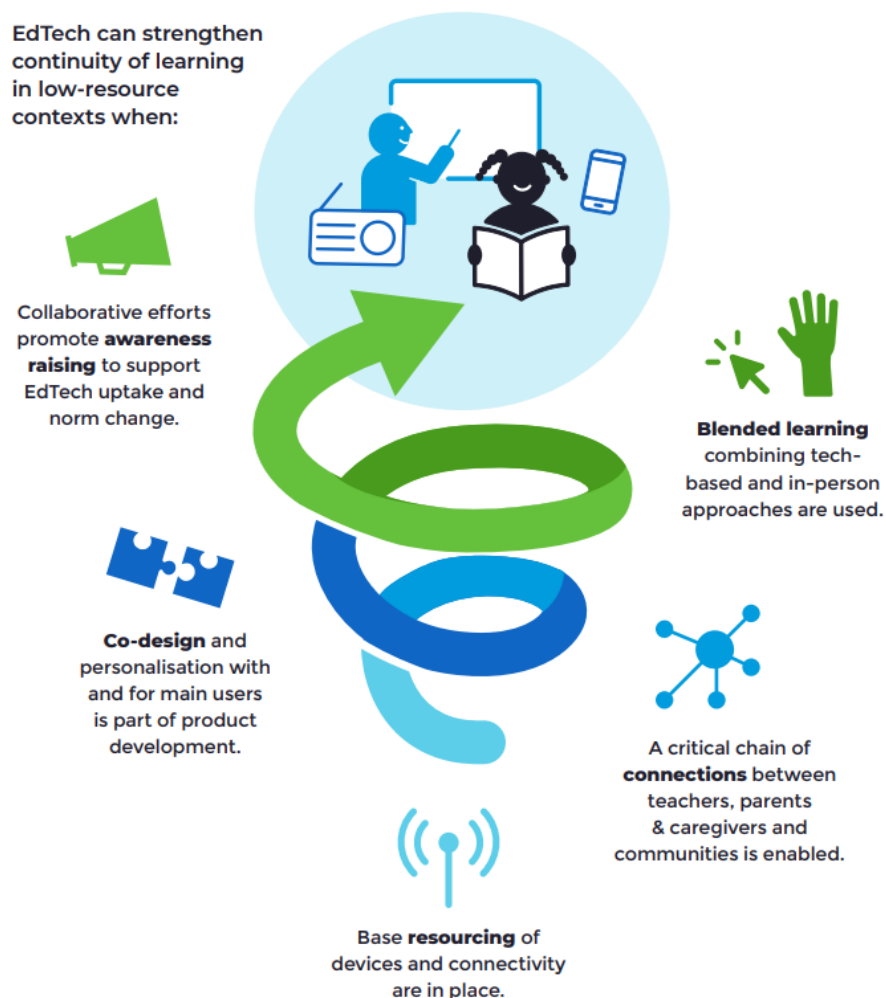
4.1. Base resourcing of devices and connectivity

A fundamental message cutting across all studies is that learners and teachers in low-income contexts need basic technology in place to be able to benefit from EdTech efforts. This is particularly challenging for individuals and groups facing compounding factors of vulnerability and marginalisation (e.g., income, location, ethnicity, gender, and ability). While some studies indicated low-income households have access to low-tech, such as mobile phones / smartphones (⇡Adil et al., 2021; ⇡Islam et al., 2021; ⇡Islam et al., 2022), others suggest that access to most devices (both low- and high-tech) is limited. This 'digital divide' (i.e., that higher-income houses have more access to EdTech tools and base resources) is likely to compound the disadvantages already faced by the most marginalised groups, further exacerbating inequality and potentially widening the gap in education outcomes between different socio-economic groups.

These studies clearly show that programmes incorporating EdTech need to explicitly consider how the most marginalised groups will — or will not — reap their benefits. This raises hard questions on whether resources such as devices, data, and internet connectivity — including hardware and end-user costs and, of course, electricity, should be subsidised when not available to more marginalised learners and teachers (↑Adil et al., 2021; ↑Aurino et al., 2022; (↑Hodor et al., 2021). While 'no-tech' interventions such as printed resource packs may be part of the solution to reaching resource-poor learners, our studies underline the fact that base resource access remains a barrier to effectiveness for many low-tech approaches using radio, TV, and mobiles, let alone high-tech efforts using smartphones, tablets, and laptops. Where it is not realistic or appropriate for governments to subsidise devices and connectivity, options such as innovative financing (e.g., leasing, subsidised purchase, co-financing by private providers, repurchase programmes, or even conditional cash transfers) might be considered.

4.2. Chains of connection as critical

Chains of connections between teachers, parents and caregivers, and communities are important in realising the potential of EdTech's impact. While teachers are rightly recognised as having a central role in education, parents and caregivers — as well as communities — are especially significant for EdTech's effectiveness, especially in remote areas. The good news is that EdTech tools can often help establish and strengthen communication channels between these groups. A Kenya study underlines the importance of teacher-to-parent-and-caregiver connections via easily accessible touch points for technical advice and answers to content questions for their children (i.e., from teachers, resource packs, lists of digital tools) (↑Tembey et al., 2021). Another study highlighted that these links could be made at low cost by timing and tailoring informal check-ins, messaging, and learning content (i.e., by phone, text message, IVR audio lessons) to caregiver background and social context (e.g., language and education level) (↑Aurino et al., 2022).

The importance of teacher-to-parent-and-caregiver links was already made in Section 3.5, but to optimise EdTech effectiveness, these links need to go further to also reach communities. Another Kenya study found community support of EdTech a major determinant in its success, highlighting that using facilitators (camp teachers and mentors) from within the community helped increase caregiver confidence that they were safe in meeting up and using radio and that reaching community elders, caregivers, siblings, and peers were all important in sharing

information with girls (↑Amenya et al., 2021). Suggestions elsewhere included that community representatives should be trained to support learning comprehension and local languages used in interventions, with libraries or designated areas equipped with devices and infrastructure (↑Hodor et al., 2021).

4.3. Co-design and personalisation

Our studies consistently and overwhelmingly show that users provide valuable feedback on how interventions can improve, both in terms of effectiveness and, in some cases, equity. In Ghana, as part of an IVR study, students reported that they would like to see more interactive elements and found the quiz the best part of the lesson (↑Afoakwah et al., 2021). In Pakistan, students indicated a preference for using social media platforms for learning (such as Facebook and YouTube, also Zoom and Google Meet), mostly through smartphones, because of the heightened interaction compared to one-way modalities, such as the government's televised educational programming (↑Islam et al., 2021). Another study included learner suggestions that they would like to see teaching at a slower pace, repeats in lessons and phone-ins introduced to ensure that viewers understand content (↑Hodor et al., 2021). In a study in Ghana, pre-service teacher trainees highlighted the need to account for gender in engagement in online learning, indicating the need for more flexibility, particularly for women who face multiple demands (↑Ananga et al., 2021). In Kenya, the need to use collaboration and co-design to address parental and caregiver concerns about safety, inappropriate behaviour, and potential dependence on technology was also highlighted, not only to increase parent and caregiver confidence in EdTech but to enable children to participate independently and more regularly without supervision (↑Tembey et al., 2021).

4.4. Blended learning as a preference

Blended learning, combining in-person teaching and learning with technology, appears desirable for a number of users, and there are indications it can amplify impact (Ashraf, et al., 2021). A cross-cutting message in many of our studies was that while learners and teachers appreciated learning via technology, they did not want to see it replacing in-person learning, nor did they believe that replacement was possible. In addition, they highlighted blended learning as a promising way of bridging remote learning during lockdowns and school activities as institutions reopen. Linking low-tech interventions to school curricula and processes (↑Adil et al., 2021); ↑Hodor et al., 2021; ↑Islam et al., 2022; ↑Tembey et al., 2021)

versus layering in EdTech as an addition and overburdening those involved was found to increase student engagement (↑Afoakwah et al., 2021) and potentially build longer-term buy-in from learners and teachers, especially if school actors are involved in the design (↑Adil et al., 2021). According to a Ghana study, 15% of teachers were already taking a blended learning approach as schools reopened (↑Hodor et al., 2021), indicating evidence of momentum in this direction.

To capitalise on this trend, more clarity is needed on how low-tech interventions, in particular, can complement in-person learning and vice versa. Some caution is advised; for example, according to student teachers in a Ghana study, content demonstrations are better done in person and exams (summative assessments) should be handwritten in person until connectivity improves (↑Ananga et al., 2021). While blended learning will differ depending on context, political will, and government and institutional capacity, the interplay between remote and in-person learning should be further tested and explored, both for finding the right formula to achieve learning outcomes and to understand how blended learning can be leveraged during future crises.

4.5. Awareness raising for uptake and norm change

Although financial hardship, made worse by the pandemic, affected whether some learners had the necessary devices, data, and internet connectivity to take advantage of EdTech offerings, our studies found that a lack of social awareness and perceptions about learning through EdTech also limited children's access. For example, a Ghana study showed that many caregivers did not know much about the EdTech resources available, including the broadcasting schedule of interventions (↑Hodor et al., 2021). According to the study in Pakistan, community and societal perceptions of technology and limited exposure among teachers to EdTech should be factored into education planning and programming (↑Adil et al., 2021). In another Ghana study, it was found that schools' active follow-up to encourage caregivers to support their children in accessing and participating in IVR audio lessons made a difference (↑Afoakwah et al., 2021).

For girls' education, targeting female parents and caregivers in taking responsibility for tech-enabled learning with their children may be the most likely way of accommodating and beginning to adjust current social norms (e.g., scheduling EdTech around girls' household responsibilities) (↑Tembey et al., 2021). Further, focus should broaden from EdTech access to attitudes and behaviours that support or inhibit girls' deeper engagement

in learning, such as teacher expectations of girls' technology competency (↑Tembey et al., 2021). Alongside building awareness, it is important to engage with the concerns, interests, and feedback of users, especially those from disadvantaged backgrounds, to build up confidence in and utility of EdTech, which can naturally broaden visibility and uptake. This might take the form of campaigns for raising awareness about the availability and benefits of EdTech (↑Islam et al., 2021;↑Tembey et al., 2021), so caregivers can schedule their children's household chores around interventions and remind them to participate (↑Hodor et al., 2021).

Across the studies, and given the dearth of rigorous evidence in the field, a number of suggested areas for further research were identified. Some of these are set out as questions in Box 4 below.

Box 4: *Potential departure points for further EdTech research*

Our EdTech and Covid-19 pandemic primary research studies also led to the identification of further evidence gaps, with other areas identified for further investigation, including:

- What factors determine an appropriate balance of blended learning involving both use of EdTech and in-person learning?

- How can EdTech facilitate learning journeys to be personalised in a feasible way in LMICs, given broad resource constraints?

- How can EdTech interventions be better designed to address overlapping factors of vulnerability of ethnic, linguistic, and indigenous minorities and migrants, including refugees?

- Is there potential for IVR to reach out-of-school children and youth?

- Do students with disabilities benefit more from EdTech under certain conditions compared to in-person learning?

- How do teacher expectations on technology competency support or inhibit girls' use of EdTech?

- What role do school leaders play in the adoption of EdTech, and what characteristics do they display?

- What roles can communities play in supporting learning via EdTech, and how can this be strengthened and capitalised on?

- How can EdTech be better leveraged during future pandemics and other crises?

5. Conclusion

This working paper has presented an overview of ten primary research studies on EdTech and the Covid-19 response. It positions this work within the broader work of EdTech Hub and offers a consolidated view of methodologies, thematic findings, and cross-cutting factors for effectiveness drawn from primary research. In comparing methodology, the paper offers an overview of the types of measures used in our studies on EdTech effectiveness. A semi-structured thematic analysis using open coding then led to the discovery of larger patterns, insights, and interlinkages across the studies in relation to user groups of learners, girls, teachers, and parents and caregivers. Using the lens of EdTech effectiveness, a further set of cross-cutting factors was identified as important for EdTech in remote learning in low-resource contexts.

Much of the evidence found through these studies reinforces earlier work on EdTech and Covid-19 in low-resource contexts produced by EdTech Hub and others. It confirms the points set out in *EdTech and Covid-19: 10 things to know* (⬆Nicolai et al., 2020) and adds deeper nuance as well as raising questions. Concluding insights are as follows:

1. **EdTech teaching and learning ecosystems deserve more attention**. A lack of or limited access to devices, data, electricity, and internet connectivity remains a major challenge to learning across the studies. However, in strengthening education quality during remote learning, more attention to the full ecosystem surrounding the learner is clearly needed. Across our studies, a range of elements such as social norms, curriculum alignment, teacher capacity and behaviour, parental engagement and community awareness is seen as critical for EdTech effectiveness, yet too often, these elements are not adequately considered in intervention design and costing.

2. **Clear and common approaches in measuring EdTech effectiveness are needed.** With EdTech research inevitably covering a broad range of interventions, better understanding and transparency in measurement would help government officials and other stakeholders use evidence in making informed investment decisions across EdTech options and supports. It is particularly important to better detail how learning outcomes can be reliably measured and to frame other proxy measures such as engagement in content, levers to access and use, group-based variations and

perceptions and awareness. Measurement of cost-effectiveness remains a clear gap.

3. **EdTech works best when users are engaged in shaping the offer.** Our studies reveal a symbiotic relationship between people and technology. Learners, including girls, teachers, parents and caregivers, all have extensive insight on how EdTech can be made more effective in design, iteration, and use. Due to the remote nature of teaching and learning during the pandemic, it was shown that technology itself can be used as a channel to enable this involvement, contribute to digital literacy, and create connections across those involved in education. More thought into the processes and standards that support this engagement is needed.

Our ten EdTech and Covid-19 research studies were a drop in an ocean of learning-by-doing during the pandemic, at a time when most of the world's education systems were turning to remote learning. EdTech will clearly continue to play an increasingly important role in education systems around the world through any remaining closures and will likely increase in importance while schools are open in the form of blended learning. The onus is, therefore, on all concerned to take steps to strengthen EdTech effectiveness based on lessons learnt to date and work towards a more rigorous evidence base on what works, where, and how.

Bibliography

This bibliography is available digitally in our evidence library at
https://docs.edtechhub.org/lib/K5BJUBRE

Adam, T., Kaye, T., & Haßler, B. (2020). *The Maldives and Sri Lanka: Question & Answer Session* (EdTech Hub Helpdesk Response No. 18). EdTech Hub. https://doi.org/10.53832/edtechhub.0018. Available from https://docs.edtechhub.org/lib/HE2Q6Z8Y. Available under Creative Commons Attribution 4.0 International. (details)

Adil, F., Nazir, R., & Akhtar, M. (2021). *Investigating the Impact on Learning Outcomes Through the Use of EdTech During Covid-19: Evidence from an RCT in the Punjab province of Pakistan* (Working Paper No. 41). EdTech Hub. https://doi.org/10.53832/edtechhub.0067. Available from https://docs.edtechhub.org/lib/FSVST5BF. Available under Creative Commons Attribution 4.0 International. (details)

Afoakwah, E., Carballo, F., Caro, A., D'Cunha, S., Dobrowolski, S., & Fallon, A. (2021). *Dialling up Learning: Testing the Impact of Delivering Educational Content via Interactive Voice Response to Students and Teachers in Ghana* [Working Paper]. EdTech Hub. https://doi.org/10.53832/edtechhub.0051. Available from https://docs.edtechhub.org/lib/P22BR78B. Available under Creative Commons Attribution 4.0 International. (details)

Agbe, E., & Sefa-Nyarko, C. (2020). *Ghana's education response during the COVID-19 crisis: EdTech to the rescue?* (Case Study; p. 17). EdTech Hub. https://doi.org/10.5281/zenodo.4706036. Available from https://docs.edtechhub.org/lib/QJ783WH5/download/UGCYK4G5/Agbe _Sefa-Nyarko_2020_Ghana_s%20education%20response%20during%2 0the%20COVID-19%20crisis.pdf. (details)

Al-Hindawi, H., & Hashem, L. (2020). *Jordan's EdTech response to COVID-19* (Case Study No. 1). EdTech Hub. https://doi.org/10.5281/zenodo.4706057. (details)

Allier-Gagneur, Z., & Moss Coflan, C. (2020). *Your Questions Answered: Using Technology to Support Gender Equity, Social Inclusion and Out-Of-School Learning* (Helpdesk Response No. 14). EdTech Hub. https://doi.org/10.53832/edtechhub.0025. Available from https://docs.edtechhub.org/lib/VX7UW757. (details)

Amenya, D., Fitzpatrick, R., Njeri M. E., Naylor, R., Page, E., & Riggall, A. (2021). *The Power of Girls' Reading Camps: Exploring the impact of radio*

*lessons, peer learning and targeted paper-based resources on girls'
remote learning in Kenya* (Working Paper No. 32). EdTech Hub.
https://doi.org/10.5281/zenodo.5651935. Available from
https://docs.edtechhub.org/lib/P8IAN448. Available under Creative
Commons Attribution 4.0 International. (details)

Ananga, E., Kadiri, A.-K., Kporwodu, M., Nkrumah, Y., Whajah, F., & Tackie, M.
(2021). *T-TEL Covid-19 Impact Assessment Study*.
https://doi.org/10.5281/zenodo.4895400. Available from
https://docs.edtechhub.org/lib/PTC9PGZW. (details)

Ashlee, A., Clericetti, G., & Mitchell, J. (2020). *Refugee Education: A Rapid
Evidence Review* (Rapid Evidence Review No. 3). EdTech Hub.
https://doi.org/10.5281/zenodo.4557019. Available from
https://docs.edtechhub.org/lib/UUNEJ7FS. Available under Creative
Commons Attribution 4.0 International, Open Access. (details)

Aurino, E., Tsinigo, E., & Wolf, S. (2022). *Nudges to Improve Learning and
Gender Parity: Preliminary findings on supporting parent-child
educational engagement during Covid-19 using mobile phones*
[Technical Report]. EdTech Hub.
https://doi.org/10.53832/edtechhub.0083. Available from
https://docs.edtechhub.org/lib/PWU63GQS. Available under Creative
Commons Attribution 4.0 International. (details)

Azevedo, J. P. (2020). *Learning poverty in the time of COVID-19: a crisis
within a crisis*. World Bank.
https://openknowledge.worldbank.org/handle/10986/34850. (details)

Chuang, R., Burnett, N., & Robinson, E. (2021). *Cost-Effectiveness and
EdTech: Considerations and case studies* (Helpdesk Response No. 32).
EdTech Hub. https://doi.org/10.5281/zenodo.5651978. Available from
https://docs.edtechhub.org/lib/WEFTUGTJ. Available under Creative
Commons Attribution 4.0 International. (details)

Chuang, R., Kaye, T., Moss Coflan, C., & Haßler, B. (2020). *Back-to-School
Campaigns Following Disruptions to Education* (EdTech Hub
Helpdesk Response No. 12A). EdTech Hub.
https://doi.org/10.53832/edtechhub.0019. Available from
https://docs.edtechhub.org/lib/DS66UGW4. Available under Creative
Commons Attribution 4.0 International. (details)

Crompton, H., Burke, D., Jordan, K., & Wilson, S. W. G. (2021). Learning with
technology during emergencies: A systematic review of K-12
education. *British Journal of Educational Technology*.

https://doi.org/10.1111/bjet.13114. Available from
https://bera-journals.onlinelibrary.wiley.com/doi/abs/10.1111/bjet.13114.
(details)

Damani, K., & Mitchell, J. (2020). *Radio: A Rapid Evidence Review* (Rapid
Evidence Review No. 4). EdTech Hub.
https://doi.org/10.5281/zenodo.4556932. Available from
https://docs.edtechhub.org/lib/YMWE6FR6. Available under Creative
Commons Attribution 4.0 International, Open Access. (details)

David, R., Pellini, A., Jordan, K., & Philips, T. (2020). *Education during the
COVID-19 crisis: opportunities and constraints of using EdTech in
low-income countries*. Zenodo. https://doi.org/10.5281/zenodo.3750976.
Available from
https://www.bsg.ox.ac.uk/sites/default/files/2020-04/Education-during-
covid-19-crisis.pdf. (details)

Doraiswamy, H., Gupta, G., Kamath, D., & Sharma, S. (2020). *India's distance
learning response to the COVID-19 crisis*. Central Square Foundation,
EdTech Hub. https://doi.org/10.5281/zenodo.4705451. (details)

EdTech Hub. (2022a). *Our strategy, part 1: empowering decision-makers
with evidence to improve learning for all*.
https://edtechhub.org/2022/02/28/our-strategy-part-1-empowering-de
cision-makers-with-evidence-to-improve-learning-for-all/. (details)

EdTech Hub. (2022b, February 28). *Our strategy, part 2: deep dive into our
approach, focus countries, and theory of change*.
https://edtechhub.org/2022/02/28/our-strategy-part-2-deep-dive-into-
our-approach-focus-countries-and-theory-of-change/. (details)

Education Endowment Foundation. (2020). *Remote Learning: Rapid
Evidence Assessment* (Rapid Evidence Review No. 9).
https://doi.org/10.5281/zenodo.4477023. Available from
https://educationendowmentfoundation.org.uk/public/files/Remote_L
earning_Rapid_Evidence_Assessment.pdf. (details)

Fab Inc. (2021). *Learning from Experience: A post-Covid-19 data
architecture for a resilient education data ecosystem in Sierra Leone*
[Working Paper]. EdTech Hub. https://doi.org/10.5281/zenodo.5498054.
Available from https://docs.edtechhub.org/lib/JTKTA5X5. Available
under Creative Commons Attribution 4.0 International. (details)

Fitzpatrick, R., McIntyre, N., Wilson, S., & Rose, P. (2020). *Covid-19, EdTech,
and Survey Alignment in Education* [Working Paper]. EdTech Hub.

https://doi.org/10.5281/zenodo.4768598. Available from https://docs.edtechhub.org/lib/84NR98PF. (details)

Global Education Evidence Advisory Panel. (2022). *Prioritizing learning during COVID-19: The most effective ways to keep children learning during and postpandemic*. World Bank, FCDO, and UNICEF Office of Research - Innocenti. https://documents1.worldbank.org/curated/en/114361643124941686/pdf/Recommendations-of-the-Global-Education-Evidence-Advisory-Panel.pdf. (details)

Gorgen, K., & McAleavy, T. (2020). *An international review of plans for school reopening.* Education Development Trust. https://docs.edtechhub.org/lib/MWNVG7LR. (details)

Haßler, B., Khalayleh, A., & McBurnie, C. (2020i). *A five-part education response to the COVID-19 pandemic* (Helpdesk Response No. 5; p. 32). EdTech Hub. https://doi.org/10.53832/edtechhub.0005. Available from https://docs.edtechhub.org/lib/JLEWADHF. Available under Creative Commons Attribution 4.0 International. (details)

Haßler, B., Nicolai, S., McBurnie, C., Jordan, K., Wilson, S., & Kreimeia, A. (2020kj). *EdTech and COVID-19 response [Save Our Future]* (Background Paper No. 3; #SaveOurFuture). Education Commission. https://doi.org/10.5281/zenodo.3983877. Available from https://saveourfuture.world/wp-content/uploads/2020/10/EdTech-and-COVID-19-Response_SOF_BP3-1.pdf. (details)

Hallgarten, J., & Fitzpatrick, R. (2020). *What can be learnt from China's recent experiences with Covid-19 and school closures that can inform other countries' education technology-enabled responses?* Education Development Trust. https://docs.edtechhub.org/lib/FY4BHGH3. (details)

Hallgarten, J., Gorgen, K., & Sims, K. (2020). *Overview of emerging country-level response to providing educational continuity under COVID-19* (p. 29). Education Development Trust. https://docs.edtechhub.org/lib/YD8GYZDT. (details)

Hodor, R., Owusu, E. A., Ofori-Davis, L., Afram, A., & Sefa-Nyarko, C. (2021). *Voices and Evidence from End-Users of the GLTV and GLRRP Remote Learning Programme in Ghana: Insights for inclusive policy and programming* [Technical Report]. EdTech Hub. https://doi.org/10.53832/edtechhub.0064. Available from

https://docs.edtechhub.org/lib/2A5NQEV8. Available under Creative Commons Attribution 4.0 International. (details)

Hollow, D., & Jefferies, K. (2022). *How EdTech Can Be Used to Help Address the Global Learning Crisis: A Challenge to the Sector for an Evidence-Driven Future* [Preprint]. EdTech Hub. https://doi.org/10.53832/edtechhub.0115. Available from https://docs.edtechhub.org/lib/UUDK52LQ. (details)

Isisi, A., Olojede, O., Adedoyin, A., & Akogun, O. (2020). *Education technology in the COVID-19 response in Nigeria* (Case Study). EdTech Hub. https://doi.org/10.5281/zenodo.4706031. (details)

Islam, A., Wang, L. C., & Hassan, H. (2022). *Delivering Remote Learning Using a Low-Tech Solution: Evidence from an RCT during the Covid-19 Pandemic* (Working Paper No. 43). EdTech Hub. https://doi.org/10.53832/edtechhub.0070. Available from https://docs.edtechhub.org/lib/FE3VBQQW. Available under Creative Commons Attribution 4.0 International. (details)

Islam, T., Hussain, M., Shimul, S. N., Rupok, R. I., & Orthy, S. R. K. (2021). *Integration of Technology in Education for Marginalised Children in an Urban Slum of Dhaka City During the Covid-19 Pandemic* [Working Paper]. EdTech Hub. https://doi.org/10.53832/edtechhub.0063. Available from https://docs.edtechhub.org/lib/5ZF9VGMK. Available under Creative Commons Attribution 4.0 International. (details)

Joynes, C., Gibbs, E., & Sims, K. (2020). *Overview of emerging country-level response to providing educational continuity under COVID-19: What's working? What isn't?https://doi.org/10.5281/zenodo.4706062*. Available from https://edtechhub.org/wp-content/uploads/2020/04/summary-emerging-country-level-responses.pdf. (details)

Kaye, T., Groeneveld, C., Moss, C., & Haßler, B. (2020). *Nepal "Ask me anything" Session: Responses to audience questions* (EdTech Hub Helpdesk Response No. 13). EdTech Hub. https://doi.org/10.53832/edtechhub.0014. Available from https://docs.edtechhub.org/lib/UXQG7GRG. Available under Creative Commons Attribution 4.0 International. (details)

Kimenyi, E., Otieno, J., & Kaye, T. (2020). *Building effective COVID-19 Education Response Plans: Insights from Africa and Asia* (EdTech Hub Helpdesk Response No. 15). EdTech Hub.

EdTech Hub

https://doi.org/10.53832/edtechhub.0041. Available from https://docs.edtechhub.org/lib/6W2UWE89. (details)

Koomar, S., Moss Coflan, C., & Kaye, T. (2020). *Using EdTech in Settings of Fragility, Conflict and Violence: A Curated Resource List* (EdTech Hub Helpdesk Request No. 11). EdTech Hub. https://doi.org/10.53832/edtechhub.0042. Available from https://docs.edtechhub.org/lib/CMS6HPI8. (details)

Liangdi, X., & Groenewegen-Lau, J. (2020). *China: testing a decade of online education preparation* (Case Study). EdTech Hub. https://doi.org/10.5281/zenodo.4705990. (details)

Major, L., & Francis, G. A. (2020). *Technology-supported personalised learning: a Rapid Evidence Review* (Rapid Evidence Review No. 1). EdTech Hub. https://doi.org/10.5281/zenodo.4556925. Available from https://docs.edtechhub.org/lib/A2II5ZV7. Available under Creative Commons Attribution 4.0 International, Open Access. (details)

McAleavy, T., & Gorgen, K. (2020a). *Best practice in pedagogy for remote teaching* (p. 10). EdTech Hub. https://doi.org/10.5281/zenodo.4705039. Available from https://edtechhub.org/wp-content/uploads/2020/04/summary-research-best-practice-pedagogy-remote-teaching.pdf. Available under Creative Commons Attribution 4.0 International License. (details)

McAleavy, T., & Gorgen, K. (2020b). *What does the research suggest is best practice in pedagogy for remote teaching?* (p. 26). https://docs.edtechhub.org/lib/89I7MWHD. (details)

McBurnie, C. (2020). *The Use of Virtual Learning Environments and Learning Management Systems During the Covid-19 Pandemic* (EdTech Hub Helpdesk Request No. 7). EdTech Hub. https://doi.org/10.53832/edtechhub.0023. Available from https://docs.edtechhub.org/lib/53YEZE6A. Available under Creative Commons Attribution 4.0 International, Open Access. (details)

Mitchell, J., & D'Rozario, J. (2022a). *Cost-Effective EdTech Paper 1: A position piece on how the sector can make progress* [Position paper]. EdTech Hub. https://doi.org/10.53832/edtechhub.0118. Available from https://docs.edtechhub.org/lib/RPR47JXT. Available under Creative Commons Attribution 4.0 International. (details)

Mitchell, J., & D'Rozario, J. (2022b). *Cost-Effective EdTech Paper 2: Good practice* [Position paper]. EdTech Hub. https://doi.org/10.53832/edtechhub.0119. Available from

https://docs.edtechhub.org/lib/ZVX4DTXQ. Available under Creative Commons Attribution 4.0 International. (details)

Mitchell, J., & D'Rozario, J. (Forthcoming). *Cost-Effective EdTech Paper 3* [Position paper]. EdTech Hub. https://doi.org/10.53832/edtechhub.0120. Available from https://docs.edtechhub.org/lib/ABGB36RA. Available under Creative Commons Attribution 4.0 International. (details)

Naylor, R., & Gorgen, K. (2020). *Overview of emerging country-level response to providing educational continuity under COVID-19: What are the lessons learned from supporting education for marginalised girls that could be relevant for EdTech responses to COVID-19 in lower- and middle-income countries?* (p. 22). EdTech Hub. https://doi.org/10.5281/zenodo.4706059. Available from https://docs.edtechhub.org/lib/SLJSKY8J. (details)

Ndaruhutse, S., Gibbs, E., & Fitzpatrick, R. (2020). *What are countries doing that already use remote learning extensively? What can we learn from them?* (p. 37). https://doi.org/10.5281/zenodo.4706067. (details)

Ngabonzima, E., Isimbi, R., Mwali, M. M., & Pellini, A. (2020). *Distance learning in the context of COVID-19: the case of Rwanda* (Case Study No. 1). EdTech Hub. https://doi.org/10.5281/zenodo.4706016. (details)

Ngware, M., & Ochieng, V. (2020). *EdTech and the COVID-19 response: A case study of Kenya* (Case Study). EdTech Hub. https://doi.org/10.5281/zenodo.4706019. (details)

Nicolai, S., Jefferies, K., & Stepanek Lockhart, A. (2022). *EdTech Evidence From Covid-19 Response: A thematic review of primary research from Bangladesh, Ghana, Kenya, Pakistan and Sierra Leone* (Working Paper No. 49). EdTech Hub. https://doi.org/10.53832/edtechhub.0114. Available from https://docs.edtechhub.org/lib/K5BJUBRE. Available under Creative Commons Attribution 4.0 International. (details)

Nicolai, S., Wilson, S., & Jefferies, K. (2020, December). *EdTech and Covid-19: 10 things to know*. EdTech Hub. https://edtechhub.org/edtech-and-covid-19-10-things-to-know/. (details)

Rahman, A., Plaut, D., Salami, T., & Carter, A. (2021). *EdTech and Covid-19: Insights from our Sandbox Portfolio. In Collaboration with Sandbox Partner Organisations* [Working Paper]. EdTech Hub. https://doi.org/10.5281/zenodo.4776960. Available from

https://docs.edtechhub.org/lib/MXMPWAA2. Available under Creative Commons Attribution 4.0 International. (details)

Save Our Future. (2020). *Averting an Education Catastrophe for the World's Children*. Save Our Future. https://saveourfuture.world/white-paper/. (details)

Suriastini, W., Setyo, P., Herawati, F., Naryanta, Moddilani, G., & Pellini, A. (2020). *COVID-19 and the education response in Indonesia: exploring the learning crisis* (Case Study). EdTech Hub. https://doi.org/10.5281/zenodo.4705994. (details)

Tabassum, R., Hadi, M., Qaisrani, A., & Shah, Q. (2020). *Education technology in the COVID-19 response in Pakistan* (Case Study). EdTech Hub. https://doi.org/10.5281/zenodo.4705912. (details)

Tembey, L., Baier, J., Ogolla, C., & Mohan, P. (2021). *Understanding Barriers to Girls' Access and Use of EdTech in Kenya During Covid-19* [Working Paper]. EdTech Hub and Busara Center for Behavioural Economics. https://doi.org/10.53832/edtechhub.0048. Available from https://docs.edtechhub.org/lib/JZM7W6QE. Available under Creative Commons Attribution 4.0 International. (details)

Traxler, J., Scott, H., Smith, M., & Hayes, S. (2020). *Learning through the crisis: Helping decision-makers around the world use digital technology to combat the educational challenges produced by the current COVID-19 pandemic* (No. 1). EdTech Hub. https://doi.org/10.5281/zenodo.4706076. (details)

UNESCO, UNICEF, & World Bank. (2022). *Where are we on education recovery? Taking the global pulse of a RAPID response*. https://www.unicef.org/reports/where-are-we-education-recovery. (details)

Watson, J., & McIntyre, N. (2020). *Educational Television: A Rapid Evidence Review* (Rapid Evidence Review No. 5). EdTech Hub. https://doi.org/10.5281/zenodo.4556935. Available from https://docs.edtechhub.org/lib/BVXSZ7G4. Available under Creative Commons Attribution 4.0 International, Open Access. (details)

Webb, D., Barringer, K., Torrance, R., & Mitchell, J. (2020). *Girls' Education and EdTech: A Rapid Evidence Review* (Rapid Evidence Review No. 2). EdTech Hub. https://doi.org/10.5281/zenodo.4737460. Available from https://docs.edtechhub.org/lib/CZBRW85R. Available under Creative Commons Attribution 4.0 International, Open Access. (details)

World Bank, UNESCO, & UNICEF. (2021). *The State of Global Learning Poverty: 2022 Update.* https://documents1.worldbank.org/curated/en/416991638768297704/pdf/The-State-of-the-Global-Education-Crisis-A-Path-to-Recovery.pdf. (details)

Annex 1: Overview of ten commissioned EdTech and Covid-19 research studies

Country	Research partner	Authors	Purpose	Tech-based intervention	User groups
Ghana	Rising Academy Network	⬆Afoakwah et al. (2021)	Promotion of foundational numeracy and literacy skills; professional development on instruction	IVR audio lessons	Network of low-cost private primary schools; students in Grades 4, 5, 6; teachers
Ghana	T-TEL	⬆Ananga et al. (2021)	Assessment of teaching and learning improvement	Online learning through virtual platform	Public colleges of education; pre-service student teachers from marginalised backgrounds
Ghana	PDA	⬆Hodor et al. (2021)	Assessment of effective continuous learning in English, mathematics, science, and social studies	Television and radio lessons	Three regions; students in basic and senior high schools, including marginalised backgrounds
Ghana	IPA	⬆Aurino et al. (2022)	Behaviour change in children's learning to promote gender parity, result assessment	Text message 'nudges'	Rural regions; parents and carers with school-aged children with low levels of literacy / education

Kenya	EDT	↑Amenya et al. (2021)	Promotion of reading and maths	Radio and reading camps	ASAL (Arid and Semi-Arid Lands) areas; girl students aged 13–15
Kenya	Busara	↑Tembey et al. (2021)	Assessment of girls' barriers, participatory product development	Television, radio, video (e.g., Youtube)	Nairobi and rural counties; girl students aged 7–14, low-income backgrounds
Bangladesh	Beyond Peace	↑Islam et al. (2021)	Assessment of device access and usage	Television, radio, smartphone, computer	Korail urban slum in Dhaka; students in Grades 6–10, low-income backgrounds
Bangladesh	Monash University	↑Islam et al. (2022)	Promotion of English and Bangla language literacy, numeracy, non-cognitive skills	IVR audio lessons	Khulna and Satkhira districts; students ages 5–10; low-income backgrounds; parents and caregivers
Pakistan	SDPI	↑Adil et al. (2021)	Promotion of maths, Urdu, and English; professional development in tech-assisted instruction	Online learning, computer-assisted teaching	Bahawalnagar district in the province of Punjab; Students in Grade 8 from a remote area; teachers
Sierra Leone	Fab Inc.	↑Fab Inc. (2021)	Development of data architecture and dashboard tool	Data system	Government staff and education stakeholders at different levels (i.e., from ministry, teachers)

Annex 2: Research questions explored across EdTech and Covid-19 research

Dialling up Learning: Testing the Impact of Delivering Educational Content via Interactive Voice Response to Students and Teachers in Ghana (↑Afoakwah et al., 2021)**.**

1. (i) Does listening to numeracy lessons delivered via IVR improve student learning outcomes?

2. How often do students listen to IVR-delivered numeracy lessons, for how long, and what are their perceptions of the lessons and the method of delivery?

3. Does listening to teacher professional development lessons delivered via IVR improve teacher knowledge and self-efficacy?

4. How often do teachers listen to IVR-delivered professional development lessons focused on teaching foundational reading, for how long and what are their perceptions of the lessons and the method of delivery?

T-TEL Covid-19 Impact Assessment Study (↑Ananga et al., 2021)**.**

1. Are student teachers (especially those from low-income backgrounds and those with visual and hearing impairments) becoming independent and responsible in their learning?

2. Do College of Education tutors have a strong understanding of eLearning, and are they confident teaching online due to the persistence of the blended learning approach that is being used in the 2020/21 academic year?

3. Can Colleges of Education cope with any future institutional closures by making the transition to online education?

4. Can Ghana's teacher education regulatory agency support the transition to online education?

5. Do student teachers have a stronger understanding of eLearning, and are they confident about undertaking online learning due to the persistence of the blended learning approach which is being used in the 2020/2021 academic year?

Voices and Evidence from End-Users of the GLTV and GLRRP Remote Learning Programme in Ghana. Insights for inclusive policy and programming (↑Hodor et al., 2021)**.**

1. How do the GLTV and GLRRP interventions meet the specific needs of marginalised groups?

2. To what extent were the GLTV and GLRRP interventions accessible to learners from marginalised groups in the context of Covid-19, and how could accessibility be improved?

3. To what extent did the GLTV and GLRRP programmes enhance educational outcomes during the Covid-19 pandemic, and what lessons can be learnt?

4. How can technology be used to support and improve learning outcomes for marginalised children?

Nudges to improve learning and gender parity: Supporting parent engagement and Ghana's educational response to covid-19 using mobile phones (↑Aurino et al., 2022).

1. Do nudges to parents in the form of SMS messages increase the rate of children returning to school and general engagement with education when schools reopen?

2. Do nudges change parental beliefs about returns to education and expectations and aspirations?

3. Do nudges improve children's learning and schooling outcomes (i.e., enrolment, attendance) in the medium term?

4. Are impacts more equitable across girls and boys if messages focus on gender parity in education and in behaviours/attitudes towards girls? If so, are the effects driven by an improvement in girls' educational outcomes or by a deterioration of that of boys?

5. Are impacts larger, and do they persist for longer if exposure is longer (24 versus 12 weeks)?

The Power of Girls Reading Camps: Exploring the impact of radio lessons, peer learning and targeted paper-based resources on girls' remote learning in Kenya (↑Amenya et al., 2021).

1. What can we learn about the impact of radio lessons, reading camps, and targeted paper-based resources on girls' learning (when combined or used separately)?

2. In what ways do radio lessons, reading camps, and targeted paper-based resources interact to support learning for marginalised girls?

3. How can members of the community (particularly caregivers, CHVs [Community Health Volunteers], and reading camp mentors) support girls' learning using radio, reading camps, and targeted resources?

4. How have these different interventions supported girls' approaches to learning to learn?

5. How have these different interventions impacted girls' attitudes towards learning?

Understanding Barriers to Girls' Access and Use of EdTech in Kenya During Covid-19 (↑Tembey et al., 2021).

1. Which barriers exist and are particularly hindering for girls to access EdTech, with a particular focus on non-structural barriers such as social norms / attitudes / beliefs? How can these be addressed?

   a. a. How do caregivers make decisions about encouraging the use of edutainment, smartphones, and low-tech (radio, IVR, USSD, TV) education solutions for their children? What have they found particularly valuable for encouraging girls?

   b. b. Which distribution channels are girls and women most likely to have access to in the face of Covid-19?

2. What in Ubongo's edutainment offers, in terms of content, access or usage, could be improved to better address the needs of girls and women during Covid-19?

Integration of Technology in Education for Marginalised Children in an Urban Slum of Dhaka City During the Covid-19 Pandemic (↑Islam et al., 2021).

1. What is the current state of children's educational technological devices in Korail slum to participate in education?

2. What are some of the underlying factors influencing the access children have to these devices?

Delivering Remote Learning Using a Low-Tech Solution: Evidence from an RCT during the Covid-19 pandemic (⬆Islam et al., 2022).

1. Can IRI-based audio lessons, delivered through feature phones, lead to better learning outcomes for primary graders?

2. Can IRI-based audio lessons lead to better non-cognitive outcomes for primary graders in the areas of leadership, communication, and planning skills?

3. Can IRI-based audio lessons increase students' efforts and caregiver involvement in children's educational activities?

Investigating the Impact on Learning Outcomes Through the Use of EdTech During Covid-19: Evidence from an RCT in the Punjab province of Pakistan (⬆Adil et al., 2021).

1. What were the key issues regarding access, barriers, and usage of EdTech by students during school closures?

2. What were the separate and combined effects of delivering TaRL, fortnightly assessments and digital training sessions online on student learning outcomes when it came to Urdu, English and maths?

3. What did stakeholders identify as the key barriers relating to access to technology for online learning during the school closures?

Learning from Experience: A post-Covid-19 data architecture for a resilient education data ecosystem in Sierra Leone (⬆Fab Inc., 2021).
Primary research question:

1. What lessons can be drawn from school-level changes in enrolment following Ebola, which can be applied to school reopening following Covid-19?

Secondary research questions:

1. How did enrolment change across the country? Are there any hotspots of incidence?

2. Are there any differences by gender in terms of re-enrolment following Ebola?

3. Is it possible to use these patterns, and household survey data, to predict likely areas of vulnerability going forward?

The study also looked at:

1. What is the optimum education data architecture, and what are the key initial steps to take towards building such an architecture, given Sierra Leone's context, prior experiences, and the field constraints?

2. How can we demonstrate how the Annual School Census (ASC), built with a well-planned new data architecture, can help the government in improving education planning by using existing ASC data?

3. What are the key components / datasets for this system — what exists now, what is planned for the future, and how can both be linked?